EPA-

TREATABILITY MANUAL

VOLUME I. Treatability Data

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

February 1983
(Reprinted)

PREFACE

In January, 1979, USEPA's Office of Enforcement and Office of Water and Waste Management requested help from the Office of Research and Development in compiling wastewater treatment performance data into a "Treatability Manual."

A planning group was set up to manage this activity under the chairmanship of William Cawley, Deputy Director, Industrial Environmental Research Laboratory - Cincinnati. The group includes participants from: 1) the Industrial Environmental Research Laboratory - Cincinnati; 2) Effluent Guidelines Division; 3) Office of Water Enforcement and Permits; 4) Municipal Environmental Research Laboratory - Cincinnati; 5) R.S. Kerr, Environmental Research Laboratory - Ada; 6 Industrial Environmental Research Laboratory - Research Triangle Park; 7) WAPORA, Incorporated; and 8) Burke-Hennessy Associates, Incorporated.

The objectives of this program are :

- to provide readily accessible data and information on treatability of industrial waste streams;
- to provide a basis for research planning by identifying gaps in knowledge of the treatability of certain pollutants and waste streams.

The primary output from this program is a five volume Treatability Manual. This was first published in June 1980, with revisions made in September 1981 and August 1982. This publication replaces Volume I in its entirety, and updates Volumes II, III, IV, and V. The individual volumes are named as follows:

Volume I - Treatability Data
Volume II - Industrial Descriptions
Volume III - Technologies
Volume IV - Cost Estimating (In the process of revision for later publication)
Volume V - Summary

ACKNOWLEDGEMENT

The development of this revision to the Treatability Manual has resulted from efforts of a large number of people. It is the collection of contributions from throughout the Environmental Protection Agency, particularly from the Office of Water Enforcement, Office of Water and Waste Management, and the Office of Research and Development. Equally important to its success were the efforts of the employees of WAPORA, Inc., and Burke-Hennessy Associates, Inc., who participated in this operation.

A list of names of contributors would not adequately acknowledge the effort expended in the development of the manual. This document exists because of the major contributions of numerous individuals within EPA and the EPA contractors, including:

Effluent Guidelines Division
Office of Water Regulations and Standards, Office of Water

Permits Division
Office of Water Enforcement and Permits, Office of Water

National Enforcement Investigation Center
Office of Enforcement

Office of Research and Development

Center for Environmental Research Information

Municipal Environmental Research Laboratory

Robert S. Kerr Environmental Research Laboratory

Industrial Environmental Research Laboratory
Research Triangle Park, NC

Industrial Environmental Research Laboratory
Cincinnati, OH

As Committee Chairman, I would like to express my sincere appreciation to the Committee Members and others who contributed to the success of this effort.

William A. Cawley, Deputy Director,
IERL-Ci
Chairman, Treatability Coordination Committee

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I.9.20-2	1/24/83	Reserved
I.10.1-1	12/22/82	Original
I.10.1-2	10/8/82	Original
I.10.1-3	1/24/83	Original
I.10.1-4	1/24/83	Original
I.10.1-5	1/24/83	Original
I.10.1-6	9/25/81	Original
I.10.2-1	12/22/82	Original
I.10.2-2	1/24/83	Reserved
I.10.2-3	1/24/83	Original
I.10.2-4	1/24/83	Original
I.10.2-5	1/24/83	Original
I.10.2-6	12/22/82	Original
I.10.3-1	12/22/83	Original
I.10.3-2	1/24/83	Original
I.10.3-3	1/24/83	Original
I.10.3-4	1/24/83	Original
I.10.3-5	1/24/83	Original
I.10.3-6	1/24/83	Reserved
I.10.4-1	12/22/82	Original
I.10.4-2	10/8/82	Original
I.10.4-3	1/24/83	Original
I.10.4-4	1/24/83	Original
I.10.4-5	1/24/83	Original
I.10.4-6	1/24/83	Reserved
I.10.5-1	12/22/82	Original
I.10.5-2	1/24/83	Original
I.10.5-3	1/24/83	Original
I.10.5-4	1/24/83	Original
I.10.5-5	1/24/83	Original
I.10.5-6	1/24/83	Reserved

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I.10.6-2	1/24/83	Reserved
I.10.6-3	1/24/83	Original
I.10.6-4	1/24/83	Original
I.10.6-5	1/24/83	Original
I.10.6-6	1/24/83	Reserved
I.10.7-1	12/22/82	Original
I.10.7-2	10/8/82	Original
I.10.7-3	1/24/83	Original
I.10.7-4	1/24/83	Original
I.10.8-1	12/22/82	Original
I.10.8-2	10/8/82	Original
I.10.8-3	1/24/83	Original
I.10.8-4	1/24/83	Original
I.10.8-5	1/24/83	Original
I.10.8-6	1/24/83	Reserved
I.10.9-1	12/22/82	Original
I.10.9-2	10/8/82	Original
I.10.9-3	1/24/83	Original
I.10.9-4	1/24/83	Original
I.10.9-5	1/24/83	Original
I.10.9-6	9/25/81	Original
I.10.10-1	12/22/82	Original
I.10.10-2	10/8/82	Original
I.10.10-3	1/24/83	Original
I.10.10-4	1/24/83	Original
I.10.10-5	1/24/83	Original
I.10.10-6	1/24/83	Reserved
I.10.11-1	12/22/83	Original
I.10.11-2	10/8/82	Original
I.10.11-3	1/24/83	Original
I.10.11-4	1/24/83	Original
I.10.11-5	1/24/83	Original
I.10.11-6	1/24/83	Reserved
I.10.12-1	12/22/82	Original
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I.10.13-1	12/22/83	Original
I.10.13-2	10/8/82	Original
I.10.13-3	1/24/83	Original
I.10.13-4	1/24/83	Original
I.10.13-5	1/24/83	Original
I.10.13-6	9/25/81	Original
I.10.14-1	12/22/82	Original
I.10.14-2	10/8/82	Original
I.10.14-3	1/24/83	Original
I.10.14-4	1/24/83	Original
I.10.14-5	1/24/83	Original
I.10.14-6	1/24/83	Reserved
I.10.15-1	12/22/83	Original
I.10.15-2	10/8/82	Original
I.10.15-3	1/24/83	Original
I.10.15-4	1/24/83	Original
I.10.15-5	1/24/83	Original
I.10.15-6	9/25/81	Original
I.10.16-1	12/22/82	Original
I.10.16-2	10/8/82	Original
I.10.16-3	1/24/83	Original
I.10.16-4	1/24/83	Original
I.10.16-5	1/24/83	Original
I.10.16-6	1/24/83	Reserved
I.10.17-1	12/22/82	Original
I.10.17-2	1/24/83	Reserved
I.10.17-3	1/24/83	Original
I.10.17-4	1/24/83	Original
I.10.17-5	1/24/83	Original
I.10.17-6	1/24/83	Reserved
I.11.1-1	12/22/82	Original
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I.11.2-1	12/22/82	Original
I.11.2-2	10/8/82	Original
I.11.2-3	1/24/83	Original
I.11.2-4	1/24/83	Original
I.11.2-5	1/24/83	Original
I.11.2-6	1/24/83	Reserved
I.11.3-1	12/22/82	Original
I.11.3-2	10/8/82	Original
I.11.3-3	1/24/83	Original
I.11.3-4	1/24/83	Original
I.11.3-5	1/24/83	Original
I.11.3-6	1/24/83	Reserved
I.11.4-1	12/22/82	Original
I.11.4-2	1/24/83	Reserved
I.11.4-3	1/24/83	Original
I.11.4-4	1/24/83	Original
I.11.4-5	1/24/83	Original
I.11.4-6	1/24/83	Reserved
I.11.5-1	12/22/82	Original
I.11.5-2	1/24/83	Reserved
I.11.5-3	1/24/83	Original
I.11.5-4	1/24/83	Original
I.11.5-5	1/24/83	Original
I.11.5-6	1/24/83	Reserved
I.11.6-1	12/22/82	Original
I.11.6-2	1/24/83	Original
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I.11.6-6	1/24/83	Reserved
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I.12.1-1	12/22/82	Original
I.12.1-2	1/24/83	Reserved
I.12.1-3	1/24/83	Original
I.12.1-4	1/24/83	Original
I.12.1-5	1/24/83	Original
I.12.1-6	1/24/83	Reserved
I.12.2-1	12/22/82	Original
I.12.2-2	10/8/82	Original
I.12.2-3	1/24/83	Original
I.12.2-4	1/24/83	Original
I.12.2-5	1/24/83	Original
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I.12.3-4	1/24/83	Original
I.12.3-5	1/24/83	Original
I.12.3-6	12/22/82	Original
I.12.4-1	12/22/82	Original
I.12.4-2	1/24/83	Original
I.12.4-3	1/24/83	Original
I.12.4-4	1/24/83	Original
I.12.4-5	1/24/83	Original
I.12.4-6	12/22/82	Original
I.12.5-1	12/22/82	Original
I.12.5-2	10/8/82	Original
I.12.5-3	1/24/83	Original
I.12.5-4	1/24/83	Original
I.12.5-5	1/24/83	Original
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I.12.6-5	1/24/83	Original
I.12.6-6	1/24/83	Reserved
I.12.7-1	12/22/82	Original
I.12.7-2	10/8/82	Original
I.12.7-3	1/24/83	Original
I.12.7-4	1/24/83	Original
I.12.7-5	1/24/83	Original
I.12.7-6	1/24/83	Reserved
I.12.8-1	12/22/82	Original
I.12.8-2	1/24/83	Original
I.12.8-3	1/24/83	Original
I.12.8-4	1/24/83	Original
I.12.8-5	1/24/83	Original
I.12.8-6	1/24/83	Reserved
I.12.9-1	12/22/82	Original
I.12.9-2	1/24/83	Original
I.12.9-3	1/24/83	Orignal
I.12.9-4	1/24/83	Reserved
I.12.9-5	1/24/83	Original
I.12.9-6	1/24/83	Reserved
I.12.10-1	12/22/82	Original
I.12.10-2	1/24/83	Original
I.12.10-3	1/24/83	Original
I.12.10-4	1/24/83	Reserved
I.12.10-5	1/24/83	Original
I.12.10-6	1/24/83	Reserved
I.12.11-1	12/22/82	Original
I.12.11-2	10/8/82	Original
I.12.11-3	1/24/83	Original
I.12.11-4	1/24/83	Original
I.12.12-1	12/22/82	Original
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I.12.13-1	12/22/82	Original
I.12.13-2	10/8/82	Original
I.12.13-3	1/24/83	Original
I.12.13-4	1/24/83	Original
I.12.13-5	1/24/83	Original
I.12.13-6	9/25/81	Original
I.12.14-1	12/22/82	Original
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I.12.14-3	1/24/83	Original
I.12.14-4	1/24/83	Original
I.12.14-5	1/24/83	Original
I.12.14-6	9/25/81	Original
I.12.15-1	12/22/83	Original
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I.12.15-3	1/24/83	Original
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I.12.16-1	12/22/82	Original
I.12.16-2	10/8/82	Original
I.12.16-3	1/24/83	Original
I.12.16-4	1/24/83	Original
I.12.16-5	1/24/83	Reserved
I.12.16-6	9/25/81	Original
I.12.17-1	12/2/82	Original
I.12.17-2	1/24/83	Reserved
I.12.17-3	1/24/83	Original
I.12.17-4	1/24/83	Original
I.12.18-1	12/22/82	Original
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I.12.19-4	1/24/83	Original
I.12.19-5	1/24/83	Original
I.12.19-6	1/24/83	Reserved
I.12.20-1	12/22/82	Original
I.12.20-2	1/24/83	Original
I.12.20-3	1/24/83	Original
I.12.20-4	1/24/83	Original
I.12.20-5	1/24/83	Original
I.12.20-6	1/24/83	Reserved
I.12.21-1	12/22/82	Original
I.12.21-2	1/24/83	Reserved
I.12.21-3	1/24/83	Original
I.12.21-4	1/24/83	Original
I.12.22-1	12/22/82	Original
I.12.22-2	10/8/82	Original
I.12.22-3	1/24/83	Original
I.12.22-4	1/24/83	Original
I.12.22-5	1/24/83	Original
I.12.22-6	1/24/83	Reserved
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I.12.23-2	1/24/83	Original
I.12.23-3	1/24/83	Original
I.12.23-4	1/24/83	Original
I.12.23-5	1/24/83	Original
I.12.23-6	12/22/82	Original
I.12.24-1	12/22/82	Original
I.12.24-2	10/8/82	Original
I.12.24-3	1/24/83	Original
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I.12.25-5	1/24/83	Original
I.12.25-6	1/24/83	Reserved
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I.12.26-3	1/24/83	Original
I.12.26-4	1/24/83	Original
I.12.26-5	1/24/83	Original
I.12.26-6	12/22/82	Original
I.12.27-1	12/22/82	Original
I.12.27-2	1/24/83	Reserved
I.12.28-1	10/8/82	Original
I.12.28-2	1/24/83	Reserved
I.12.29-1	10/8/82	Original
I.12.29-2	1/24/83	Reserved
I.12.30-1	12/22/82	Original
I.12.30-2	1/24/83	Reserved
I.12.31-1	12/22/82	Original
I.12.31-2	1/24/83	Reserved
I.13.1-1	12/22/82	Original
I.13.1-2	10/8/82	Original
I.13.1-3	1/24/83	Original
I.13.1-4	1/24/83	Original
I.13.1-5	1/24/83	Original
I.13.1-6	9/25/81	Original
I.13.2-1	12/22/82	Original
I.13.2-2	10/8/82	Original
I.13.2-3	1/24/83	Original
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I.13.4-1	12/22/82	Original
I.13.4-2	10/8/82	Original
I.13.4-3	1/24/83	Original
I.13.4-4	1/24/83	Original
I.13.4-5	1/24/83	Original
I.13.4-6	12/22/82	Original
I.13.4-7	12/22/82	Original
I.13.4-8	12/22/82	Original
I.13.5-1	12/22/82	Original
I.13.5-2	1/24/83	Original
I.13.5-3	1/24/83	Original
I.13.5-4	1/24/83	Original
I.13.5-5	1/24/83	Original
I.13.5-6	1/24/83	Reserved
I.13.6-1	12/22/83	Original
I..13.6-2	1/24/83	Reserved
I.13.6-3	1/24/83	Original
I.13.6-4	1/24/83	Original
I.13.7-1	12/22/82	Original
I.13.7-2	10/8/82	Original
I.13.7-3	1/24/83	Original
I.13.7-4	1/24/83	Original
I.13.7-5	1/24/83	Original
I.13.7-6	1/24/83	Reserved
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I.13.8-3	1/24/83	Original
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I.13.8-5	1/24/83	Reserved
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I.13.10-1	12/22/82	Original
I.13.10-2	10/8/82	Original
I.13.10-3	1/24/83	Original
I.13.10-4	1/24/83	Original
I.13.10-5	1/24/83	Original
I.13.10-6	1/24/83	Reserved
I.13.11-1	12/22/82	Original
I.13.11-2	10/8/82	Original
I.13.11-3	1/24/83	Original
I.13.11-4	1/24/83	Original
I.13.11-5	1/24/83	Original
I.13.11-6	9/25/81	Original
I.13.11-7	12/22/82	Original
I.13.12-1	12/22/82	Original
I.13.12-2	10/8/82	Original
I.13.12-3	1/24/83	Original
I.13.12-4	1/24/83	Original
I.13.13-1	12/22/82	Original
I.13.13-2	10/8/82	Original
I.13.13-3	1/24/83	Original
I.13.13-4	1/24/83	Original
I.13.13-5	1/24/83	Reserved
I.13.13-6	12/22/82	Original
I.13.14-1	10/8/82	Original
I.13.14-2	1/24/83	Reserved
I.13.15-1	10/8/82	Original
I.13.15-2	1/24/83	Reserved
I.13.16-1	10/8/82	Original
I.13.16-2	1/24/83	Reserved
I.13.17-1	10/8/82	Original
I.13.17-2	1/24/83	Reserved

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I.13.19-3	1/24/83	Original
I.13.19-4	1/24/83	Original
I.13.19-5	1/24/83	Original
I.13.19-6	1/24/83	Reserved
I.13.20-1	12/22/82	Original
I.13.20-2	1/24/83	Original
I.13.20-3	1/24/83	Original
I.13.20-4	1/24/83	Original
I.13.20-5	1/24/83	Original
I.13.20-6	12/22/82	Original
I.13.21-1	12/22/82	Original
I.13.21-2	10/8/82	Original
I.13.21-3	1/24/83	Original
I.13.21-4	1/24/83	Original
I.13.22-1	10/8/82	Original
I.13.22-2	1/24/83	Reserved
I.13.23-1	10/8/82	Original
I.13.23-2	1/24/83	Reserved
I.13.24-1	12/22/82	Original
I.13.24-2	1/24/83	Original
I.13.24-3	1/24/83	Original
I.13.24-4	1/24/83	Orignal
I.13.24-5	1/24/83	Original
I.13.24-6	12/22/82	Original
I.13.25-1	12/22/82	Original
I.13.25-2	1/24/83	Reserved
I.13.25-3	1/24/83	Original
I.13.25-4	1/24/83	Original
I.13.25-5	1/24/83	Reserved
I.13.25-6	12/22/82	Original

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I.13.27-2	1/24/83	Reserved
I.13.28-1	10/8/82	Original
I.13.28-2	1/24/83	Reserved
I.13.29-1	10/8/82	Original
I.13.29-2	1/24/83	Reserved
I.13.30-1	10/8/82	Original
I.13.30-2	1/24/83	Reserved
I.13.31-1	10/8/82	Original
I.13.31-2	1/24/83	Reserved
I.13.32-1	10/8/82	Original
I.13.32-2	1/24/83	Reserved
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I.13.33-2	1/24/83	Original
I.13.34-1	10/8/82	Original
I.13.34-2	1/24/83	Original
I.13.35-1	10/8/82	Original
I.13.35-2	1/24/83	Reserved
I.13.36-1	10/8/82	Original
I.13.36-2	1/24/83	Reserved
I.13.37-1	10/8/82	Original
I.13.37-2	1/24/83	Reserved
I.13.38-1	10/8/82	Original
I.13.38-2	1/24/83	Reserved
I.13.39-1	10/8/82	Original
I.13.39-2	1/24/83	Reserved

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I.13.41-2	1/24/83	Reserved
I.13.42-1	10/8/82	Original
I.13.42-2	1/24/83	Reserved
I.13.43-1	10/8/82	Original
I.13.43-2	1/24/83	Reserved
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I.14.1-2	1/24/83	Original
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I.1 INTRODUCTION

Volume I is a compendium of treatability data for specific compounds. It is the first of a five volume set on industrial wastewater treatability. Volume II is a collection of industrial wastewater discharge information and includes data for both raw and treated wastewaters. Volume III is a compilation of available performance data for existing wastewater treatment technologies. Volume IV is being revised to include cost data for the treatment technologies described in Volume III. Volume V is an executive summary and describes the methods used in preparing the data in Volumes I, II, and III. The information contained in this manual was obtained from the open literature, government publications, on-going Office of Research and Development (ORD) treatability studies, equipment vendors, and regional and state EPA offices.

I.1.1 VOLUME I ORGANIZATION AND CONTENTS

Volume I of the Treatability Manual supplies data on specific compounds. It is intended to provide facile reference to physical data on the pollutants, their occurrence patterns, and methods of treatment and/or removal. The compound data are reported as presented in the source or as an abstracted description of the source data. Pollutants are grouped according to the following chemical categories:

- Metals and Inorganics
- Ethers
- Phthalates
- Nitrogen Compounds
- Phenols
- Aromatics
- Polynuclear Aromatic Hydrocarbons
- PCB's and Related Compounds
- Halogenated Hydrocarbons
- Pesticides
- Oxygenated Compounds
- Miscellaneous

The three-part entry for each pollutant includes the items discussed below:

- Description of the Pure Species

This section includes information such as name, formula, alternate names, Chemical Abstracts Registry Number, molecular or atomic weight, melting and boiling points, water solubility, and vapor pressure. For organic compounds Henry's law constants, log octanol/water partition coefficients, biodegradability information, and carbon adsorption data are also presented; for metals, common ionization states and precipitation/coagulation properties are given.

A separate entry in this section summarizes current knowledge on probable fates in an aqueous medium. Processes considered in this category are photolysis, oxidation, hydrolysis, volatilization, sorption, biological processes, and other significant reactions and interactions. When literature fate data for a specific compound are inadequate or nonexistent, the fate of closely related compounds is discussed, and the data are identified as pertaining to the general class of compounds. Also, for each compound, a summary is provided of the water quality criteria as developed by USEPA persuant to Section 304 (a) (1) of the Clean Water Act.

- Industrial Occurrence Data

Wastewater pollutant summaries are presented in tabular form for each industrial category in which the chemical substance has been detected. Where testing has indicated that the pollutant does not occur in the industrial category, this is indicated. The minimum, maximum, and average concentrations are reported for both untreated and treated wastewater. The number of samples and detections used as the basis for the reported concentrations also are indicated. This information is developed based on criteria summarized in Table 1-1. Volume II includes more specific information regarding waste streams for each industry.

- Pollutant Treatability/Removability

For each alternative standard treatment process, removal ranges and median concentrations for the compounds of interest are presented for actual wastewater samples, where appropriate data are available. The criteria for presenting these data are included in Table 1-1. Cross references to the Volume III technology sections, where these data are presented in more detail, are given in the compound sections.

TABLE 1-1. CRITERIA FOR DEVELOPING DATA PRESENTATION IN VOLUME I, TREATABILITY MANUAL

Sources of Data

1. Data in Volume I describing compound properties are developed from the references cited on the respective sheets and summarized in Section I.16.

2. Data in Volume I describing the concentrations reported in raw wastewater are developed from data presented in the industry specific development documents and engineering reports. The source document data for these sheets included industry summary data, subcategory summary data, and plant specific data. Industry summary data are presented in the following: Coal Mining, Ore Mining and Dressing, and Textile Mills. Subcategory summary data are presented in the following industries: Metal Finishing, Porcelain Enameling, Photographic Equipment and Supplies, Coil Coating, Pulp and Paperboard Mills, Battery Manufacturing, Nonferrous Metals Manufacturing, Organic Chemicals and Plastics and Synthetic Resins, Leather Tanning and Finishing, and Soap and Detergent. The majority of the industries have plant specific data referenced: Steam Electric Power Plants, Iron and Steel Manufacturing, Rubber Processing, Auto and Other Laundries, Petroleum Refining, Timber Products Processing, Gum and Wood Chemicals, Paint and Ink Formulation, Pharmaceutical Manufacturing, Foundries, Explosives Manufacturing, Inorganic Chemicals Manufacturing, Electrical and Electronic Components, and Aluminum Forming.

3. Data in Volume I describing the concentrations reported in treated wastewater are developed from data presented in development documents and engineering reports. The source document data for these sheets included industry summary data, subcategory summary data, and plant specific data. Industry summary data are presented in the following: Coal Mining, Ore Mining and Dressing, and Textile Mills. Subcategory summary data are presented in the following industries: Photographic Equipment and Supplies, Pulp and Paperboard Mills, Nonferrous Metals Manufacturing, Organic Chemicals and Plastics and Synthetic Resins, and Leather Tanning and Finishing. The majority of the industries have plant specific data referenced including: Inorganic Chemicals Manufacturing, Aluminum Forming, Metal Finishing, Porcelain Enameling, Coil Coating, Steam Electric Power Plants, Iron and Steel Manufacturing, Rubber Processing, Auto and Other Laundries, Petroleum Refining, Timber Products Processing, Gum and Wood Chemicals, Paint and Ink Formulation, Pharmaceutical Manufacturing, and Foundries. Treated data are not available for Soap and Detergent Manufacturing, Explosives Manufacturing, Electrical and Electronic Components, and Battery Manufacturing.

4. Data in Volume I describing pollutant removability are developed from the data presented in Volume III of the Treatability Manual.

TABLE 1-1. CRITERIA FOR DEVELOPING DATA PRESENTATION IN VOLUME I, TREATABILITY MANUAL (continued)

5. Data in Volume I describing water quality criteria are developed from the references cited.

Reliability of Data

1. The data selected for inclusion in Volume I were developed using analytic protocols designed to confirm the presence of the compound in the wastewater matrix and to quantify the amount present. Data collected using a protocol designed to indicate only presence or absence of a compound (i.e., the so-called screening protocols) are not included in Volume I, except as noted on each table.

2. The sampling and analytic protocols for all data presented in Volumes II and III of the Manual are identified in Volume V, Section 7.

Interpretation of Data

1. The standard general rules used to interpret the industry summary, subcategory summary, and plant specific data available in the reference sources for developing the Volume I sheets (raw and treated wastewater) are presented below.

    a. Two significant figures (in µg/L), rounded to the nearest even number, are used for presentation and computation.

    b. The full value of the pollutant specific detection limit is assumed for computation and presentation where the source document gives data as BDL, below detection limit.

    c. Industry summary data are presented as given in the source, with no interpretation or calculation.

    d. Subcategory summary data are compiled into one data summary for Volume I. The number of samples for all subcategories are summed as are the number of detections. The minimum value is determined as the lowest detected value of all subcategories. The maximum value is the highest detected value of all subcategories. The mean is determined by averaging the means representative of all subcategories. This is calculated as the sum of subcategory means divided by the number of mean values (excluding zero or not detected).

    e. Plant specific data are presented as the minimum, maximum, and mean concentrations based on detections unless otherwise noted. If there are no detections, values are not given for minimum, maximum, and mean. If there is only one detection, the value is given as the maximum.

TABLE 1-1. CRITERIA FOR DEVELOPING DATA PRESENTATION IN VOLUME I, TREATABILITY MANUAL (continued)

Number of samples equals the number of data points including those in which a pollutant was not detected (ND). Following the convention in the majority of source documents, a 3-day sampling episodes at one plant is averaged and presented as one data point.

Number of detections equals the number of data points above zero including those values that are reported as below detection levels (BDL), but excluding those values reported as not detected (ND).

Minimum of detections equals the lowest detected value greater than zero or not detected (ND).

Maximum of detections equals the highest detected value reported.

Mean of detections is calculated as the sum of all data points (except zero and ND) divided by the number of detections. (Example: three values ND, 4, and 12; mean equals 8).

2. Exceptions to the general rules listed above for the raw and treated wastewater sheets are as follows:

   a. Pulp and Paperboard Mills, Metal Finishing, Battery Manufacturing, and Nonferrous Metals Manufacturing - minimum, maximum, and mean are based on number of samples, rather than number of detections.

   b. Battery Manufacturing - minimum, maximum, and mean are based on samples, rather than detections. Reference cites "ND" and "0.0" for samples. ND has been interpreted as not detected, with a numerical value of zero. The "0.0" is reported by the reference to be from zero to 0.005, and has been interpreted as 0.005 for these summaries, and has been included as a detection.

   c. Nonferrous Metals Manufacturing - metals data in reference represent flow weighted averages of individual waste streams per plant. Organics represent subcategory summary data with the minimum, maximum, and mean based on samples, rather than detections. The reference reports as "detections" only organic compounds measured at concentrations > 10 µg/L, although the minimum, maximum, and mean are computed using numerical values less than this level. Therefore, number of detections reported in Volume I represent detections > 10 µg/L.

   d. Paint and Ink Formulation - reference data represent averages of batch samples per plant, calculated as the sum of batch values divided by the number of batch runs (including ND; not including "not run"). The number of samples equals the number of batch averages, including ND. The number of detections equals the number of batch averages, not including ND.

TABLE 1-1. CRITERIA FOR DEVELOPING DATA PRESENTATION IN VOLUME I, TREATABILITY MANUAL (continued)

e. Organic Chemicals and Plastics and Synthetic Resins - reference does not present data for the minimum, maximum, and number of detections. The raw and treated wastewater tables reflect this with NA, not available.

f. Ore Mining and Dressing - reference does not present data for the minimum value. The table reflects this with NA, not available.

g. Pharmaceutical Manufacturing - plant data in the reference are represented as a range. The plant minimum and maximum values are averaged to compute the summary data for Volume I.

h. Coil Coating - data are presented in the reference by subcategory. The reference treats "*" (BDL = <10 µg/L) as a detection, but in the averaging process equates "*" to zero. Since the raw plant data are not given, "*" can not be recalculated. Volume I is based on "*" as equal to zero (0.0) for the minimum, maximum, and mean calculations.

   However, ND is distinguished from zero (0.0) so that ND is excluded from the minimum, maximum, and mean.

3. The pollutant removability data in Volume I are based on the data presented in Volume III. The median effluent concentration is based on the values reported in the Technology Data Sheets for all full-scale or pilot-scale systems. Percent removals are calculated for Volume III according to the following rules:

   a) If influent is a number and effluent is an inequality, the percent removal is presented as an inequality.

   b) If influent is "X" and effluent is "<X", the percent removal is not meaningful (NM).

   c) If influent is "<X" and effluent is "X", the percent removal is "NM".

   d) If influent is "<X" and effluent is "<X", the percent removal is NM.

   e) If influent is "X" and effluent is ND, percent removal is >99.

   f) If influent is ND and effluent is ND, percent removal is NM.

   g) If influent is BDL and effluent is ND, percent removal is NM.

   h) If influent is BDL and effluent is BDL, percent removal is NM.

   i) If influent is "X" and effluent is BDL, percent removal is calculated with BDL equal to one-half the detection limit. An asterisk denotes this as an approximate value.

TABLE 1-1. CRITERIA FOR DEVELOPING DATA PRESENTATION IN VOLUME I, TREATABILITY MANUAL (concluded)

j) Average percent removal for several treatment plants is calculated as follows:

<u>example</u>: <0% and 50%: mean removal = 25%
(<0 removal is considered to be 0 removal)

<u>example</u>: >0% and >50%: mean removal = >25%

k) Not meaningful (NM) is not reported in the range of removal column, except when all data are presented as being not meaningful.

I.1.2 PHYSICAL AND CHEMICAL PROPERTIES DATA

Physical/chemical data presented in this volume are useful in predicting environmental fate or probable effectiveness of alternative treatment approaches. A brief description of the presentation and utility of individual parameters follows.

I.1.2.1 Henry's Law Constant

Henry's law constant is the relative equilibrium concentration of a compound in air and water at a constant temperature and is defined by the following equation:

$$K = \frac{P}{S}$$

where

K = Henry's law constant, m^3 atm mol^{-1}

P = compound's vapor pressure in atmospheres

S = compound's solubility in water in moles per cubic meter

The constant is an expression of the equilibrium distribution of a compound between air and water. The constant indicates qualitatively the volatility of a compound and is frequently used in equations that attempt to predict "stripping" of a compound from aqueous solution. Increasing values of the constant favor volatilization as a fate mechanism and indicate amenability to steam or air stripping. Reported constants in this manual are measured values unless noted differently.

I.1.2.2 Log Octanol/Water Partition Coefficient

The log octanol/water partition coefficient or log P is the equilibrium distribution of a compound between two immiscible solvents, n-octanol and water. It is defined by the following equation:

$$\text{Log } P = \text{Log } \frac{C_{A,O}}{C_{A,H_2O}}$$

where

$C_{A,O}$ = concentration of compound in n-octanol phase

C_{A,H_2O} = concentration of compound in water phase

Log P varies with temperature. The temperature of determination is assumed to be 25°C, although in many cases the temperature and method of determination are not known.

Log P measures the affinity of a compound for octanol and water phases. It is a useful parameter for predicting the bioconcentration potential of compounds and sorption of compounds by organic soils where experimental values are not available. It is also used to determine the applicability of solvent extraction as a treatment alternative. Increasing values favor strong bioaccumulation, adsorption, and solvent extraction potentials.

I.1.2.3 Carbon Adsorption Data

Batch equilibrium carbon adsorption isotherm data can be used to estimate the relative effectiveness of carbon in adsorbing organic compounds. The adsorption isotherm is the relationship, at a given temperature and other conditions, between the amounts of a substance adsorbed and its equilibrium concentrations remaining in solution.

Carbon adsorption data can be plotted according to the Freundlich equation. This is an empirical equation that is widely used and has been found to describe adequately the adsorption process in dilute solution. The Freundlich equation has the form:

$$\frac{X}{M} = KC_f^{1/n}$$

Data can be fitted to the logarithmic form of the above equation, which has the form:

$$\log \frac{X}{M} = \log K + 1/n \log C_f$$

where

$X = C_o - C_f$ = initial concentration of solute minus final concentration of solute in solution at equilibrium, mg/L

M = weight in grams of adsorbent (carbon) per liter

C_f = final concentration of solute in mg/L

K = intercept at $C_f = 1$ ($\log C_f = 0$)

$1/n$ = slope of the line

For dilute solutions, this equation yields a straight line with a slope of 1/n and an intercept equal to the value of K when $C_f = 1$ ($\log C_f = 0$). The intercept is roughly an indicator of adsorption capacity and the slope, 1/n, of adsorption intensity.

The concentration of compound on the carbon in equilibrium with a concentration C_f is given by the X/M value, expressed as mg compound/gram of carbon.

Figures 1 and 2 are presented to illustrate the interpretation of adsorption isotherms. In Figure 1, the isotherm for Carbon A is at a relatively high level and has only a slight slope. This means that adsorption is relatively great over the entire range of concentrations studied. The fact that the isotherm for Carbon B in Figure 1 is at a lower level indicates proportionally less adsorption, although adsorption improves at higher concentrations over that at low concentrations. An isotherm having a steep slope, Carbon C, indicates that adsorption is good at high concentrations but much less at low concentrations.

The actual pH for which the compound adsorption data were developed is shown on the data sheets. For most compounds, Calgon Corporation Filtrasorb 300 granular carbon was used unless otherwise indicated. The carbon was pulverized and screened before use in the test. For most compounds, the isotherm test was conducted at neutral pH. For those compounds where an effect is expected because of pH, the test may have been conducted at acid and/or basic pH as well as at neutral.

The adsorbability is defined as the carbon dose required to reduce a pollutant concentration from concentration a to concentration b, as for example, reduction from 10 mg/L to 1.0 mg/L. Several ranges are shown for each compound. All have been computed by using the equation of the adsorption for the specific compound. Where extrapolation beyond the experimental points occurs, it is assumed that the curve is linear over the entire range of the concentration used in the computation.

I.1.2.4 Biodegradability

Biodegradability data are based on studies in which the compounds were subjected to a specific set of controlled conditions. The biodegradability test method used in the studies was the static culture flask screening procedure of Bunch and Chambers, using BOD dilution water containing 5 mg yeast extract per liter as the synthetic medium, 5 and 10 mg/L concentrations of the test compound, a 7-day static incubation at 25°C in the dark, followed by 3 weekly subcultures (totaling 28 days of incubation) and incorporating settled domestic wastewater as microbial inoculum [1-57, 60, 61, 62, 63].

For experimental purposes the compounds were divided into the following classes of organic compounds:

Phenols
Phthalate Esters
Naphthalenes

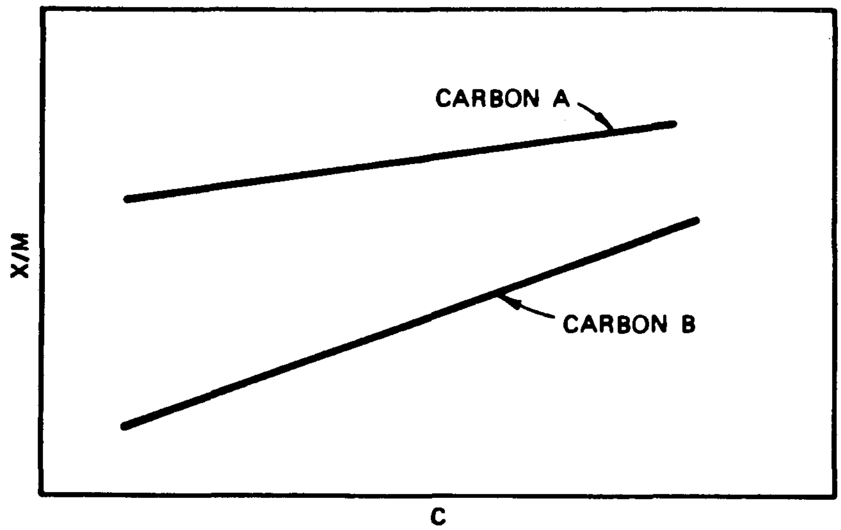


Figure 1. Adsorption isotherm, Carbon A and B.

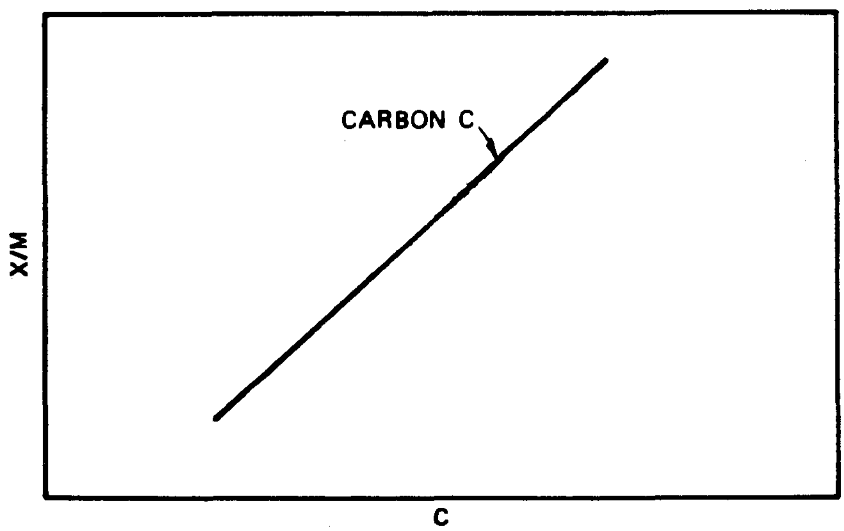


Figure 2. Adsorption isotherm, Carbon C.

Monocyclic Aromatics
Polycyclic Aromatics
Polychlorinated Biphenyls
Halogenated Ethers
Nitrogenous Organics
Halogenated Aliphatics
Organochlorine Insecticides

For each class of compounds, differing methods were used to obtain solution. For the more insoluble compounds, an emulsion, rather than a solution was used. Initial and final concentrations of the compounds were determined by gas chromatography.

A schematic of the test procedure is shown in Figure 3. Initial concentrations of compounds were determined in duplicate. Final concentrations, after each 7 days' incubation period, were determined in triplicate. Microbial cultures were transferred successively to each subsequent subculture thus permitting an assessment of microbial adaptation or in some instances toxicity. Replicate analyses were averaged and the biodegradability of each compound was described according to the following qualitative classification.

D - Significant degradation
> 80% degradation in initial culture and in all subsequent subcultures

A - Significant degradation, gradual adaptation
20-80% degradation in initial culture followed by increasing percent degradation in subsequent subcultures

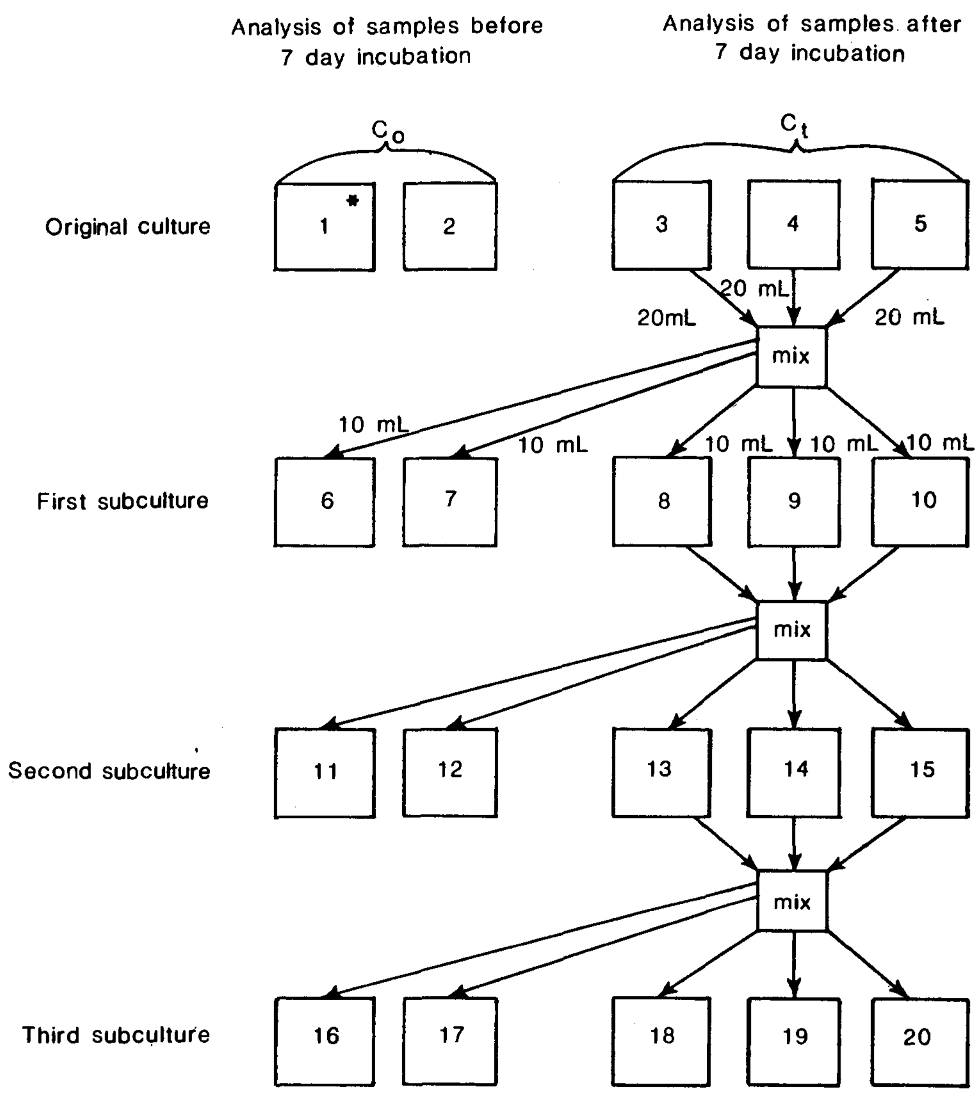
N - Not significantly degraded
< 50% degradation in all cultures with fairly uniform percent degradation in subsequent cultures

T - Significant degradation in initial culture but decreasing in subsequent subculture indicating possible toxicity.

For compounds marked 'volatile' there is some uncertainty about the biodegradability as determined by this screening test. Loss of compound may thus be due to biodegradability and/or volatility. However, control flasks were used where necessary to characterize removal by volatility alone in order to aid in the interpretation of the mechanism of compound removal.

While the tests were performed on 5 mg/L and 10 mg/L concentrations of each compound, only the results for the 5 mg/L concentration are shown. Information is also provided in those instances where 10 mg/L concentrations are shown to be toxic.

Figure 3. Static culture flask biodegradability protocol.



Flow chart using specific analysis for test compound

C_o - average concentration of test compound from 2 flasks or bottles analyzed before incubation
C_t - average concentration of test compound from 3 flasks or bottles analyzed after incubation
* - numerical designation of culture flask or bottle used in the biodegradability test

I.1.2.5 Metal Precipitation/Coagulation Properties

Removal curves are given to illustrate the effect of chemical coagulation on metals removal. Percent removal of metal is plotted as a function of pH of the treated water for each coagulant (lime softening, alum, ferric sulfate, and/or ferrous sulfate) with available data. Data describing initial compound concentration and the coagulant dose are presented in summary form. The actual test protocol is described in the reference cited.

I.1.2.6 Environmental Occurrence of Metals

In the following sections on physical and chemical properties of metals and certain inorganics, it is important to note that the metallic form of the metal, rarely if ever, is of concern in the aqueous environment, largely because of the extreme aqueous insolubility of the metal. Most metals, however, can and do react to form a variety of salts and oxides which are soluble. It is these salt and oxide compounds which can exert adverse environmental impacts.

Certain metals can be transformed to organic complexes directly via microbial interactions and metals may also be present in the aqueous environment via adsorption on clay particles or inorganic precipitates.

I.1.3 INDUSTRIAL OCCURRENCE AND TREATABILITY/REMOVABILITY DATA

Summary tables for each chemical substance are included in Sections I.4 through I.15, where there are data available on the industrial occurrence in the raw or treated wastewater, or for the treatability/removability of the chemical substance. Table 1-2 indicates the chemical compounds that have no data for these summary tables, which therefore are not included in this Volume.

TABLE 1-2. CHEMICAL COMPOUNDS FOR WHICH NO INDUSTRIAL OCCURRENCE OR REMOVABILITY DATA ARE PRESENTED

Page 2's: Industrial Occurrence, Raw Wastewater

- Butylamine
- Diethylamine
- Ethylenediamine
- Monoethylamine
- Monomethylamine
- Triethylamine
- Trimethylamine
- Aniline
- Benzoic acid
- Benzyl chloride
- Styrene
- Quinoline
- Nitrotoluene
- Naphthenic acid
- Allyl chloride
- 2,2-Dichloropropionic acid
- Phosgene
- Ethylene dibromide
- Epichlorohydrin
- Kelthane
- Naled
- Dichlone
- Kepone
- Diuron
- Carbofuran
- Mercaptodimethur
- Captan
- Carbaryl
- Coumaphos
- Diazinon
- Dicamba
- Dichlobenil
- Malathion
- Methyl parathion
- Parathion
- Guthion
- Ethion
- Isoprene
- Chlorpyrifos
- Dichlorvos
- Diquat
- Disulfoton
- Mevinphos
- Mexacarbate
- Trichlorfon
- Propargite
- Carbon disulfide
- Acetaldehyde
- Acetic acid
- Allyl alcohol
- Amyl acetate
- n-Butyl acetate
- Butyric acid
- Formaldehyde
- Formic acid
- Fumaric acid
- Maleic acid
- Methyl methacrylate
- Propionic acid
- Vinyl acetate
- Adipic acid
- Crotonaldehyde
- Furfural
- Propylene oxide
- Methyl mercaptan
- Dodecyl benzenesulfonic acid
- Cyclohexane
- Strychnine
- Zinc phenol sulfonate

TABLE 1-2. CHEMICAL COMPOUNDS FOR WHICH NO INDUSTRIAL OCCURRENCE OR REMOVABILITY DATA ARE PRESENTED

Page 3's: Industrial Occurrence, Treated Wastewater

- Butylamine
- Diethylamine
- Ethylenediamine
- Monoethylamine
- Monomethylamine
- Triethylamine
- Trimethylamine
- Aniline
- Benzoic acid
- Benzyl chloride
- Styrene
- Quinoline
- Nitrotoluene
- Naphthenic acid
- Allyl chloride
- 2,2-Dichloropropionic acid
- Phosgene
- Ethylene dibromide
- Epichlorohydrin
- Kelthane
- Naled
- Dichlone
- Kepone
- Diuron
- Carbofuran
- Mercaptodimethur
- Captan
- Carbaryl
- Coumaphos
- Diazinon
- Dicamba
- Dichlobenil
- Malathion
- Methyl parathion
- Parathion
- Guthion
- Ethion
- Isoprene
- Chlorpyrifos
- Dichlorvos
- Diquat
- Disulfoton
- Mevinphos
- Mexacarbate
- Trichlorfon
- Propargite
- Carbon disulfide
- Acetaldehyde
- Acetic acid
- Allyl alcohol
- Amyl acetate
- n-Butyl acetate
- Butyric acid
- Formaldehyde
- Formic acid
- Fumaric acid
- Maleic acid
- Methyl methacrylate
- Propionic acid
- Vinyl acetate
- Adipic acid
- Crotonaldehyde
- Furfural
- Propylene oxide
- Methyl mercaptan
- Dodecyl benzenesulfonic acid
- Cyclohexane
- Strychnine
- Zinc phenol sulfonate

TABLE 1-2. CHEMICAL COMPOUNDS FOR WHICH NO INDUSTRIAL OCCURRENCE OR REMOVABILITY DATA ARE PRESENTED (CONTINUED)

Page 4's: Pollutant Removability

- Bis(2-chloroethyl) ether
- Bis(2-chloroisopropyl) ether
- 2-Chloroethyl vinyl ether
- 4-Chlorophenyl phenyl ether
- 4-Bromophenyl phenyl ether
- Bis(2-chloroethoxy)methane
- Butylamine
- Diethylamine
- Ethylenediamine
- Monoethylamine
- Monomethylamine
- Triethylamine
- Trimethylamine
- 3,3'-Dichlorobenzidine
- Acrylonitrile
- Resorcinol
- Aniline
- Benzoic acid
- Benzyl chloride
- Quinoline
- Nitrotoluene
- Dibenzo(a,h)anthracene
- Naphthenic acid
- Hexachloroethane
- Hexachlorobutadiene
- Methyl bromide
- Dichlorodifluoromethane
- Allyl chloride
- 2,2-Dichloropropionic acid
- Phosgene
- Ethylene dibromide
- Epichlorohydrin
- Endosulfan sulfate
- β-Endosulfan
- δ-BHC
- Aldrin
- Dieldrin
- 4,4'-DDD
- Endrin
- Kelthane
- Naled
- Dichlone
- Kepone
- Diuron
- Heptachlor epoxide
- Carbofuran
- Mercaptodimethur
- Toxaphene
- Captan
- Carbaryl
- Coumaphos
- Diazinon
- Dicamba
- Dichlobenil
- Malathion
- Methyl parathion
- Parathion
- Guthion
- Ethion
- Isoprene
- Chlorpyrifos
- Dichlorvos
- Diquat
- Disulfoton
- Mevinphos
- Mexacarbate
- Trichlorfon
- Propargite
- Carbon disulfide
- Allyl alcohol
- Amyl acetate
- n-Butyl acetate
- Butyric acid
- Fumaric acid
- Maleic acid
- Methyl methacrylate
- Vinyl acetate
- Adipic acid
- Crotonaldehyde
- Furfural
- Propylene oxide
- Methyl mercaptan
- Dodecyl benzenesulfonic acid
- Cyclohexane
- Strychnine
- 2,3,7,8-Tetrachlorodibenzo-p-dioxin
- Zinc phenol sulfonate

I.2 POLLUTANT SELECTION

Pollutants selected for study in Volume I of the wastewater treatability manual are taken from the list of 299 compounds considered in Section 311 of the Water Pollution Control Act. Selection for inclusion in Volume I was based on a consideration of pollutant toxicity and stability in an aqueous environment. Of the 299 compounds initially considered, 129 had been designated as Toxic (Priority) Pollutants by the EPA and were included for study. (Although the pollutants dichlorodifluoromethane, trichlorofluoromethane, and bis(chloromethyl)ether have been delisted from the EPA priority pollutant list, they have been retained in Volume I). Ninety-seven of the remaining pollutants were found to dissociate, volatilize, or otherwise degrade readily in an aqueous environment and were not considered. This left 73 pollutants that did not readily degrade or disappear from an aqueous environment. These were added to the list of 129 toxic pollutants to make a total of 202 included for study in Volume I. Other pollutants will be added for study as time and data availability permit.

In addition, a number of conventional or classical water pollutants not addressed in Volume I are covered in Volumes II and III. These are listed below.

- Total suspended solids
- Total volatile solids
- Total dissolved solids
- Total solids
- Volatile suspended solids
- Total kjeldahl nitrogen
- Chemical oxygen demand
- Biochemical oxygen demand
- Oil and grease
- Total phosphorus
- Phosphate phosphorus
- Total organic chlorine
- Total organic carbon
- Fluoride
- Aluminum
- Manganese
- Vanadium
- Barium
- Iron
- Tin
- Titanium
- Hexavalent chromium
- Sulfite
- Chloride
- Bismuth
- Thiocyanate
- Potassium
- Silica
- Calcium
- Magnesium
- Sodium
- Molybdenum
- Cobalt
- Tellurium
- Palladium
- Gold
- Yttrium
- Osmium
- Iridium
- Rhodium
- Platinum
- Boron
- Sulfides
- Ammonia
- Ammonia nitrogen
- Nitrate nitrogen
- Strontium
- Nitrate
- Radium
- Radium, dissolved
- Silicon
- Strontium

Compound: Antimony

Formula: Sb

Alternate Names [1-1]: Antimony black;

CAS #: 7440-36-0

Physical, Chemical, and Biological Properties [1-2, 1-3, 1-4]:

atomic weight: 121.8
melting point, °C: 630
boiling point (760 torr), °C: 1,380
vapor pressure (25°C), torr: negligible
solubility in water, mg/L: Antimonic acid and antimony oxides are very slightly soluble
common oxidation states: cations - +5, +3; anion - -3
water quality criteria: See page I.4.1-5

Probable Fate [1-2]:

photolysis: Not important under natural conditions (<100°C)

oxidation: Present as soluble oxide or antimonite salts under natural redox conditions

hydrolysis: Oxide or antimonic acid formed by hydrolysis

volatilization: Not important under natural redox conditions

sorption: Adsorbed to clays; coprecipitates with iron and aluminum compounds

biological processes: Slight bioaccumulation and probable biomethylation

other reactions/interactions: Not important

Precipitation/Coagulation Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF ANTIMONY

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	38	38	2.5	2,400	<190
Coal Mining (b)	103	45	1.0	240	40
Inorganic Chemicals Manufacturing (b)	41	41	0.4	7,700	360
Iron and Steel Manufacturing (a)	30	29	<1.0	4,200	<150
Aluminum Forming	1	1		<100	
Battery Manufacturing (g) (h)	51	4	ND	190	4.3
Electrical/Electronic Components (c)	26	25	0.7	190	<15
Foundries	21	7	30	3,400	1,100
Metal Finishing (b) (g)	217	133	ND	600	74
Photographic Equipment/Supplies (d)	54	5	1.9	220	70
Porcelain Enameling	39	16	2.0	22,000	2,900
Explosives Manufacturing	6	1		350	
Pharmaceutical Manufacturing	1	1		2.0	
Nonferrous Metals Manufacturing (i)	32	32	<2.0	1.4 × 10E5	<9,500
Ore Mining and Dressing (b)	82	6	NA	100	43
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	200
Paint and Ink Formulation (c)	33	33	<10	1,500	<210
Petroleum Refining (b)	16	16	<1.0	360	<38
Soap and Detergent Manufacturing (a)	1	1		1.0	
Steam Electric Power Plants (e)	11	3	3.0	4.0	3.5
Textile Mills (b) (f)	65	47	1.0	520	41
Timber Products Processing	23	23	0.5	47	5.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ANTIMONY

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	12	11	2.5	2,200	<240
Coal Mining (b)	114	44	1.0	260	29
Inorganic Chemicals Manufacturing (b)	21	17	<2.0	<450	<150
Iron and Steel Manufacturing (a)	19	19	2.0	300	<84
Foundries	21	8	<10	400	<110
Photographic Equipment/Supplies (d)	19	6	10	770	280
Porcelain Enameling	13	9	2.0	6,500	3,100
Pharmaceutical Manufacturing	2	2	1.0	2.0	1.5
Nonferrous Metals Manufacturing (g)	34	34	0.5	4,000	<560
Ore Mining and Dressing (b)	71	3	NA	100	34
Organic Chemicals and Plastics and Synthetic Resins	7	NA	NA	NA	190
Paint and Ink Formulation (c)	19	19	<10	<1,000	<89
Petroleum Refining (b)	17	17	<1.0	370	<39
Steam Electric Power Plants (e)	12	4	3.5	10	6.4
Textile Mills (b) (f)	83	65	1.0	870	170
Timber Products Processing	10	10	1.0	14	3.5

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ANTIMONY

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	14	1	0 - 50	1.3 - 590	
-powdered	4	1	NM	<25 - 150	
Chemical Oxidation					III.3.1.2
-ozone	2		NM	25 - 1,200	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	4	NM	<10 - <25	
-barium chloride		1	0	50	
-combined precipitants		4	NM	<25 - <25	
-lime		3	81 - >99	ND - 180	
-sodium carbonate		2	>84	<15 - 57	
-sulfide		1	71	150	
-unspecified		1	NM	<18	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	24	
-sodium sulfide		2	NM	<50 - <250	
Chemical Reduction		2	NM	3.7 - 40	III.3.1.4
Coagulation and Flocculation	2	2	51 - 81	4.0 - 120	III.3.1.5
Filtration	16	11	0 - 92*	BDL - 1,800	III.3.1.9
Flotation		9	4 - 95*	ND - 2,300	III.3.1.10
Oil Separation		1	NM	290	III.3.1.14
Reverse Osmosis	6		10 - 37	90 - 200	III.3.1.16
Sedimentation	1	18	0 - 86	BDL - 1,000	III.3.1.18
Solvent Extraction		1	NM	41	III.3.1.20
Ultrafiltration		1	NM	300	III.3.1.21
Activated Sludge		22	33 - 90	BDL - 670	III.3.2.1
Lagoons					III.3.2.2
-aerated		2	82 - >99	ND - 30	

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a)(1) of the Clean Water Act. These summaries apply to antimony.

Freshwater Aquatic Life

The available data for antimony indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 9,000 and 1,600 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Toxicity to algae occurs at concentrations as low as 610 µg/L.

Saltwater Aquatic Life

No saltwater organisms have been adequately tested with antimony, and no statement can be made concerning acute or chronic toxicity.

Human Health

For the protection of human health from the toxic properties of antimony ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 146 µg/L.

For the protection of human health from the toxic properties of antimony ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 45,000 µg/L.

Compound: Arsenic

Formula: As

Alternate Names: None

CAS #: 7440382

Physical, Chemical, and Biological Properties [1-2, 1-3]:

atomic weight: 74.9
melting point (28 atmospheres), °C: 817
boiling point (760 torr), °C: Sublimes at 613
vapor pressure (25°C), torr: Negligible
solubility in water, mg/L: As_2O_5, 1.5×10^6 at 16°C; As_2O_3, 3.7×10^4 at 20°C
common oxidation states: cations - +5, +3; anion - -3
water quality criteria: See page I.4.2-5

Probable Fate [1-2]:

photolysis: Not important

oxidation: Under reducing condition, arsenic is a stable solid; dissolved arsenic acid is present in oxygenated water

hydrolysis: Hydrolyzed to arsenious and arsenic acid forms (soluble)

volatilization: Not important under natural redox conditions

sorption: Arsenic is removed by clays, iron and manganese oxides, and aluminum

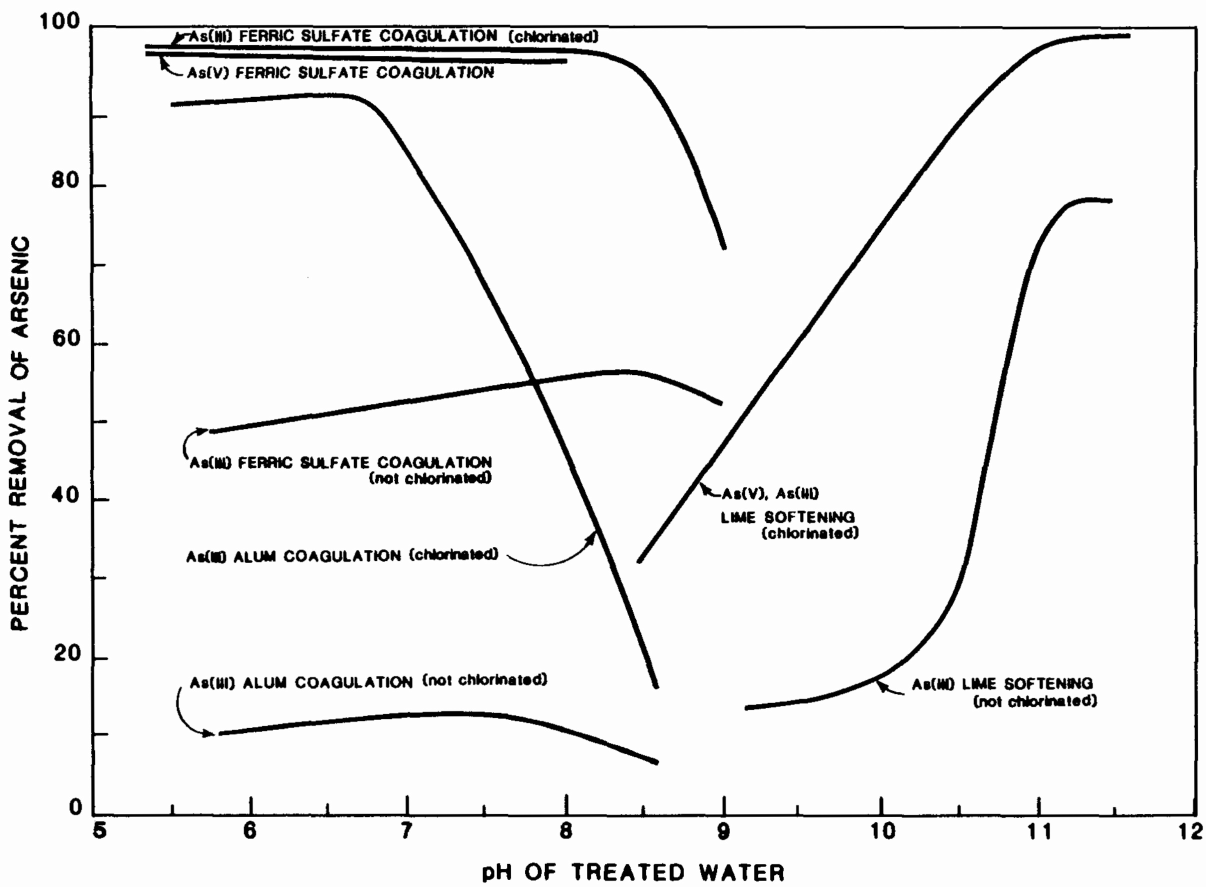
biological processes: Bioaccumulated, but not biomagnified; biotransformed to organic arsenicals under anaerobic conditions.

other reactions/interactions: Not important

Precipitation/Coagulation Data, Arsenic [1-5]:

	As (III)	As (V)
Test Conditions:		
Sample:	(a) chlorinated (b) not chlorinated	(a) unspecified (b) chlorinated
Coagulant dose:	(a,b) ferric sulfate - 30 mg/L (a,b) lime softening - unspecified (a,b) alum - 30 mg/L	(a) ferric sulfate - 30 mg/L (b) lime softening - unspecified
Initial concentration:	All tests - 0.3 mg/L	0.05 mg/L
Most effective methods reported:	ferric sulfate coagulation, pH 6-8 alum coagulation, pH 6-7 excess lime softening oxidation before treatment required	ferric sulfate coagulation, pH 6-8 alum coagulation, pH 6-7 excess lime softening

OBSERVED REMOVAL



INDUSTRIAL OCCURRENCE OF ARSENIC

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	37	36	<1.0	2,000	<120
Coal Mining (b)	104	49	2.0	6,500	340
Inorganic Chemicals Manufacturing (b)	44	44	2.0	44,000	<1,200
Iron and Steel Manufacturing (a)	43	41	5.0	1,200	<150
Aluminum Forming	23	21	<2.0	200	<20
Battery Manufacturing (f) (h)	56	27	ND	3,400	190
Electrical/Electronic Components (c)	26	25	1.0	120	<16
Foundries	21	6	3.0	1,500	480
Metal Finishing (b) (g)	218	143	ND	120	14
Photographic Equipment/Supplies (d)	57	10	0.29	1,300	410
Porcelain Enameling	39	14	3.0	2,800	790
Gum and Wood Chemicals	3	3	19	110	58
Pharmaceutical Manufacturing	2	2	3.0	4.0	3.5
Nonferrous Metals Manufacturing (i)	31	31	<2.0	1.6 x 10E5	<7,800
Ore Mining and Dressing (b)	114	106	NA	12,000	2,200
Organic Chemicals and Plastics and Synthetic Resins	28	NA	NA	NA	62
Paint and Ink Formulation (c)	6	6	<25	1,000	<300
Petroleum Refining (b)	17	17	3.0	440	<59
Soap and Detergent Manufacturing (a)	2	2	1.0	20	10
Steam Electric Power Plants (e)	20	11	1.5	3.1 x 10E5	<28,000
Textile Mills (b) (f)	70	35	1.0	220	41
Timber Products Processing	23	23	1.0	14,000	630

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ARSENIC

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	9	8	2.0	18	<10
Coal Mining (b)	114	44	2.0	72	12
Inorganic Chemicals Manufacturing (b)	22	17	<3.0	380	<81
Iron and Steel Manufacturing (a)	30	29	4.0	400	<45
Aluminum Forming	23	22	<2.0	750	<62
Foundries	21	8	<10	30	<11
Photographic Equipment/Supplies (d)	21	3	10	10	10
Porcelain Enameling	14	7	81	2,600	1,500
Gum and Wood Chemicals	3	3	17	76	47
Pharmaceutical Manufacturing	1	1		1.0	
Nonferrous Metals Manufacturing (g)	33	33	<2.0	4,800	<430
Ore Mining and Dressing (b)	100	83	NA	1,500	160
Organic Chemicals and Plastics and Synthetic Resins	26	NA	NA	NA	74
Paint and Ink Formulation (c)	1	1		<1,000	
Petroleum Refining (b)	18	18	<4.0	800	<86
Steam Electric Power Plants (e)	11	3	4.5	300	110
Textile Mills (b) (f)	64	33	1.0	160	24
Timber Products Processing	10	10	2.0	7,000	740

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ARSENIC

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	14	1	0 - >99	<1.0 - 42	
-powdered	4		NM	<20 - <20	
Chemical Oxidation					III.3.1.2
-ozone	2		0 - 48	4.0 - 43	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1		NM	62	
-barium chloride		2	>33	<2.0 - 15	
-combined precipitants		1	>99	ND	
-lime		6	25 - >99	ND - 80	
-sodium carbonate		2	96	10 - 68	
-sulfide		1	74	62	
Chemical Precipitation with Filtration					III.3.1.3
-lime	3	1	25 - >75	<1.0 - 110	
-sodium sulfide		2	NM	BDL - 360	
Chemical Reduction		2	33	4.0 - 17	III.3.1.4
Coagulation and Flocculation	2	4	37 - 92	BDL - 62	III.3.1.5
Filtration	16	6	0 - >99	BDL - 120	III.3.1.9
Flotation		7	8 - >99	ND - 18	III.3.1.10
Oil Separation		3	NM	BDL - 31	III.3.1.14
Reverse Osmosis	6		57 - >99	<1.0 - 15	III.3.1.16
Sedimentation	1	24	0 - >99	BDL - 230	III.3.1.18
Solvent Extraction		1	48	140	III.3.1.20
Ultrafiltration	1		NM	BDL	III.3.1.21
Activated Sludge		29	20 - 98*	BDL - 160	III.3.2.1
Lagoons					III.3.2.2
-aerated		4	>99	ND - 22	

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a)(1) of the Clean Water Act. These summaries apply to arsenic.

Freshwater Aquatic Life

For freshwater aquatic life the concentration of total recoverable trivalent inorganic arsenic should not exceed 440 µg/L at any time. Short-term effects on embryos and larvae of aquatic vertebrate species have been shown to occur at concentrations as low as 40 µg/L.

Saltwater Aquatic Life

The available data for total recoverable trivalent inorganic arsenic indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 508 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of trivalent inorganic arsenic to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of arsenic through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 22 ng/L, 2.2 ng/L, and 0.22 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 175 ng/L, 17.5 ng/L, and 1.75 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Asbestos

Formula: Chrysotile: $Mg_3Si_2O_5(OH)_4$;
Tremolite: $CaMg_3(SiO_3)_4$;
Crocidolite: $Na_2(Fe(II),Mg)_3Fe(III)_2Si_8O_{22}(OH)_2$

Alternate Names [1-1]: Chrysotile; Amosite; Amphibole; Crocidolite; Tremolite; Anthophylite

CAS #: 1332-21-4

Physical, Chemical, and Biological Properties:

molecular weight: Varies
melting point, °C: Varies
boiling point (760 torr), °C: Unknown
vapor pressure (25°C), mg/L: Not applicable
solubility in water (25°C), mg/L: Not applicable
water quality criteria: See page I.4.3-5

Probable Fate [1-2]:

photolysis: Asbestos is not photolyzed under environmental conditions

oxidation: Asbestos is resistant to oxidation

hydrolysis: Asbestos is not hydrolyzed under environmental conditions

volatilization: Negligible from aqueous solutions, may be aerosol under windy conditions

sorption: Does not have an adsorptive affinity for solutes normally found in natural water systems

biological processes: No evidence was found regarding bioaccumulation

other reactions/interactions: Asbestos is refractory in the aquatic environment

Precipitation/Coagulation Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF ASBESTOS

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Nonferrous Metals Manufacturing (c)	10	10	2,500	1.3 x 10E11	2.2 x 10E10
Textile Mills (a) (b)	15	7	1.0	200	31

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Mean calculated using medians.
(c) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ASBESTOS

	Treated wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Nonferrous Metals Manufacturing (c)	2	2	2.0 x 10E10	2.5 x 10E9	1.1 x 10E10
Textile Mills (a) (b)	11	3	1.0	390	140

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Mean calculated using medians.
(c) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ASBESTOS

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Chemical Precipitation with Sedimentation					III.3.1.3
-barium chloride		2	75	5.7 x 10E8 - 2.3 x 10E9	
-lime		2	95 - >99	6.1 x 10E6 - 8.2 x 10E6	
Filtration	8	2	36 - >99	1,600 - 3.2 x 10E9	III.3.1.9
Sedimentation	2	14	50 - >99	1.2 x 10E6 - 3.3 x 10E10	III.3.1.18

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to asbestos.

Freshwater Aquatic Life

No freshwater organisms have been tested with any asbestiform mineral and no statement can be made concerning acute or chronic toxicity.

Saltwater Aquatic Life

No saltwater organisms have been tested with any asbestiform mineral and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of asbestos through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer risk for every 100,000 people exposed]. The corresponding criteria are 300,000 fibers/L, 30,000 fibers/L, and 3,000 fibers/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on a "acceptable" risk level.

Compound: Beryllium

Formula: Be

Alternate Names: None

CAS #: 7440-41-7

Physical, Chemical, and Biological Properties [1-2, 1-3]:

atomic weight: 9.012
melting point, °C: 1,278
boiling point (5 mm Hg), °C: 2,970
vapor pressure (25°C), torr: Negligible
solubility in water (30°C), mg/L: BeO, 0.2
common oxidation states: cation - +2
water quality criteria: See page I.4.4-5

Probable Fate [1-2]:

photolysis: No data found on photolysis of beryllium

oxidation: Not important

hydrolysis: Soluble beryllium salts are hydrolyzed to form insoluble beryllium hydroxide

volatilization: Airborne dusts are the most widely known hazard associated with beryllium

sorption: Beryllium may be adsorbed by clays and other mineral surfaces at low pH

biological processes: Beryllium is only slightly bioaccumulated

other reactions/interactions: No data were found relative to aquatic fate on biotransformation of beryllium or its compounds

Precipitation/Coagulation Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF BERYLLIUM

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Auto and Other Laundries (a)	19	19	0.2	<15	<3.2
Coal Mining (b)	104	32	0.0	450	39
Inorganic Chemicals Manufacturing (b)	3	3	0.2	15	10
Iron and Steel Manufacturing (a)	3	3	<10	20	<13
Aluminum Forming	19	15	<0.5	<20	<7.7
Electrical/Electronic Components (c)	28	25	<1.0	<15	<2.1
Foundries	21	10	<10	16	<11
Metal Finishing (b) (g)	71	67	ND	110	10
Photographic Equipment/Supplies (d)	53	5	0.63	13	6.0
Porcelain Enameling	39	15	0.01	120	16
Pharmaceutical Manufacturing	3	3	1.0	10	7.0
Nonferrous Metals Manufacturing (h)	31	31	<1.0	310	<43
Ore Mining and Dressing (b)	84	43	NA	920	140
Organic Chemicals and Plastics and Synthetic Resins	2	NA	NA	NA	35
Paint and Ink Formulation (c)	33	33	<4.0	<73	<11
Petroleum Refining (b)	16	16	<1.5	<12	<2.6
Steam Electric Power Plants (e)	17	6	<10	<10	<10
Textile Mills (b) (f)	58	3	2.0	3.0	3.0
Timber Products Processing	23	23	0.5	19	2.5

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BERYLLIUM

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	1		<1.0	
Coal Mining (b)	114	7	ND	3.0	2.0
Inorganic Chemicals Manufacturing (b)	2	1		2.0	
Iron and Steel Manufacturing (a)	2	2	<10	20	<15
Foundries	21	8	<10	20	<10
Photographic Equipment/Supplies (d)	19	5	1.3	7.5	3.6
Pharmaceutical Manufacturing	3	3	1.0	10	7.0
Nonferrous Metals Manufacturing (g)	33	33	<1.0	370	<34
Ore Mining and Dressing (b)	73	10	NA	11	5.0
Organic Chemicals and Plastics and Synthetic Resins	2	NA	NA	NA	30
Paint and Ink Formulation (c)	19	19	2.0	20	<9.4
Petroleum Refining (b)	17	17	<1.5	<2.5	<2.1
Steam Electric Power Plants (e)	12	3	2.0	2.5	2.3
Textile Mills (b) (f)	78	1		1.0	
Timber Products Processing	10	10	2.0	13	3.1

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BERYLLIUM

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	14		NM	<0.04 - 5.4	
-powdered	4		NM	<2.0 - <2.5	
Chemical Oxidation					III.3.1.2
-ozone	2		NM	<0.04 - <4.0	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		4	NM	<6.0 - <10	
-combined precipitants		5	11 - >99	ND - <10	
-lime		1	NM	<20	
-sodium carbonate		2	>75	<1.0 - 11	
-sulfide		1	NM	BDL	
-unspecified		1	NM	<4.0	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	<0.04	
-sodium sulfide		2	NM	BDL - <15	
Chemical Reduction		2	0	<1.0 - 1.0	III.3.1.4
Coagulation and Flocculation	2	1	NM	<0.04 - 2.2	III.3.1.5
Filtration	14	4	0 - 71	<0.04 - <10	III.3.1.9
Sedimentation	1	15	0 - >98	BDL - 20	III.3.1.18
Activated Sludge		14	NM	BDL - BDL	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	>50	<1.0	

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to beryllium.

Freshwater Aquatic Life

The available data for beryllium indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 130 and 5.3 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Hardness has a substantial effect on acute toxicity.

Saltwater Aquatic Life

The limited saltwater data base available for beryllium does not permit any statement concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of beryllium through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 68 ng/L, 6.8 ng/L, and 0.68 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 1,170 ng/L, 117 ng/L, and 11.7 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Cadmium

Formula: Cd

Alternate Names: None

CAS #: 7440-43-9

Physical, Chemical, and Biological Properties [1-2, 1-3, 1-4]:

atomic weight: 112.4
melting point, °C: 321
boiling point (760 torr), °C: 765
vapor pressure (25°C), torr: Negligible
solubility in water, mg/L: $CdCl_2$, 1.40×10^6 at 20°C; CdS, 1.3 at 18°C; $Cd(OH)_2$, 2.6 at 25°C
common oxidation states: cation - +2 (always +2 in water)
water quality criteria: See page I.4.5-5

Probable Fate [1-2]:

photolysis: It is not an important mechanism in determining fate of cadmium compounds

oxidation: In reducing condition, Cd may precipitate with reduced sulfur to form CdS

hydrolysis: Aqueous solutions of cadmium salts are hydrolyzed to form hydroxide compounds

volatilization: It is not known to form volatile compounds

sorption: Sorption processes are important in determining cadmium transport, partitioning, and potential for remobilization

biological processes: Strong bioaccumulation in the tissues of aquatic and marine organisms

other reactions/interactions: Organic ligands of biological origin may affect solubility and adsorption

Precipitation/Coagulation Data, Cadmium [1-5]:

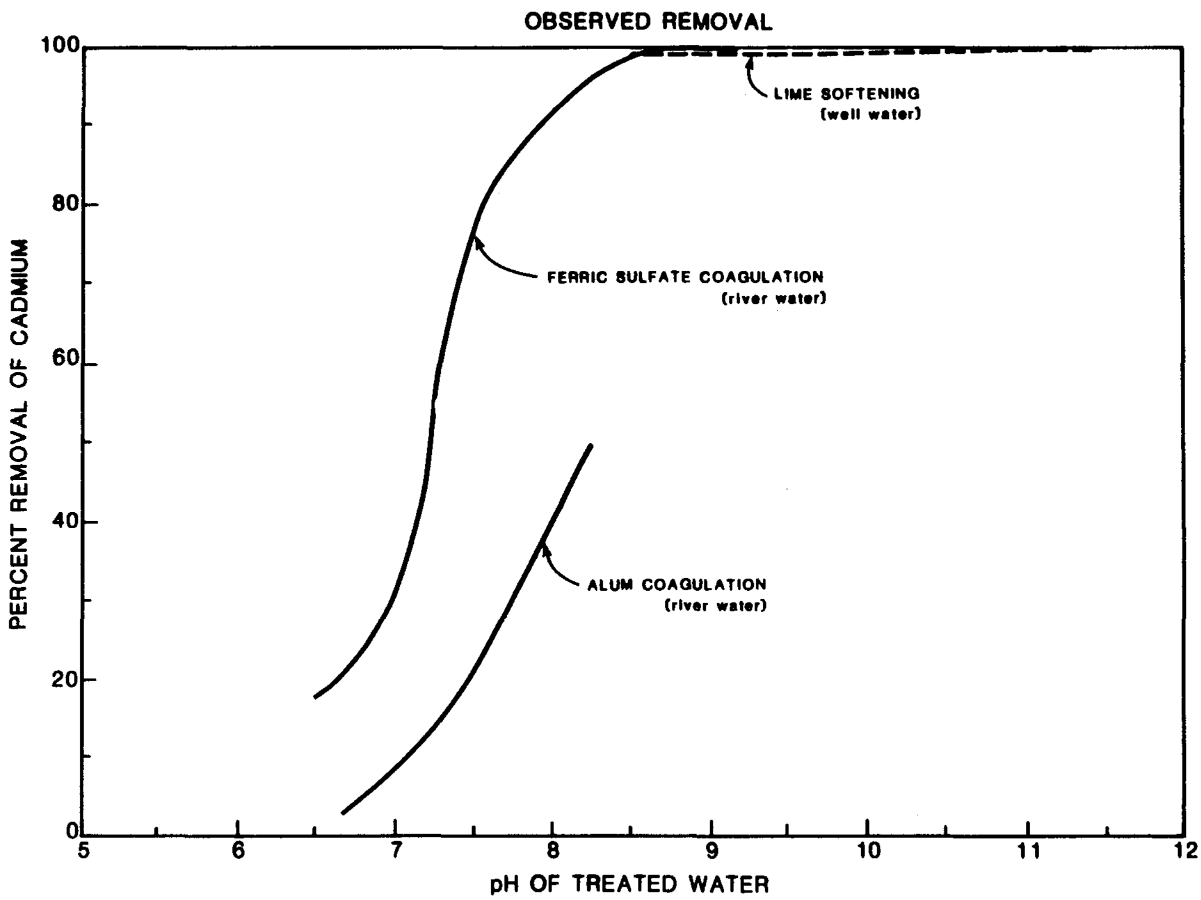
Test Conditions:

Sample: (a) river water
(b) well water

Coagulant dose (not reported): (a) ferric sulfate
(b) alum
(c) lime softening

Initial concentration, all tests: cadmium, 0.03 mg/L

Most effective methods reported: ferric sulfate coagulation, above pH 8
lime softening
excess lime softening



INDUSTRIAL OCCURRENCE OF CADMIUM

	Raw wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	80	79	<2.0	520	<49
Coal Mining (b)	104	24	6.0	290	42
Inorganic Chemicals Manufacturing (b)	45	45	0.2	1,600	<120
Iron and Steel Manufacturing (a)	54	54	<10	4,000	<290
Aluminum Forming	28	24	<0.5	180	<28
Battery Manufacturing (g) (h)	79	71	ND	2.3 x 10E5	5,500
Coil Coating	81	27	0.58	270	33
Electrical/Electronic Components (c)	28	27	0.3	15	<3.8
Foundries	27	7	20	2,200	680
Metal Finishing (b) (g)	260	190	ND	22,000	320
Photographic Equipment/Supplies (d)	59	38	0.47	51,000	1,700
Porcelain Enameling	43	35	0.46	9,600	1,400
Pharmaceutical Manufacturing	4	4	6.0	11	9.5
Nonferrous Metals Manufacturing (i)	32	32	4.5	80,000	<5,200
Ore Mining and Dressing (b)	106	54	NA	1,200	210
Organic Chemicals and Plastics and Synthetic Resins	24	NA	NA	NA	10
Paint and Ink Formulation (c)	33	33	<8.0	810	<77
Petroleum Refining (b)	16	16	<1.5	<100	<13
Rubber Processing	5	5	<1.0	43	<9.7
Soap and Detergent Manufacturing (a)	1	1		1.0	
Steam Electric Power Plants (e)	20	14	<1.0	100	<19
Textile Mills (b) (f)	76	25	1.0	46	7.0
Timber Products Processing	23	23	0.5	10	2.4

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF CADMIUM

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	12	12	<2.0	60	<12
Coal Mining (b)	114	16	3.0	23	12
Inorganic Chemicals Manufacturing (b)	24	21	0.1	120	<21
Iron and Steel Manufacturing (a)	35	35	<1.0	1,500	<97
Aluminum Forming	30	27	<0.5	500	<61
Coil Coating	16	16	1.0	68	18
Foundries	27	13	0.3	840	<76
Metal Finishing (b) (g)	3	3	5.0	50	26
Photographic Equipment/Supplies (d)	23	16	1.0	74	18
Porcelain Enameling	19	16	1.5	5,200	880
Gum and Wood Chemicals	1	1		110	
Pharmaceutical Manufacturing	3	3	2.0	10	7.3
Nonferrous Metals Manufacturing (h)	33	33	<2.0	7,600	<880
Ore Mining and Dressing (b)	92	36	NA	77	14
Organic Chemicals and Plastics and Synthetic Resins	25	NA	NA	NA	13
Paint and Ink Formulation (c)	19	19	<9.0	100	<31
Petroleum Refining (b)	17	17	<1.5	<12	<7.7
Rubber Processing	5	5	<1.0	37	<8.7
Steam Electric Power Plants (e)	12	9	1.0	9.0	14
Textile Mills (b) (f)	96	31	1.0	130	8.0
Timber Products Processing	10	10	1.0	7.0	3.1

NA, not available. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CADMIUM

Treatment process	Number of data points Pilot scale	Number of data points Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	14	3	76 - 95	<1.5 - <40	
-powdered	4		NM	<1.5 - <10	
Chemical Oxidation					III.3.1.2
-ozone	2		NM	<2.0 - 250	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		5	38 - 88	12 - 47	
-combined precipitants		5	>99	ND - <80	
-lime	1	13	22 - >99	ND - 80	
-sodium carbonate		2	67 - >99	4.0 - <5.0	
-sodium hydroxide		3	28 - >99	ND - 930	
-sulfide		1	NM	73	
-unspecified		17	0 - 99	5.0 - 100	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1	1	>99	ND - <2.0	
-sodium sulfide		2	NM	<14 - 120	
-unspecified		2	65 - 86	6.0 - 6.0	
Chemical Reduction		6	0 - 64	BDL - 19	III.3.1.4
Coagulation and Flocculation	2	4	>99	BDL - 20	III.3.1.5
Filtration	17	12	0 - >99	ND - 97	III.3.1.9
Flotation		9	0 - >99	BDL - <72	III.3.1.10
Oil Separation		3	>97	BDL - 200	III.3.1.14
Reverse Osmosis	6		0 - 50	14 - 48	III.3.1.16
Sedimentation	2	23	0 - >99	ND - 200	III.3.1.18
Ultrafiltration	4	2	56 - 93	BDL - <200	III.3.1.21
Activated Sludge		29	0 - 99*	BDL - 20	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	>97	<2.0	

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to cadmium.

Freshwater Aquatic Life

For total recoverable cadmium the criterion (in µg/L) to protect freshwater aquatic life as derived using the Guidelines in the numerical value given by e (1.05 [ln (hardness)] -8.53) as a 24-hour average and the concentration (in µg/L) should not exceed the numerical value given by e (1.05 [ln (hardness)] -3.73) at any time. For example, at hardnesses of 50, 100, and 200 mg/L as $CaCo_3$ the criteria are 0.012, 0.025, and 0.051 µg/L, respectively, and the concentration of total recoverable cadmium should not exceed 1.5, 3.0 and 6.3 µg/L, respectively, at any time.

Saltwater Aquatic Life

For total recoverable cadmium the criterion to protect saltwater aquatic life as derived using the Guidelines is 4.5 µg/L as a 24-hour average and the concentration should not exceed 59 µg/L at any time.

Human Health

The ambient water quality criterion for cadmium is recommended to be identical to the existing drinking water standard which is 10 µg/L. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Compound: Chromium

Formula: Cr

Alternate Names: None

CAS #: 7440-47-3

Physical, Chemical, and Biological Properties [1-2, 1-3]:

atomic weight: 52.00
melting point, °C: 1,860
boiling point (760 torr), °C: 2,670
vapor pressure (25°C), torr: Negligible
solubility in water (0°C), mg/L: CrO_3 (as H_2CrO_4), 6.17×10^5
common oxidation states: cations - +2, +3, +6
water quality criteria: See page I.4.6-5

Probable Fate [1-2]:

photolysis: Not important

oxidation: Cr(VI) slowly transformed to more stable Cr(III), Cr (II) oxidizes readily to Cr(III)

hydrolysis: Cr(III) transformed to $Cr(OH)_3$ or Cr_2O_3 (both insoluble at neutral or alkaline pH)

volatilization: Not important

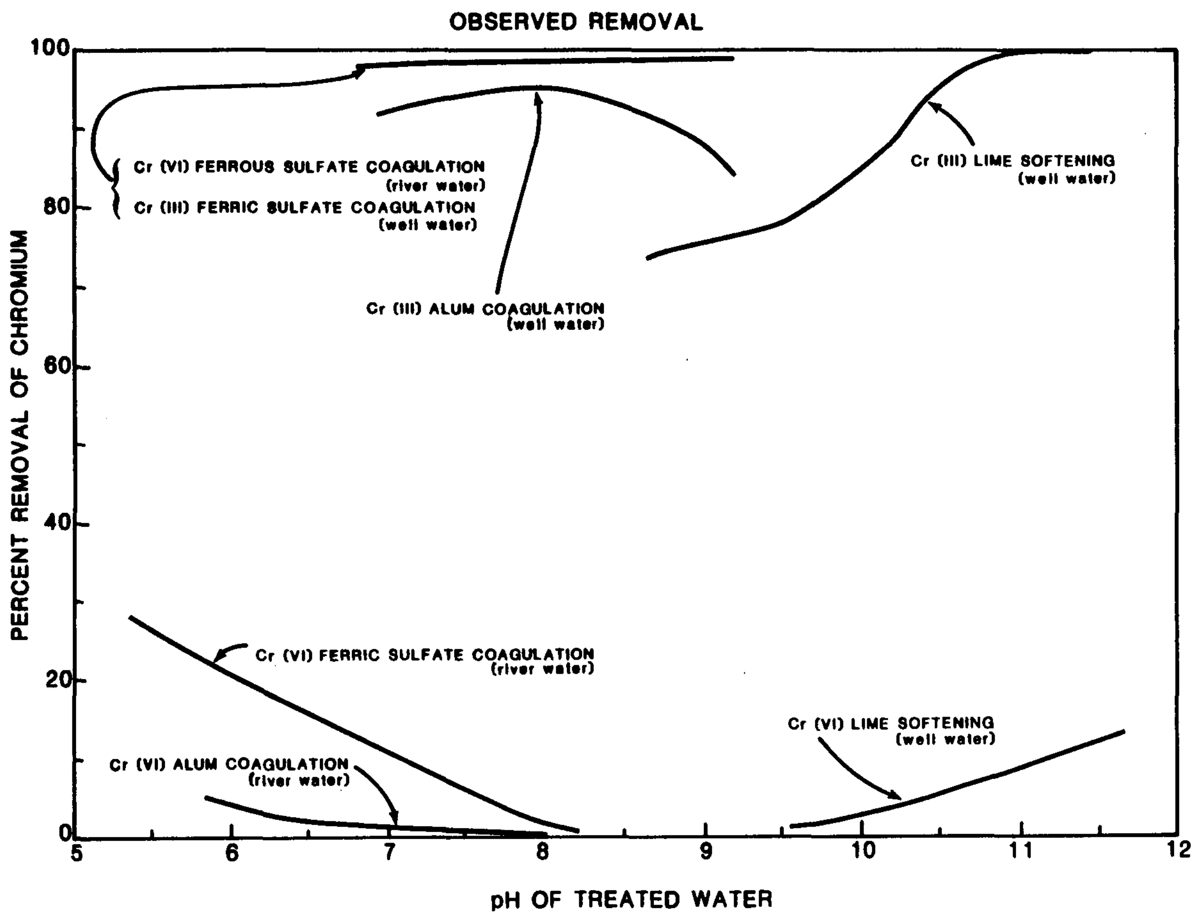
sorption: Cr(VI) may be adsorbed by organic materials; sorption of Cr(III) may be ancillary to precipitation of $Cr(OH)_3$; strongly sorbed by activated carbon

biological processes: Bioaccumulated by many aquatic organisms and passed on through the food chain; biogenic complexing agents may have some effect on chromium distribution

other reactions/interactions: Cr(VI) is very toxic to aquatic organisms

Precipitation/Coagulation Data, Chromium [1-5]:

Test Conditions:	Cr (III)	Cr (VI)
Sample:	(a) river water (b) well water	(a) river water (b) well water
Coagulant dose:	(a,b) ferric sulfate - 30 mg/L (a,b) alum - 30 mg/L (b) lime softening - unspecified	(a) ferric sulfate - 30 mg/L (b) ferrous sulfate - 30 mg/L (a) alum - 30 mg/L (b) lime softening - unspecified
Initial concentration:	All tests - 0.15 mg/L	0.15 mg/L
Most effective methods reported:	ferric sulfate coagulation, pH 6-9 alum coagulation, pH 7-9 excess lime softening	ferric sulfate coagulation, pH 7-9.5



INDUSTRIAL OCCURRENCE OF CHROMIUM

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	85	84	<4.0	8,800	<400
Coal Mining (b)	104	64	6.0	7,500	290
Inorganic Chemicals Manufacturing (b)	48	48	4.0	4.2 x 10E5	24,000
Iron and Steel Manufacturing (a)	103	103	3.0	3.7 x 10E5	19,000
Leather Tanning and Finishing	18	18	430	5.5 x 10E5	1.3 x 10E5
Aluminum Forming	30	26	7.0	7.9 x 10E5	<36,000
Battery Manufacturing (g) (h)	78	71	ND	3.2 x 10E5	7,900
Coil Coating	81	71	4.0	9.6 x 10E5	1.3 x 10E5
Electrical/Electronic Components (c)	28	27	<1.0	1,200	<120
Foundries	36	16	7.0	4,600	<660
Metal Finishing (b) (g)	172	132	ND	35,000	1,600
Photographic Equipment/Supplies (d)	59	53	1.6	3,100	260
Porcelain Enameling	39	39	0.49	1,100	200
Gum and Wood Chemicals	5	5	83	1,500	560
Pharmaceutical Manufacturing	8	8	1.0	150	62
Nonferrous Metals Manufacturing (i)	32	32	1.7	5.2 x 10E5	<19,000
Ore Mining and Dressing (b)	85	70	NA	18,000	3,800
Organic Chemicals and Plastics and Synthetic Resins	72	NA	NA	NA	390
Paint and Ink Formulation (c)	33	33	<53	1.2 x 10E5	<14,000
Petroleum Refining (b)	16	16	<7.5	1,300	<380
Pulp and Paperboard Mills (g)	178	178	<1.0	1,800	58
Rubber Processing	5	5	6.0	720	300
Soap and Detergent Manufacturing (a)	4	4	4.9	99	35
Steam Electric Power Plants (e)	25	22	3.0	26,000	<3,800
Textile Mills (b) (f)	76	61	1.0	4,900	330
Timber Products Processing	23	23	1.0	3,900	210

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Minimum, maxium, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF CHROMIUM

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	13	13	<5.0	620	<190
Coal Mining (b)	114	63	6.0	860	46
Inorganic Chemicals Manufacturing (b)	28	27	5.0	1.3 x 10E5	<5,000
Iron and Steel Manufacturing (a)	92	91	9.0	1.0 x 10E5	<3,200
Leather Tanning and Finishing	6	6	<20	20,000	<4,200
Aluminum Forming	32	29	<1.0	1.0 x 10E6	<99,000
Coil Coating	16	16	3.3	1.0 x 10E5	7,300
Foundries	35	20	<10	<150	<26
Metal Finishing (b) (g)	23	23	4.0	23,000	1,900
Photographic Equipment/Supplies (d)	23	16	2.6	170	46
Porcelain Enameling	20	19	2.0	1,100	290
Gum and Wood Chemicals	5	5	48	740	230
Pharmaceutical Manufacturing	7	7	2.0	81	30
Nonferrous Metals Manufacturing (h)	34	34	<4.0	20,000	<1,300
Ore Mining and Dressing (b)	75	26	NA	1,800	140
Organic Chemicals and Plastics and Synthetic Resins	69	NA	NA	NA	73
Paint and Ink Formulation (c)	19	19	<25	17,000	<1,100
Petroleum Refining (b)	17	17	<7.5	1,000	<110
Pulp and Paperboard Mills (g)	163	162	ND	1,100	33
Rubber Processing	5	5	19	410	150
Steam Electric Power Plants (e)	12	12	4.0	1,000	110
Textile Mills (b) (f)	96	65	1.0	1,800	97
Timber Products Processing	10	10	1.0	4,400	450

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CHROMIUM

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	15	3	10 - 95	<4.0 - 260	
-powdered	4		73 - 97	24 - 110	
Chemical Oxidation					III.3.1.2
-ozone	2		NM	6.3 - <200	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	7	13 - 95	34 - 280	
-barium chloride		2	50 - 93	25 - 30	
-combined precipitants		5	37 - >99	ND - 17,000	
-lime	1	17	47 - >99	ND - 250	
-sodium carbonate		2	>99	27 - 430	
-sodium hydroxide		4	79 - 99	18 - 3,000	
-sulfide		1	8	60	
-unspecified		19	12 - >99	5.0 - 7.9 x 10E5	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	6.7	
-sodium sulfide		2	>67	<50 - <50	
-unspecified		2	88 - 95	130 - 610	
Chemical Reduction		8	18 - >99	5.0 - 1.3 x 10E5	III.3.1.4
Coagulation and Flocculation	2	8	72 - 99	17 - 1,300	III.3.1.5
Filtration	18	15	0 - >99	<4.0 - 320	III.3.1.9
Flotation		12	20 - >99	2.0 - 620	III.3.1.10
Ion Exchange		1	96	490	III.3.1.12
Neutralization		1	>99	40	III.3.1.13
Oil Separation		3	82 - >98	9.0 - 240	III.3.1.14
Reverse Osmosis	7		3 - 67	100 - 900	III.3.1.16
Sedimentation	1	33	0 - >99	BDL - 30,000	III.3.1.18
Ultrafiltration	7	2	67 - 82	2.0 - 2,900	III.3.1.21
Activated Sludge		39	5 - 99	BDL - 20,000	III.3.2.1
Lagoons					III.3.2.2
-aerated		7	0 - 99	9.0 - 1,100	
-non-aerated		1	>99	ND	
Trickling Filter		1	NM	17	

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to chromium.

Freshwater Aquatic Life

For total recoverable hexavalent chromium the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.29 µg/L as a 24-hour average and the concentration should not exceed 21 µg/L at any time.

For freshwater aquatic life the concentration (in µg/L) of total recoverable trivalent chromium should not exceed the numerical value given by "e(1.08[ln(hardness)] + 3.48)" at any time. For example, at hardnesses of 50, 100, and 200 mg/l as $CaCO_3$ the concentration of total recoverable trivalent chromium should not exceed 2,200, 4,700, and 9,900 µg/L, respectively, at any time. The available data indicate that chronic toxicity to freshwater aquatic life occurs at concentrations as low as 44 µg/L and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

For total recoverable hexavalent chromium the criterion to protect saltwater aquatic life as derived using the Guidelines is 18 µg/L as a 24-hour average and the concentration should not exceed 1,260 µg/L at any time.

For total recoverable trivalent chromium, the available data indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 10,300 µg/L, and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of trivalent chromium to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of Chromium III ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 170 mg/L.

For the protection of human health from the toxic properties of Chromium III ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 3,433 mg/L.

The ambient water quality criterion for total Chromium VI is recommended to be identical to the existing drinking water standard which is 50 µg/L. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Compound: Copper

Formula: Cu

Alternate Names: None

CAS #: 7440-50-8

Physical, Chemical, and Biological Properties [1-2, 1-3, 1-4]:

atomic weight: 63.55
melting point, °C: 1,080
boiling point (760 torr), °C: 2,570
vapor pressure (25°C), torr: Negligible
solubility in water (0°C), mg/L: $CuCl_2$, 7.06×10^5
common oxidation states: cations - +1, +2, +3
water quality criteria: See page I.4.7-5

Probable Fate [1-2]:

photolysis: Not important

oxidation: Cu(I) quickly oxidized in water; transformation Cu(II) to CuO and $Cu_2(OH)_2CO_3$ very pH-dependent

hydrolysis: CuO and $Cu_2(OH)_2CO_3$ formed, but less effective than sorption

volatilization: Not important

sorption: Sorbed by hydrous iron and manganese oxides, enhanced by complexing with ligands

biological processes: Bioaccumulated by all organisms, but not biomagnified; biotransformation not important

other reactions/interactions: Organic ligands are important in sorption and complexation processes

Precipitation/Coagulation Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF COPPER

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Auto and Other Laundries (a)	67	67	0.9	11,000	<1,100
Coal Mining (b)	104	75	4.0	6,500	430
Inorganic Chemicals Manufacturing (b)	47	47	4.0	2.2 x 10E6	90,000
Iron and Steel Manufacturing (a)	104	104	12	28,000	1,700
Leather Tanning and Finishing	18	18	35	740	170
Aluminum Forming	29	25	9.0	2.4 x 10E6	<99,000
Battery Manufacturing (g) (h)	54	52	ND	3,200	280
Coil Coating	81	58	4.0	980	67
Electrical/Electronic Components (c)	28	27	5.0	1,800	400
Foundries	34	24	20	1.1 x 10E5	6,000
Metal Finishing (b) (g)	198	190	ND	5.0 x 10E5	8,600
Photographic Equipment/Supplies (d)	57	57	29	2,700	330
Porcelain Enameling	39	37	0.15	8.1 x 10E5	53,000
Explosives Manufacturing	5	5	5.0	940	200
Gum and Wood Chemicals	5	5	33	3,500	1,200
Pharmaceutical Manufacturing	8	8	20	6,700	1,600
Nonferrous Metals Manufacturing (i)	32	32	21	2.1 x 10E6	86,000
Ore Mining and Dressing (b)	103	100	NA	4.6 x 10E5	80,000
Organic Chemicals and Plastics and Synthetic Resins	72	NA	NA	NA	90
Paint and Ink Formulation (c)	33	33	100	1.0 x 10E5	9,400
Petroleum Refining (b)	17	17	<4.5	380	<79
Pulp and Paperboard Mills (g)	178	178	<1.0	650	53
Rubber Processing	4	4	<7.3	1,400	<360
Soap and Detergent Manufacturing (a)	8	8	6.7	3,400	460
Steam Electric Power Plants (e)	41	41	4.0	1.2 x 10E7	4.5 x 10E5
Textile Mills (b) (f)	76	69	3.0	3,100	290
Timber Products Processing	23	23	8.0	1,600	320

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF COPPER

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	13	13	1.0	660	250
Coal Mining (b)	114	61	3.0	46	15
Inorganic Chemicals Manufacturing (b)	26	24	1.0	18,000	<1,100
Iron and Steel Manufacturing (a)	93	92	7.0	1,000	<120
Leather Tanning and Finishing	6	6	5.0	37	<15
Aluminum Forming	32	29	<4.0	2.2 x 10E6	<1.6 x 10E5
Coil Coating	16	15	1.0	120	17
Foundries	32	24	7.0	2,400	<190
Metal Finishing (b) (g)	25	25	4.3	40,000	2,800
Photographic Equipment/Supplies (d)	23	23	24	15,000	2,400
Porcelain Enameling	20	19	3.0	6,000	1,200
Gum and Wood Chemicals	5	5	16	3,000	1,200
Pharmaceutical Manufacturing	7	7	3.0	61	25
Nonferrous Metals Manufacturing (h)	34	34	6.1	3.0 x 10E5	<14,000
Ore Mining and Dressing (b)	90	83	NA	4,600	230
Organic Chemicals and Plastics and Synthetic Resins	65	NA	NA	NA	40
Paint and Ink Formulation (c)	19	19	<60	27,000	<1,600
Petroleum Refining (b)	18	18	<4.5	300	<40
Pulp and Paperboard Mills (g)	163	162	<1.0	160	<21
Rubber Processing	4	4	<5.0	410	<110
Steam Electric Power Plants (e)	12	11	8.0	80	33
Textile Mills (b) (h)	96	82	2.0	320	54
Timber Products Processing	10	10	18	280	96

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR COPPER

Treatment process	Number of data points Pilot scale	 Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	16	3	13 - >85	<4.0 - 360	
-powdered	4		61 - 96	<5.5 - 29	
Chemical Oxidation					III.3.1.2
-chlorine		1	14	320	
-ozone	2		NM	85 - 590	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	6	30 - >99	ND - 27,000	
-barium chloride		2	>50 - 73	<20 - 30	
-combined precipitants		5	43 - 98	9.0 - <320	
-lime	4	25	34 - >99	ND - 700	
-sodium carbonate		2	4 - 83	48 - 1,300	
-sodium hydroxide		5	36 - 98	1.0 - 5,900	
-sulfide		1	88	38	
-unspecified		19	0 - >99	4.0 - 2.2 x 10E6	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1	1	99	16 - 100	
-sodium sulfide		2	>98	<25 - 30	
-unspecified		2	72 - 94	260 - 440	
Chemical Reduction		7	21 - 99	BDL - 1,700	III.3.1.4
Coagulation and Flocculation	2	8	>0 - 99	<10 - 170	III.3.1.5
Filtration	24	15	0 - >99	<4.0 - 4,500	III.3.1.9
Flotation		12	9 - 98	5.0 - 660	III.3.1.10
Neutralization		1	98	30	III.3.1.13
Oil Separation		3	93 - 99*	BDL - 450	III.3.1.14
Reverse Osmosis	7		64 - 90	26 - 28,000	III.3.1.16
Sedimentation	2	38	0 - >99	ND - 1,100	III.3.1.18
Ultrafiltration	4	2	>44 - 99	BDL - 1,100	III.3.1.21
Activated Sludge		39	2 - >99*	BDL - 170	III.3.2.1
Lagoons					III.3.2.2
-aerated		8	26 - 94	5.0 - 3,000	
-non-aerated		1	NM	18	
Trickling Filters		1	NM	42	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to copper.

Freshwater Aquatic Life

For total recoverable copper the criterion to protect freshwater aquatic life as derived using the Guidelines is 5.6 µg/L as a 24-hour average and the concentration (in µg/L) should not exceed the numerical value given by e(0.94 [ln(hardness)] - 1.23) at any time. For example, at hardnesses of 50, 100, and 200 mg/l $CaCO_3$ the concentration of total recoverable copper should not exceed 12, 22, and 43 µg/L at any time.

Saltwater Aquatic Life

For total recoverable copper the criterion to protect saltwater aquatic life as derived using the Guidelines is 4.0 µg/L as a 24-hour average and the concentration should not exceed 23 µg/L at any time.

Human Health

Sufficient data is not available for copper to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1 mg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: Cyanides (Total)

Formula:
- Cyanide ion; CN^-
- Hydrogen cyanide; HCN (Prussic acid)
- Nitriles; RCN (R = organic group)

Alternate Names: None

CAS #: 57-12-5 for cyanide ion/74-90-8 for HCN

Physical, Chemical, and Biological Properties for HCN [1-1]:

molecular weight: (HCN) 27.03
melting point, °C: -13.3
boiling point (760 torr), °C: 25.6
vapor pressure (20°C), torr: 620
solubility in water (25°C), mg/L: soluble in all proportions
water quality criteria: See page I.4.8-5

Probable Fate [1-2]:

photolysis: Presence of titanium dioxide causes rapid photooxidation of cyanide ion; otherwise, only some metallocyanides are photodecomposed

oxidation: Strong oxidizing agents are required to oxidize cyanides

hydrolysis: Too slow to compete with other fate mechanisms

volatilization: HCN, which composes almost all the free cyanides under natural conditions, is very rapidly volatilized

sorption: Cyanides are sorbed by organic materials and to some extent clay minerals (including clays, biological solids, activated carbon, and sediments), but high solubility precludes strong adsorption

biological processes: Toxicity precludes bioaccumulation; almost all organisms biodegrade cyanides, but not as rapidly as volitalization

other reactions/interactions: Forms simple alkali cyanides and complex metal and organic cyanides

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF CYANIDES (TOTAL)

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	41	38	<10	1,000	<130
Coal Mining (b)	57	3	2.0	8.0	6.0
Inorganic Chemicals Manufacturing (b)	5	4	710	1.1 x 10E5	30,000
Iron and Steel Manufacturing (a)	21	17	3.0	43,000	11,000
Leather Tanning and Finishing	14	9	10	100	39
Aluminum Forming	4	4	<0.2	1,300	<560
Battery Manufacturing (g) (h)	36	26	ND	7,200	460
Coil Coating	79	50	5.0	7,500	530
Electrical/Electronic Components (c)	28	25	2.0	<40	<9.6
Foundries	42	24	0.1	210	34
Metal Finishing (b) (g)	197	159	ND	2.4 x 10E6	1.1 x 10E5
Photographic Equipment/Supplies (d)	40	31	3.0	1,700	210
Porcelain Enameling (i)	21	4	4.0	140	29
Explosives Manufacturing	5	5	6.0	2,600	560
Pharmaceutical Manufacturing	7	7	20	270	160
Ore Mining and Dressing (b)	68	24	NA	1,200	320
Organic Chemicals and Plastics and Synthetic Resins	48	NA	NA	NA	12,000
Paint and Ink Formulation (c)	6	6	26	540	<220
Petroleum Refining (b)	17	16	<10	1,300	160
Pulp and Paperboard Mills (g)	99	90	ND	2,600	130
Soap and Detergent Manufacturing (a)	4	4	0.1	16	8.9
Steam Electric Power Plants (e)	11	2	4.0	15,000	7,500
Textile Mills (b) (f)	65	24	4.0	240	37

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Cyanides (total) was detected in screening, however there is no verification data.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF CYANIDES (TOTAL)

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	8	8	<10	530	<130
Coal Mining (b)	62	5	3.0	7.0	5.0
Inorganic Chemicals Manufacturing (b)	3	3	10	360	150
Iron and Steel Manufacturing (a)	29	28	1.0	38,000	3,500
Leather Tanning and Finishing	6	6	<10	400	<110
Aluminum Forming	24	23	0.6	100	<23
Coil Coating	16	9	0.5	840	130
Foundries	40	34	1.0	490	<42
Metal Finishing (b) (g)	31	27	ND	25,000	1,000
Photographic Equipment/Supplies (d)	24	18	20	1,200	310
Pharmaceutical Manufacturing	8	8	0.46	250	79
Ore Mining and Dressing (b)	57	14	NA	600	140
Organic Chemicals and Plastics and Synthetic Resins	40	NA	NA	NA	230
Paint and Ink Formulation (c)	1	1		660	
Petroleum Refining (b)	17	16	<0.5	140	<51
Pulp and Paperboard Mills (g)	84	75	ND	200	30
Steam Electric Power Plants (e)	12	2	22	22	22
Textile Mills (b) (f)	91	34	3.0	980	83

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CYANIDES (TOTAL)

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	10		0 - >90	<2.0 - 4.0	
-powdered	3		50 - 68	<20 - 45	
Chemical Oxidation					III.3.1.2
-chlorine	1	2	82 - >99	<2.0 - 130	
-ozone	4		>33 - >98	<2.0 - 1,500	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		6	NM	BDL - <120	
-combined precipitants		4	>86	<15 - <31	
-lime		8	52 - >99	ND - 5,500	
-sodium carbonate		2	50*	<5.0 - 5.0*	
-sodium hydroxide		3	>99 - >99	ND - BDL	
-unspecified		18	0 - >99	BDL - 5,200	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	27	
-sodium sulfide		1	NM	<20	
-unspecified		2	0 - 80	5.0 - 400	
Chemical Reduction		5	0 - 40	<5.0 - 190	III.3.1.4
Coagulation and Flocculation	2	3	26 - >60	BDL - 14	III.3.1.5
Filtration	13	9	0 - >99	2.0 - 260	III.3.1.9
Flotation		7	0 - <62	<10 - 2,300	III.3.1.10
Oil Separation		3	13	BDL - 13	III.3.1.14
Reverse Osmosis	4		>50 - 91	<4.0 - 2,200	III.3.1.16
Sedimentation	2	18	20 - >99	ND - 4,500	III.3.1.18
Solvent Extraction		1	27	16,000	III.3.1.20
Ultrafiltration		2	45	BDL - 6.0	III.3.1.21
Activated Sludge		35	0 - >99	ND - 38,000	III.3.2.1
Lagoons					III.3.2.2
-aerated		3	91 - >99	ND - 150	
Trickling Filters		1	79	16	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to cyanide.

Freshwater Aquatic Life

For free cyanide (sum of cyanide present as HCN and CN^-, expressed as CN) the criterion to protect freshwater aquatic life as derived using the Guidelines is 3.5 µg/L as a 24-hour average and the concentration should not exceed 52 µg/L at any time.

Saltwater Aquatic Life

The available data for free cyanide (sum of cyanide present as HCN and CN^-, expressed as CN) indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 30 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. If the acute-chronic ratio for saltwater organisms is similar to that for freshwater organisms, chronic toxicity would occur at concentrations as low as 2.0 µg/L for the tested species and at lower concentrations among species that are more sensitive than those tested.

Human Health

The ambient water quality criterion for cyanide is recommended to be identical to the existing drinking water standard which is 200 µg/L. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Compound: Lead

Formula: Pb

Alternate Names: None

CAS #: 7439-92-1

Physical, Chemical, and Biological Properties [1-2, 1-3]:

atomic weight: 207.2
melting point, °C: 328
boiling point (760 torr), °C: 1,740
vapor pressure (25°C), torr: Negligible
solubility in water (20°C), mg/L: PbO, 17; $PbCl_2$, 9.9×10^3
common oxidation states: cations - +2, +4
water quality criteria: See page I.4.9-5

Probable Fate [1-2]:

photolysis: Not important

oxidation/reduction: Pb(IV) readily reduces to Pb(II); solubility control by $PbSO_4$ at low pH and by $PbCO_3$ at high pH

hydrolysis: Not important at pH <11.5

volatilization: Importance of volatilization of $(CH_3)_4Pb$ unknown in natural condition

sorption: Pb removed to sediments effectively by inorganic solids, hydrous iron oxides and crystalline structures

biological processes: Bioaccumulation by aquatic organisms and biomethylation by microbes under anaerobic conditions

other reactions/interactions: Forms insoluble complexes with major environmental anions - hydroxide, carbonate, sulfide and sulfate

Precipitation/Coagulation Data, Lead [1-5]:

Test Conditions:

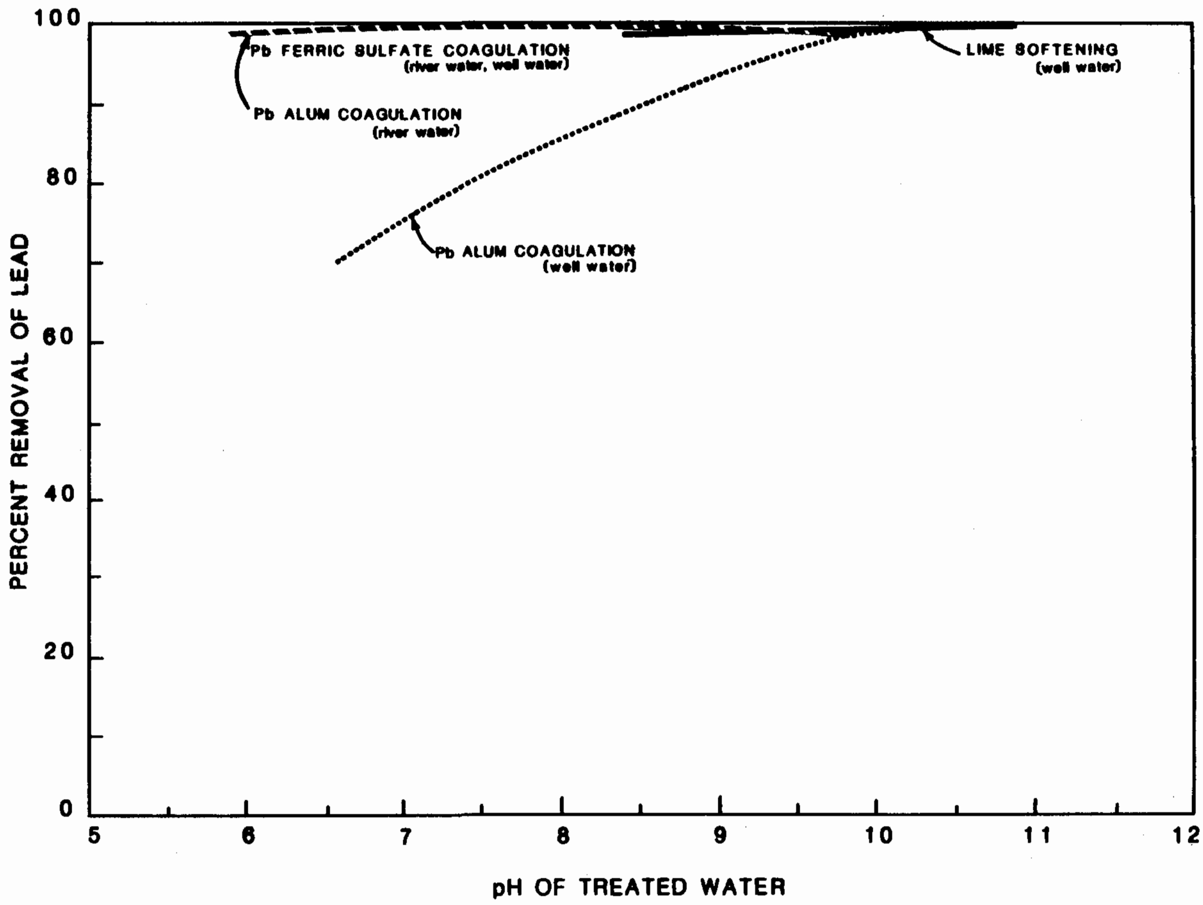
Sample: (a) river water - pH 7.3
(b) well water - pH 7.5

Coagulant dose: (a,b) ferric sulfate - 30 mg/L
(a,b) alum - 30 mg/L
(b) lime softening, unspecified

Initial concentration, all tests: lead, 0.15 mg/L

Most effective methods reported: ferric sulfate coagulation, pH 6-9
alum coagulation, pH 6-9
lime softening
excess lime softening

OBSERVED REMOVAL



INDUSTRIAL OCCURRENCE OF LEAD

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	88	87	<20	22,000	<2,000
Coal Mining (b)	104	41	2.0	5,500	490
Inorganic Chemicals Manufacturing (b)	47	47	2.5	3.7 x 10E5	11,000
Iron and Steel Manufacturing (a)	94	92	<10	1.6 x 10E6	<20,000
Leather Tanning and Finishing	18	18	28	3,500	680
Aluminum Forming	41	36	4.0	57,000	<3,000
Battery Manufacturing (f) (g)	78	41	ND	46,000	<1,600
Coil Coating	81	35	5.5	3,600	650
Electrical/Electronic Components (c)	28	27	3.5	360	<84
Foundries	42	28	<10	1.4 x 10E5	<16,000
Metal Finishing (b) (f)	248	192	ND	3.9 x 10E5	4,500
Photographic Equipment/Supplies (d)	59	16	13	400	130
Porcelain Enameling	39	38	4.0	8.8 x 10E5	44,000
Explosives Manufacturing	11	6	10	110	43
Gum and Wood Chemicals	5	5	12	42	20
Pharmaceutical Manufacturing	4	4	25	210	72
Nonferrous Metals Manufacturing (h)	32	32	<20	2.6 x 10E7	<9.2 x 10E5
Ore Mining and Dressing (b)	86	70	NA	1.3 x 10E5	4,200
Organic Chemicals and Plastics and Synthetic Resins	40	NA	NA	NA	150
Paint and Ink Formulation (c)	33	33	22	9.0 x 10E5	<8,400
Petroleum Refining (b)	16	16	18	320	<77
Pulp and Paperboard Mills (f)	178	178	<1.0	9,000	150
Rubber Processing	1	1		70	
Soap and Detergent Manufacturing (a)	5	5	13	57	27
Steam Electric Power Plants (e)	19	17	1.7	5,200	<610
Timber Products Processing	23	23	1.0	91	17

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Detections may include values less than 5 µg/L.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF LEAD

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	13	13	<20	1,000	<210
Coal Mining (b)	114	22	2.0	620	66
Inorganic Chemicals Manufacturing (b)	24	23	1.0	1,500	<120
Iron and Steel Manufacturing (a)	80	80	<1.0	5,500	<320
Leather Tanning and Finishing	6	6	8.0	80	43
Aluminum Forming	32	29	7.0	30,000	<3,300
Coil Coating	16	8	12	290	120
Foundries	40	32	5.9	8,500	<640
Metal Finishing (b) (f)	9	6	ND	2,000	250
Photographic Equipment/Supplies (d)	20	8	5.0	48	21
Porcelain Enameling	20	14	97	8.8 x 10E5	1.1 x 10E5
Gum and Wood Chemicals	3	3	13	58	29
Pharmaceutical Manufacturing	4	4	25	40	31
Neferrous Metals Manufacturing (g)	34	34	<17	4.5 x 10E6	<1.4 x 10E5
Ore Mining and Dressing (b)	75	31	NA	960	130
Organic Chemicals and Plastics and Synthetic Resins	40	NA	NA	NA	63
Paint and Ink Formulation (c)	19	19	98	<16,000	<1,800
Petroleum Refining (b)	17	17	<18	110	<39
Pulp and Paperboard Mills (f)	163	161	ND	190	13
Rubber Processing	1	1		670	
Steam Electric Power Plants (e)	12	9	1.2	60	13
Timber Products Processing	10	10	1.0	37	9.9

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR LEAD

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	15	2	2 - >72	<18 - 400	
-powdered	4		>78	<18 - 38	
Chemical Oxidation					III.3.1.2
-chlorine		1	0	2,500	
-ozone	2		>29	<22 - <900	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	7	0 - 96	23 - 800	
-barium chloride		2	83	30 - 50	
-combined precipitants		5	0 - >99	ND - 14,000	
-lime	4	18	0 - >99	ND - 440	
-sodium carbonate		2	94 - >99	15 - 1,900	
-sodium hydroxide		4	>99 - >99	ND - ND	
-sulfide		1	>14	<50	
-unspecified		19	26 - 99	BDL - 1,000	
Chemical Precipitation with Filtration					III.3.1.3
-lime	4	1	85 - >99	ND - 94	
-sodium sulfide		2	>77 - 95	<73 - 2,900	
-unspecified		2	58* - 77	BDL - 32	
Chemical Reduction		8	25 - >99	ND - 1.2 x 10E5	III.3.1.4
Coagulation and Flocculation	2	6	0 - >99	BDL - 580	III.3.1.5
Filtration	24	17	0 - >99	BDL - 2,100	III.3.1.9
Flotation		13	9 - <99	ND - 1,000	III.3.1.10
Oil Separation		3	97* - 99	BDL - 600	III.3.1.14
Reverse Osmosis	6		11 - 34	250 - 520	III.3.1.16
Sedimentation	2	34	0 - >99	ND - 16,000	III.3.1.18
Ultrafiltration	4	2	>44 - 94	BDL - 1,000	III.3.1.21
Activated Sludge		38	0 - >99	ND - 220	III.3.2.1
Lagoons					III.3.2.2
-aerated		6	>23 - >99	ND - 80	
-non-aerated		1	>99	ND	
Trickling Filters		1	NM	49	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to lead.

Freshwater Aquatic Life

For total recoverable lead the criterion (in µg/L) to protect freshwater aquatic life as derived using the Guidelines is the numerical value given by e(2.35[ln(hardness)] - 9.48) as a 24-hour average and the concentration (in µg/L) should not exceed the numerical value given by e(1.22[ln (hardness)] - 0.47) at any time. For example, at hardnesses of 50, 100, and 200 mg/L as $CaCO_3$ the criteria are 0.75, 3.8, and 20 µg/L, respectively, as 24-hour averages, and the concentrations should not exceed 74, 170, and 400 µg/L, respectively, at any time.

Saltwater Aquatic Life

The available data for total recoverable lead indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 668 and 25 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

The ambient water quality criterion for lead is recommended to be identical to the existing drinking water standard which is 50 µg/L. Anaylsis of the toxic effects data resulted in a calculated level which is protective to human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Compound: Mercury

Formula: Hg

Alternate Names [1-1]: Quick silver; Liquid silver

CAS #: 7439-97-6

Physical, Chemical, and Biological Properties [1-2, 1-3, 1-4]:

atomic weight: 200.6
melting point, °C: -38.9
boiling point (760 torr), °C: 357
vapor pressure (25°C), torr: 0.0012
solubility in water, mg/L: HgO, 53 at 25°C; HgS (α), 0.01 at 18°C; HgS (β), insoluble; $HgCl_2$, 6.9×10^4 at 20°C
common oxidation states: cations - +1, +2
water quality criteria: See page I.4.10-5

Probable Fate [1-2]:

photolysis: Breakdown of atmospheric dimethyl mercury to methyl mercury of slight importance

oxidation/reduction: Oxidation of metallic mercury forms ionic mercury (later adsorbed); reduction forms HgS precipitate

hydrolysis: Not important

volatilization: Metallic Hg, methylated Hg, and adsorbed Hg all volatilizable

sorption: Hg is adsorbed by most particles, buried in sediment, and reduced to HgS

biological processes: Bioaccumulated by all organisms and readily methylated metabolically

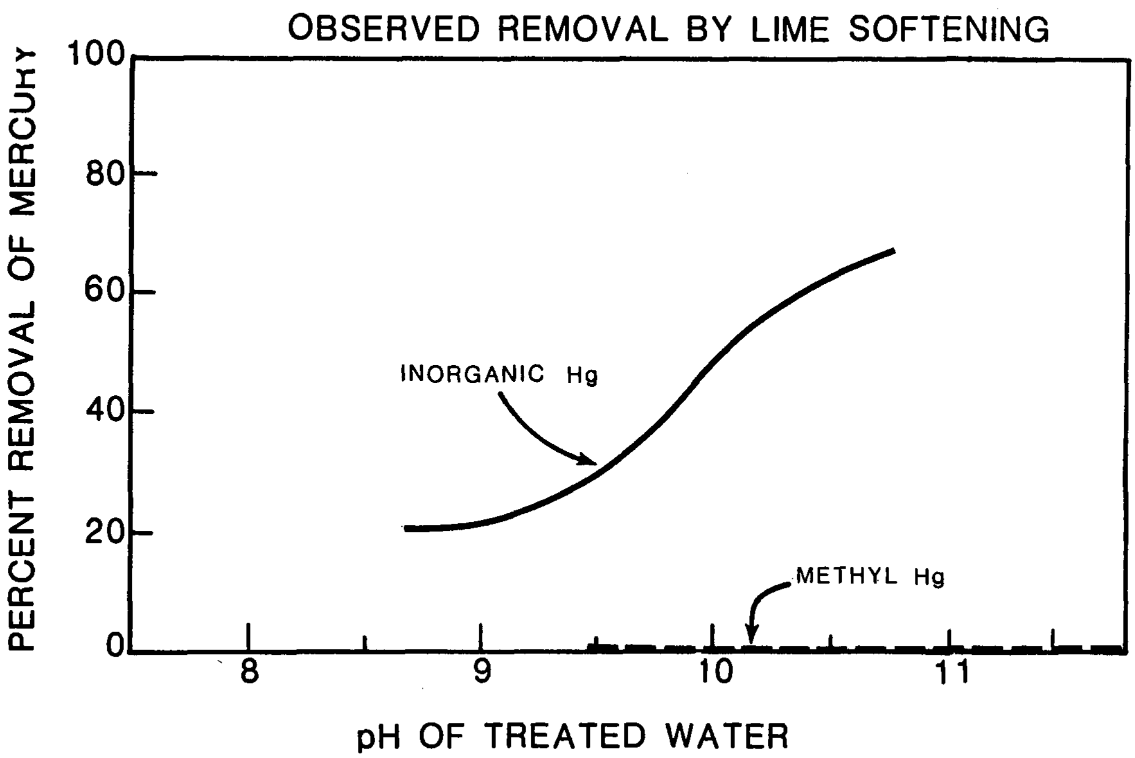
other reactions/interactions: Most common forms are elemental mercury, mercuric compounds, and organic complexes

Precipitation/Coagulation Data, Mercury [1-5]:

Test Conditions:	Inorganic	Organic
Sample:	unspecified	unspecified
Coagulant dose:	not reported	not reported

Initial concentration, all tests: unspecified

Most effective methods reported:
ferric sulfate coagulation,
pH 7-8



INDUSTRIAL OCCURRENCE OF MERCURY

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	69	69	<0.1	51	<2.4
Coal Mining (b)	104	44	0.2	43	5.0
Inorganic Chemicals Manufacturing (b)	39	39	0.4	1.2 x 10E5	3,900
Iron and Steel Manufacturing (a)	4	4	0.1	34	17
Aluminum Forming	37	33	<0.05	21	<2.4
Battery Manufacturing (f) (g)	57	43	ND	1.2 x 10E5	2,200
Electrical/Electronic Components (c)	28	27	<1.0	51	<4.7
Foundries	42	22	0.01	<10	<2.4
Metal Finishing (b) (f)	214	67	ND	400	4.0
Photographic Equipment/Supplies (d)	54	8	0.2	29,000	5,900
Pharmaceutical Manufacturing	7	7	1.0	310	42
Nonferrous Metals Manufacturing (h)	32	32	<0.1	6,400	<240
Ore Mining and Dressing (b)	87	54	NA	20	4.0
Organic Chemicals and Plastics and Synthetic Resins	36	NA	NA	NA	2.0
Paint and Ink Formulation (c)	29	29	<1.0	55,000	<6,100
Petroleum Refining (b)	15	14	<0.1	<1.6	<0.65
Pulp and Paperboard Mills (f)	178	178	<0.5	2.4	<0.56
Rubber Processing	4	4	1.1	3.2	2.2
Soap and Detergent Manufacturing (a)	1	1		76	
Steam Electric Power Plants (e)	18	9	<0.2	15,000	<1,700
Timber Products Processing	23	23	0.05	18	2.9

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Detections may include values less than 5 µg/L.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF MERCURY

Industry	Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
	Treated wastewater				
Auto and Other Laundries (a)	8	8	<0.2	2.0	<0.72
Coal Mining (b)	114	39	0.1	13	1.5
Inorganic Chemicals Manufacturing (b)	17	11	<0.4	320	<60
Iron and Steel Manufacturing (a)	6	6	0.1	0.3	<0.17
Aluminum Forming	31	28	<0.1	<70	<4.8
Foundries	40	36	0.07	10	<2.4
Photographic Equipment/Supplies (d)	22	4	0.5	1.7	1.1
Pharmaceutical Manufacturing	6	6	0.2	1.0	0.81
Nonferrous Metals Manufacturing (g)	33	33	0.06	70	<3.8
Ore Mining and Dressing (b)	80	37	NA	250	13
Organic Chemicals and Plastics and Synthetic Resins	27	NA	NA	NA	1.0
Paint and Ink Formulation (c)	18	18	<1.0	4,000	<710
Petroleum Refining (b)	18	15	<0.3	<3.0	<0.68
Pulp and Paperboard Mills (f)	163	162	ND	2.2	<0.54
Rubber Processing	5	5	0.87	3.1	2.0
Steam Electric Power Plants (e)	11	3	0.2	1.5	0.9
Timber Products Processing	10	10	0.1	2.0	1.4

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelian Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR MERCURY

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	6		0	<0.1 - <1.1	
-powdered	1		NM	0.6	
Chemical Oxidation					III.3.1.2
-ozone	1		NM	<1.1	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		5	6 - 93	1.7 - 4,000	
-barium chloride		1	87	0.5	
-combined precipitants		4	69 - >97	<0.6 - 980	
-lime		5	75 - >96	0.1 - 8.0	
-sodium carbonate		2	NM	<1.0 - 11	
-sulfide		1	97	200	
-unspecified		5	0 - 99	<1.0 - 140	
Chemical Precipitation with Filtration					III.3.1.3
-lime	3	1	NM	0.5 - 3.3	
-sodium sulfide		2	99	<50 - 100	
Chemical Reduction		2	NM	<1.0 - <5.0	III.3.1.4
Coagulation and Flocculation		3	70	0.3 - <1.0	III.3.1.5
Filtration	8	6	0 - 86	0.1 - 2,900	III.3.1.9
Flotation		8	33 - 88	BDL - 2.0	III.3.1.10
Oil Separation		2	80	BDL - 2.0	III.3.1.14
Sedimentation		23	0 - >97	BDL - 84	III.3.1.18
Ultrafiltration	4	1	11 - 33	0.4 - <2.0	III.3.1.21
Activated Sludge		24	33 - 94*	ND - 1.6	III.3.2.1
Lagoons					III.3.2.2
-aerated		2	>99	0.1 - 1.6	

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to mercury.

Freshwater Aquatic Life

For total recoverable mercury the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.20 μg/L as a 24-hour average and the concentration should not exceed 4.1 μg/L at any time.

Saltwater Aquatic Life

For total recoverable mercury the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.10 μg/L as a 24-hour average and the concentration should not exceed 3.7 μg/L at any time.

Human Health

For the protection of human health from the toxic properties of mercury ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 144 ng/L.

For the protection of human health from the toxic properties of mercury ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 146 ng/L.

Note - These values include the consumption of freshwater, estuarine, and marine species.

Compound: Nickel

Formula: Ni

Alternate Names: None

CAS #: 7440-02-0

Physical, Chemical, and Biological Properties [1-2, 1-3]:

atomic weight: 58.71
melting point, °C: 1,450
boiling point (760 torr), °C: 2,730
vapor pressure (25°C), torr: Negligible
solubility in water, mg/L: NiS, 3.6 at 18°C; $NiCl_2$, 6.42×10^5 at 20°C
common oxidation states: cations - +2
water quality criteria: See page I.4.11-5

Probable Fate [1-2]:

photolysis: Not important

oxidation: Under reducing conditions with sulfur, NiS is formed; otherwise unimportant

hydrolysis: Hydrolysis under natural conditions removes no nickel from solution

volatilization: Not important

sorption: Ni coprecipitates with hydrous metal oxides, and to a lesser degree is adsorbed by organic matter and incorporated in crystalline minerals

biological processes: Slightly bioaccumulated; no biotransformation noted

other reactions/interactions: Not important

Precipitation/Coagulation Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF NICKEL

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	85	84	<5.0	2,400	<170
Coal Mining (b)	104	51	23	10,000	730
Inorganic Chemicals Manufacturing (b)	48	48	3	1.1 x 10E6	35,000
Iron and Steel Manufacturing (a)	97	97	5.0	2.4 x 10E5	<6,700
Leather Tanning and Finishing	18	18	5.0	160	52
Aluminum Forming	31	27	<1.0	2,800	<140
Battery Manufacturing (f) (g)	79	65	ND	5.1 x 10E5	19,000
Coil Coating	81	21	3.5	31,000	2,700
Electrical/Electronic Components (c)	28	27	<1.0	5,000	<430
Foundries	40	21	5.0	910	<170
Metal Finishing (b) (f)	207	181	ND	4.2 x 10E5	14,000
Photographic Equipment/Supplies (d)	59	27	1.6	790	99
Porcelain Enameling	39	28	82	67,000	19,000
Explosives Manufacturing	2	1		100	
Gum and Wood Chemicals	4	4	19	2,500	700
Pharmaceutical Manufacturing	6	6	15	130	62
Nonferrous Metals Manufacturing (h)	32	32	<5.0	3.1 x 10E6	<1.2 x 10E5
Ore Mining and Dressing (b)	86	70	NA	14,000	3,600
Organic Chemicals and Plastics and Synthetic Resins	22	NA	NA	NA	410
Paint and Ink Formulation (c)	33	33	<20	13,000	<580
Petroleum Refining (b)	16	16	<10	280	<40
Pulp and Paperboard Mills (f)	178	178	<1.0	160	<18
Rubber Processing	1	1		610	
Soap and Detergent Manufacturing (a)	5	5	2.3	67	30
Steam Electric Power Plants (e)	33	30	1.7	5.0.x 10E5	1.0 x 10E5
Timber Products Processing	23	23	3.0	270	70

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Detections may include values less than 5 µg/L.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF NICKEL

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	12	12	<5.0	270	<65
Coal Mining (b)	112	25	5.0	180	75
Inorganic Chemicals Manufacturing (b)	28	26	5.0	1,400	<160
Iron and Steel Manufacturing (a)	83	83	5.0	31,000	<1,100
Leather Tanning and Finishing	6	6	4.0	34	24
Aluminum Forming	27	24	<1.0	20,000	<1,300
Coil Coating	16	8	9	510	180
Foundries	39	32	<10	180	<36
Metal Finishing (b) (f)	30	30	3.0	23,000	2,400
Photographic Equipment/Supplies (d)	28	16	1.2	50	23
Porcelain Enameling	17	16	14	45,000	13,000
Gum and Wood Chemicals	4	4	43	660	250
Pharmaceutical Manufacturing	5	5	6.0	85	33
Nonferrous Metals Manufacturing (g)	34	34	<5.0	60,000	<3,100
Ore Mining and Dressing (b)	75	43	NA	1,300	220
Organic Chemicals and Plastics and Synthetic Resins	21	NA	NA	NA	430
Paint and Ink Formulation (c)	19	19	<5.0	51,000	<2,800
Petroleum Refining (b)	17	17	<10	61	<25
Pulp and Paperboard Mills (f)	163	163	ND	270	15
Rubber Processing	1	1		400	
Steam Electric Power Plants (e)	12	12	3.5	470	62
Timber Products Processing	10	10	2.0	150	32

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR NICKEL

Treatment process	Number of data points Pilot scale	Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	15	3	10 - 67	BDL - <700	
-powdered	4		>58	<5.0 - 22	
Chemical Oxidation					III.3.1.2
-ozone	2		NM	66 - 5,000	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	6	0 - 25	10 - 51,000	
-combined precipitants		5	4 - >25	<50 - 10,000	
-lime	1	15	6 - >99	ND - 5,200	
-sodium carbonate		2	96	18 - 640	
-sodium hydroxide		3	>99	ND - 210	
-sulfide		1	NM	<50	
-unspecified		19	8 - >99	9.0 - 6,400	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1	1	>99	ND - 73	
-sodium sulfide		2	>64	<50 - <50	
-unspecified		2	55 - 98	44 - 1,000	
Chemical Reduction		6	47 - >99	BDL - 1,700	III.3.1.4
Coagulation and Flocculation	2	6	44 - 99	BDL - 2,600	III.3.1.5
Filtration	18	12	0 - >99	BDL - 700	III.3.1.9
Flotation		12	0 - >99	ND - 270	III.3.1.10
Neutralization		1	>99	20	III.3.1.13
Oil Separation		3	>96	BDL - 500	III.3.1.14
Reverse Osmosis	6		9 - 72	62 - 210	III.3.1.16
Sedimentation	1	31	0 - >99	BDL - 2,000	III.3.1.18
Ultrafiltration	4	1	>32 - >85	<10 - <1,000	III.3.1.21
Activated Sludge		38	0 - >99	ND - 400	III.3.2.1
Lagoons					III.3.2.2
-aerated		6	0 - 50	<5.0 - 230	

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to nickel.

Freshwater Aquatic Life

For total recoverable nickel the criterion (in µg/L) to protect freshwater aquatic life as derived using the Guidelines is the numerical value given by e[(0.76[ln(hardness)] + 1.06) as a 24-hour average and the concentration (in µg/L) should not exceed the numerical value given by e(0.76[ln(hardness)] + 4.02) at any time. For example, at hardnesses of 50, 100, and 200 mg/L as $CaCO_3$ the criteria are 56, 96, and 160 µg/L, respectively, as 24-hour averages, and the concentrations should not exceed 1,100, 1,800, and 3,100 µg/L, respectively, at any time.

Saltwater Aquatic Life

For total recoverable nickel the criterion to protect saltwater aquatic life as derived using the Guidelines is 7.1 µg/L as a 24-hour average and the concentration should not exceed 140 µg/L at any time.

Human Health

For the protection of human health from the toxic properties of nickel ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 13.4 µg/L.

For the protection of human health from the toxic properties of nickel ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 100 µg/L.

Compound: Selenium

Formula: Se

Alternate Names: None

CAS #: 7782-49-2

Physical, Chemical, and Biological Properties [1-2, 1-3, 1-4]:

atomic weight: 78.96
melting point, °C: 217 (metallic form)
boiling point (760 torr), °C: 685
vapor pressure (25°C), torr: Negligible
solubility in water (14°C), mg/L: SeO_2, 3.84 x 10^5; SeO_3 decomposes, very soluble
common oxidation states: cations - +4, +6; anion - -2
water quality criteria: See page I.4.12-5

Probable Fate [1-2]:

photolysis: Not important

oxidation: In aerobic waters, soluble anions are formed; under reducing conditions, selenium or metal selenides (insoluble) go into sediment, possibly forming volatile H_2Se

hydrolysis: SeO_4^{-2}, SeO_4^{-2}, and $HSeO_3^-$ (all soluble) are formed

volatilization: H_2Se can be formed; volatilization can also follow biomethylation

sorption: Adsorbed by hydrous metal oxides (strongly), clays, and organic chemicals, but only a small percentage of total Se is sorbed

biological processes: Bioaccumulation by many species; possible biological redox reactions, and some biomethylation

other reactions/interactions: Not important

Precipitation/Coagulation Data, Selenium [1-5]:

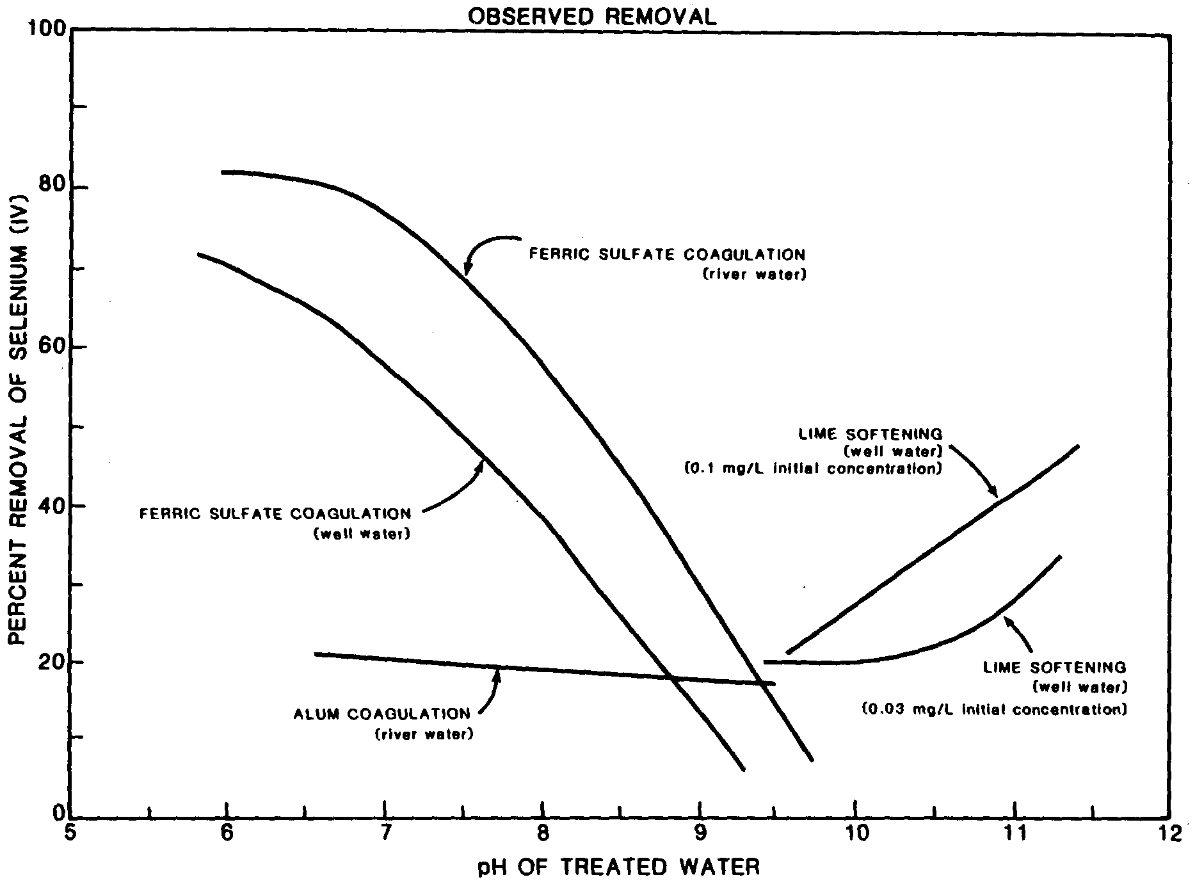
Test Conditions: Se (IV)

Sample: (a) river water
(b) well water

Coagulant dose:
(a,b) ferric sulfate - 25 mg/L
(a,b) alum - 25 mg/L
(b) lime softening - 0.1 mg/L; 0.03 mg/L

Initial concentration, all tests: 0.1 mg/L; 0.03 mg/L

Most effective methods reported: ferric sulfate coagulation, pH 6-7
ion exchange
reverse osmosis



INDUSTRIAL OCCURRENCE OF SELENIUM

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	22	20	<1.0	120	<16
Coal Mining (b)	104	39	1.0	450	66
Inorganic Chemicals Manufacturing (b)	15	15	<5.0	69	<18
Iron and Steel Manufacturing (a)	16	16	1.0	1,000	<130
Battery Manufacturing (f) (g)	30	13	ND	2,100	170
Electrical/Electronic Components (c)	26	22	2.0	180	<12
Foundries	42	6	<10	1,200	<250
Metal Finishing (b) (f)	58	53	ND	60	8.0
Photographic Equipment/Supplies (d)	54	4	7.6	42	24
Porcelain Enameling	39	30	0.36	1.6 × 10E5	7,800
Gum and Wood Chemicals	1	1		11	
Pharmaceutical Manufacturing	4	4	1.0	40	27
Nonferrous Metals Manufacturing (h)	31	31	<2.0	23,000	<910
Ore Mining and Dressing (b)	84	58	NA	1,500	230
Organic Chemicals and Plastics and Synthetic Resins	20	NA	NA	NA	72
Paint and Ink Formulation (c)	6	6	<25	<1,500	<330
Petroleum Refining (b)	16	16	4.0	<20	<14
Rubber Processing	1	1		<20	
Steam Electric Power Plants (e)	18	9	<2.0	24,000	<2,700
Timber Products Processing	23	23	0.8	53	4.9

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Detections may include values less than 5 µg/L.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF SELENIUM

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	3	3	<1.0	7.0	<3.3
Coal Mining (b)	114	32	1.0	160	22
Inorganic Chemicals Manufacturing (b)	14	12	<5.0	110	<44
Iron and Steel Manufacturing (a)	22	18	1.0	650	<80
Foundries	40	23	0.8	<10	<9.6
Photographic Equipment/Supplies (d)	8	1		21	
Porcelain Enameling	19	12	28	63,000	12,000
Gum and Wood Chemicals	1	1		19	
Pharmaceutical Manufacturing	4	4	1.0	40	27
Nonferrous Metals Manufacturing (f)	33	33	<1.0	2,300	<120
Ore Mining and Dressing (b)	73	37	NA	900	60
Organic Chemicals and Plastics and Synthetic Resins	18	NA	NA	NA	33
Paint and Ink Formulation (c)	1	1		<1,200	
Petroleum Refining (b)	17	17	3.0	<20	<16
Rubber Processing	1	1		<25	
Steam Electric Power Plants (e)	12	3	3.0	13	6.7
Timber Products Processing	10	10	1.0	39	5.7

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR SELENIUM

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	11		0 - >50	<1.0 - 50	
-powdered	4		>13	<20 - 40	
Chemical Oxidation					
-ozone	1		NM	<1.0	III.3.1.2
Chemical Precipitation with Sedimentation					III.3.1.3
-barium chloride		1	NM	10	
-lime		2	>99	ND - 87	
-sodium carbonate		2	62	<4.0 - 280	
-sulfide		1	NM	BDL	
Chemical Precipitation with Filtration					III.3.1.3
-lime	2	1	40	<1.0 - 41	
-sodium sulfide		2	>71	BDL - <10	
Chemical Reduction		2	NM	<11 - 40	III.3.1.4
Coagulation and Flocculation		1	NM	<4.5	III.3.1.5
Filtration	10	5	0 - 10	BDL - 100	III.3.1.9
Flotation		3	NM	BDL - 8.5	III.3.1.10
Oil Separation		1	NM	76	III.3.1.14
Sedimentation		22	0 - 98	<2.0 - 32	III.3.1.18
Solvent Extraction		1	NM	630	III.3.1.20
Activated Sludge		20	NM	BDL - 41	III.3.2.1
Lagoons					III.3.2.2
-aerated		4	>9 - >99	ND - <200	
-non-aerated		1	44	18	

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to selenium.

Freshwater Aquatic Life

For total recoverable inorganic selenite the criterion to protect freshwater aquatic life as derived using the Guidelines is 35 µg/L as a 24-hour average and the concentration should not exceed 260 µg/L at any time.

The available data for inorganic selenate indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 760 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of inorganic selenate to sensitive freshwater aquatic life.

Saltwater Aquatic Life

For total recoverable inorganic selenite the criterion to protect saltwater aquatic life as derived using the Guidelines is 54 µg/L as a 24-hour average and the concentration should not exceed 410 µg/L at any time.

No data are available concerning the toxicity of inorganic selenate to saltwater aquatic life.

Human Health

The ambient water quality criterion for selenium is recommended to be identical to the existing drinking water standard which is 10 µg/L. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Compound: Silver

Formula: Ag

Alternate Names: None

CAS #: 7440-22-4

Physical, Chemical, and Biological Properties [1-2, 1-3, 1-4]:

atomic weight: 107.9
melting point, °C: 962
boiling point (760 torr), °C: 2,210
vapor pressure (25°C), torr: Negligible
solubility in water, mg/L: Ag_2O, 13 at 20°C; AgCl, 0.89 at 10°C
common oxidation states: cations - +1 (principal state), +2, +3
water quality criteria: See page I.4.13-5

Probable Fate [1-2]:

photolysis: Not important in aquatic environment

oxidation: Ag and Ag^+ compounds (most insoluble) are the only forms usually present (both precipitate)

hydrolysis: Important only at high pH, where Ag_2O may precipitate

volatilization: Not important

sorption: Strongly sorbed by MnO_2, then released in saline water; some sorption by clays and organic materials and iron oxides

biological processes: Bioaccumulated by many aquatic organisms; little food chain magnification

other reactions/interactions: Not important

Precipitation/Coagulation Data, Silver [1-5]:

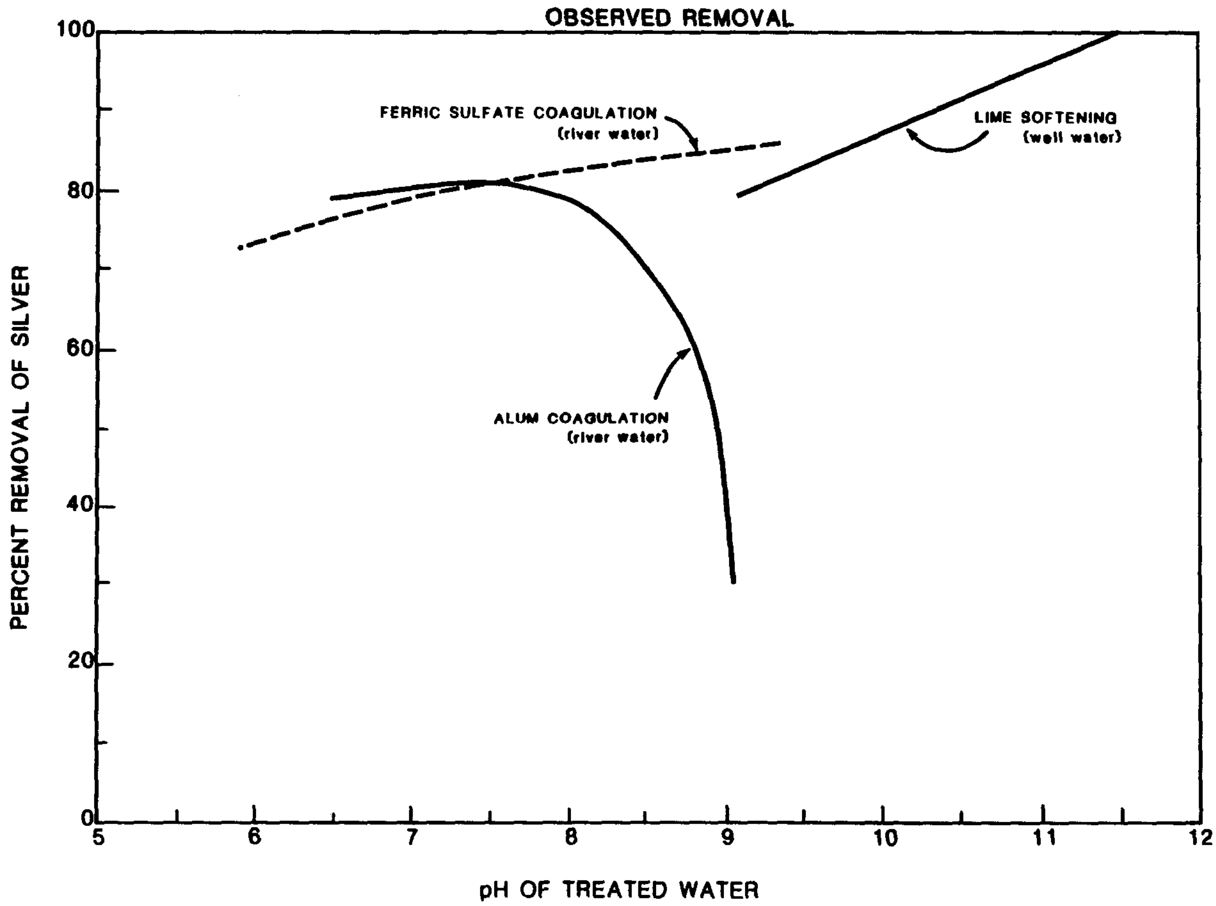
Test Conditions:

Sample: (a) river water
(b) well water

Coagulant dose:
(a) ferric sulfate - 30 mg/L
(a) alum - 30 mg/L
(b) lime softening - unspecified

Initial concentration, all tests: 0.15 mg/L

Most effective methods reported: ferric sulfate coagulation, pH 7-9
alum coagulation, pH 6-8
lime softening
excess lime softening



INDUSTRIAL OCCURRENCE OF SILVER

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	30	30	<1.0	130	<18
Coal Mining (b)	104	32	4.0	64	18
Inorganic Chemicals Manufacturing (b)	28	28	<5	580	<41
Iron and Steel Manufacturing (a)	39	38	<1.0	500	<91
Battery Manufacturing (f) (g)	49	31	ND	2,400	1,300
Electrical/Electronic Components (c)	28	27	<1.0	25	<6.0
Foundries	9	3	5.0	70	35
Metal Finishing (b) (f)	207	145	ND	6.0 × 10E5	23,000
Photographic Equipment/Supplies (d)	60	32	0.2	37,000	2,900
Pharmaceutical Manufacturing	2	2	1.0	10	5.5
Nonferrous Metals Manufacturing (h)	31	31	<2.6	4,700	<350
Ore Mining and Dressing (b)	84	29	NA	1,100	840
Organic Chemicals and Plastics and Synthetic Resins	7	NA	NA	NA	23
Paint and Ink Formulation (c)	33	33	<4.0	100	<15
Petroleum Refining (b)	16	16	<3.0	130	<17
Soap and Detergent Manufacturing (a)	3	3	1.8	94	55
Steam Electric Power Plants (e)	17	8	0.5	70	<22
Timber Products Processing	23	23	0.5	7.0	1.8

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Detections may include values less than 5 µg/L.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF SILVER

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	7	7	<1.0	<66	<15
Coal Mining (b)	114	29	2.0	31	16
Inorganic Chemicals Manufacturing (b)	10	8	<7.0	260	<47
Iron and Steel Manufacturing (a)	28	28	1.0	340	<32
Foundries	9	3	<10	<10	<10
Metal Finishing (b) (f)	5	4	ND	65	26
Photographic Equipment/Supplies (d)	23	15	1.0	1,800	420
Pharmaceutical Manufacturing	2	2	1.0	10	5.5
Nonferrous Metals Manufacturing (g)	33	33	1.0	9,200	<560
Ore Mining and Dressing (b)	73	9	NA	40	16
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	11
Paint and Ink Formulation (c)	19	19	<1.0	<20	<9.4
Petroleum Refining (b)	17	17	<3.0	<20	<11
Steam Electric Power Plants (e)	12	6	0.17	5.5	3.4
Timber Products Processing	10	10	1.0	4.0	1.9

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR SILVER

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption					III.3.1.1
-granular	15	2	0 - 36	1.7 - <100	
-powdered	4		NM	<3.0 - <3.0	
Chemical Oxidation					III.3.1.2
-ozone	2		NM	16 - 1,300	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	5	NM	<7.0 - 170	
-barium chloride		1	NM	20	
-combined precipitants		4	NM	<8.0 - <10	
-lime		2	>99 - >99	ND - ND	
-sodium carbonate		2	>97	<2.0 - 22	
-sodium hydroxide		3	76	11 - 64	
-sulfide		1	NM	BDL	
-unspecified		9	0 - 67	0.12 - 35	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1	1	40	9.0 - 12	
-sodium sulfide		2	93*	BDL - <15	
Chemical Reduction		3	42 - 77	<1.0 - 34	III.3.1.4
Coagulation and Flocculation	2	3	10	<1.0 - 250	III.3.1.5
Filtration	17	11	0 - 91*	BDL - <100	III.3.1.9
Flotation		5	45	BDL - 66	III.3.1.10
Oil Separation		1	NM	250	III.3.1.14
Reverse Osmosis	6		0 - 76	20 - 78	III.3.1.16
Sedimentation	1	23	>50 - 96	1.0 - <100	III.3.1.18
Solvent Extraction		1	NM	<25	III.3.1.20
Activated Sludge		24	3 - 96*	ND - 95	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	NM	<10	

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to silver.

Freshwater Aquatic Life

For freshwater aquatic life the concentration (in µg/L) of total recoverable silver should not exceed the numerical value given by "e[1.72(ln(hardness) - 6.52)]" at any time. For example, at hardnesses of 50, 100, 200 mg/L as $CaCO_3$ the concentration of total recoverable silver should not exceed 1.2, 4.1, and 13 µg/L, respectively, at any time. The available data indicate that cronic toxicity to freshwater aquatic life may occur at concentrations as low as 0.12 µg/L.

Saltwater Aquatic Life

For saltwater aquatic life the concentration of total recoverable silver should not exceed 2.3 µg/L at any time. No data are available concerning the chronic toxicity of silver to sensitive saltwater aquatic life.

Human Health

The ambient water quality criterion for silver is recommended to be identical to the existing drinking water standard which is 50 µg/L. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Compound: Thallium

Formula: Tl

Alternate Names [1-1]: Thallium salt

CAS #: 7440-28-0

Physical, Chemical, and Biological Properties [1-2, 1-3, 1-4]:

molecular weight: 204.4
melting point, °C: 304
boiling point (760 torr), °C: 1,460
vapor pressure (25°C), torr: Negligible
solubility in water, mg/L: Tl_2S, 2.0×10^2 at 20°C; TlCl, 2.9×10^3 at 16°C
common oxidation states: cations - +1, +3
water quality criteria: See page I.4.14-5

Probable Fate [1-2]:

photolysis: Not important

oxidation: Tl(III) present only in very oxidizing water; in reducing conditions, metallic Tl or sulfide may precipitate

hydrolysis: Hydrolysis of Tl^{3+} to insoluble $Tl(OH)_3$ unimportant because of low Tl^{3+} content of natural water

volatilization: No evidence found indicating formation of volatile thallium compounds

sorption: Tl^+ adsorbed strongly by clay minerals and to a lesser degree by hydrous metal oxides

biological processes: Quickly bioaccumulated by aquatic organisms

other reactions/interactions: Not important

Precipitation/Coagulation Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF THALLIUM

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Auto and Other Laundries (a)	18	16	<4.0	<50	<22
Coal Mining (b)	104	27	1.0	180	26
Inorganic Chemicals Manufacturing (b)	17	17	2.0	380	<47
Iron and Steel Manufacturing (a)	4	4	65	210	120
Electrical/Electronic Components (c)	28	27	<1.0	120	<26
Foundries	9	2	<10	3,800	<1,900
Metal Finishing (b) (f)	58	53	ND	500	59
Photographic Equipment/Supplies (d)	54	8	0.8	280	45
Pharmaceutical Manufacturing	1	1		1.0	
Nonferrous Metals Manufacturing (g)	29	29	<20	1,300	<220
Ore Mining and Dressing (b)	82	3	NA	1,200	800
Organic Chemicals and Plastics and Synthetic Resins	5	NA	NA	NA	29
Paint and Ink Formulation (c)	33	33	<10	<1,000	<70
Petroleum Refining (b)	17	17	<1.0	<15	<10
Soap and Detergent Manufacturing (a)	2	2	5.9	18	12
Steam Electric Power Plants (e)	11	1		1.0	
Timber Products Processing	23	23	0.5	10	1.7

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF THALLIUM

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	<5.0	50	<28
Coal Mining (b)	113	19	1.0	140	13
Inorganic Chemicals Manufacturing (b)	15	13	0.33	260	<70
Iron and Steel Manufacturing (a)	4	4	50	80	60
Foundries	9	3	<10	<10	<10
Photographic Equipment/Supplies (d)	17	3	5.0	5.0	5.0
Pharmaceutical Manufacturing	1	1		1.0	
Nonferrous Metals Manufacturing (f)	31	31	<1.0	2.0 × 10E6	<160
Ore Mining and Dressing (b)	71	3	NA	840	530
Organic Chemicals and Plastics and Synthetic Resins	5	NA	NA	NA	23
Paint and Ink Formulation (c)	19	19	<10	<1,000	<68
Petroleum Refining (b)	19	19	<1.0	<15	<10
Steam Electric Power Plants (e)	12	0			
Timber Products Processing	10	10	1.0	7.0	2.3

NA, not available. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR THALLIUM

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	11		NM	<15 - <50	
-powdered	4		NM	<15 - <15	
Chemical Oxidation					III.3.1.2
-ozone	1		NM	<50	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		5	50	<10 - 110	
-combined precipitants		4	>37	<10 - <10	
-lime		2	58 - >75	1.1 - <20	
-sodium carbonate		1	NM	41	
-sulfide		1	NM	200	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	<50	
-sodium sulfide		2	NM	<45 - 150	
Chemical Reduction		2	0 - 94	<1.0 - 50	III.3.1.4
Coagulation and Flocculation		1	NM	<1.0	III.3.1.5
Filtration	11	4	NM	0.1 - <100	III.3.1.9
Flotation		3	NM	BDL - 50	III.3.1.10
Sedimentation		14	38 - >83	BDL - <1,000	III.3.1.18
Activated Sludge		20	38	BDL - 29	III.3.2.1
Lagoons					III.3.2.2
-aerated		3	7 - >80	13 - 58	

BDL, below detection limit; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to thallium.

Freshwater Aquatic Life

The available data for thallium indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 1,400 and 40 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Toxicity to one species of fish occurs at concentrations as low as 20 µg/L after 2,600 hours of exposure.

Saltwater Aquatic Life

The available data for thallium indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 2,130 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of thallium to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of thallium ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 13 µg/L.

For the protection of human health from the toxic properties of thallium ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 48 µg/L.

Compound: Zinc

Formula: Zn

Alternate Names: None

CAS #: 7440-66-6

Physical, Chemical, and Biological Properties [1-2, 1-3, 1-4]:

molecular weight: 65.38
melting point, °C: 420
boiling point (760 torr), °C: 907
vapor pressure (25°C), torr: Negligible
solubility in water, mg/L: ZnO, 1.6 at 29°C; $ZnCl_2$, 4.32 x 10^6 at 25°C
common oxidation states: cation - always +2 in aqueous solution
water quality criteria: See page I.4.15-5

Probable Fate:

photolysis: Not important

oxidation: ZnS precipitates under reducing conditions; most redox conditions do not affect Zn directly, but affect materials which sorb Zn

hydrolysis: $Zn(OH)_2$ and ZnO precipitate after formation by hydrolysis

volatilization: Not important

sorption: Dominant fate of Zn is sorption by hydrous metal oxides, clay minerals, and organic materials

biological processes: Strongly bioaccumulated in all organisms and biotransformed to many zinc-containing enzymes.

other reactions/interactions: Forms complexes with organic and inorganic ligands which increase solubility, and increase the tendency for adsorption

Precipitation/Coagulation Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF ZINC

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Auto and Other Laundries (a)	87	86	100	10,000	<2,100
Coal Mining (b)	104	91	7.0	30,000	1,400
Inorganic Chemicals Manufacturing (b)	49	49	1	1.6 x 10E5	5,200
Iron and Steel Manufacturing (a)	115	115	20	1.9 x 10E5	<9,400
Leather Tanning and Finishing	18	18	96	2,600	540
Aluminum Forming	41	37	<10	2.1 x 10E6	<62,000
Battery Manufacturing (f) (g)	80	79	ND	3.3 x 10E6	1.8 x 10E5
Coil Coating	81	79	13	7.1 x 10E5	51,000
Electrical/Electronic Components (c)	28	27	<10	360	<74
Foundries	42	30	90	3.5 x 10E5	51,000
Metal Finishing (b) (f)	194	193	ND	1.6 x 10E7	1.1 x 10E5
Photographic Equipment/Supplies (d)	56	56	2.7	4.3 x 10E6	3.0 x 10E5
Porcelain Enameling	38	37	78	2.0 x 10E5	49,000
Explosives Manufacturing	11	10	24	2,700	700
Gum and Wood Chemicals	5	5	50	600	280
Pharmaceutical Manufacturing	8	8	69	2,700	530
Nonferrous Metals Manufacturing (h)	32	32	30	2.0 x 10E6	<2.0 x 10E5
Ore Mining and Dressing (b)	106	106	NA	3.0 x 10E5	34,000
Organic Chemicals and Plastics and Synthetic Resins	39	NA	NA	NA	25,000
Paint and Ink Formulation (c)	33	33	<600	4.3 x 10E5	<60,000
Petroleum Refining (b)	18	18	<45	2,100	<480
Pulp and Paperboard Mills (f)	178	178	5.0	54,000	1,100
Rubber Processing	2	2	100	14,000	7,000
Soap and Detergent Manufacturing (a)	7	7	15	2,500	620
Steam Electric Power Plants (e)	32	29	10	8.4 x 10E5	93,000
Timber Products Processing	23	23	120	26,000	1,600

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Detections may include values less than 5 µg/L.
(h) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF ZINC

Industry	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Auto and Other Laundries (a)	13	12	60	2,300	<510
Coal Mining (b)	113	85	6.0	380	59
Inorganic Chemicals Manufacturing (b)	28	26	1.0	1.2 x 10E5	<4,800
Iron and Steel Manufacturing (a)	100	100	10	38,000	<1,300
Leather Tanning and Finishing	6	6	49	170	91
Aluminum Forming	30	27	<10	2.0 x 10E6	<1.4 x 10E5
Coil Coating	16	16	86	28,000	3,200
Foundries	40	32	12	1.9 x 10E5	9,000
Metal Finishing (b) (f)	10	10	23	41,000	7,200
Photographic Equipment/Supplies (d)	23	20	12	4,600	1,200
Porcelain Enameling	20	20	12	3.7 x 10E5	51,000
Gum and Wood Chemicals	5	5	37	38,000	7,700
Pharmaceutical Manufacturing	8	8	1.0	2,000	340
Nonferrous Metals Manufacturing (g)	34	34	58	2.0 x 10E6	<1.5 x 10E5
Ore Mining and Dressing (b)	92	82	NA	11,000	900
Organic Chemicals and Plastics and Synthetic Resins	39	NA	NA	NA	490
Paint and Ink Formulation (c)	19	19	<600	35,000	<7,700
Petroleum Refining (b)	19	19	33	1,000	<280
Pulp and Paperboard Mills (f)	163	163	ND	2,900	200
Rubber Processing	2	2	2,500	13,000	7,800
Steam Electric Power Plants (e)	12	9	2.3	1,200	220
Timber Products Processing	10	10	47	31,000	3,400

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ZINC

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	16	3	7 - >99	<1.0 - 6,000	
-powdered	4	1	22 - 98	<45 - 140	
Chemical Oxidation					III.3.1.2
-ozone	3		96	90 - 460	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	6	61 - 97	40 - <8,900	
-barium chloride		2	50 - 80	30 - 30	
-combined precipitants		5	68 - >99	32 - 35,000	
-lime	4	24	25 - >99	13 - 26,000	
-sodium carbonate		2	83 - 99	330 - 11,000	
-sodium hydroxide		5	80 - >99	44 - 560	
-sulfide		1	66	100	
-unspecified		19	10 - >99	ND - 1.8 × 10E6	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1	1	99	10 - 330	
-sodium sulfide		2	>92 - >99	<25 - <100	
-unspecified		2	91 - 99	140 - 890	
Chemical Reduction		8	77 - >99	BDL - 1,500	III.3.1.4
Coagulation and Flocculation	2	8	11 - 98	BDL - 6,700	III.3.1.5
Filtration	25	17	0 - >99	16 - 18,000	III.3.1.9
Flotation		13	12 - >99	ND - 53,000	III.3.1.10
Neutralization		1	99	30	III.3.1.13
Oil Separation		4	94* - >97	BDL - 680	III.3.1.14
Reverse Osmosis	11		31 - 99	25 - 8,600	III.3.1.16
Sedimentation	3	38	0 - >99	BDL - 1.0 × 10E5	III.3.1.18
Solvent Extraction		1	50	120	III.3.1.20
Ultrafiltration	4	2	>64 - 98	BDL - 5,200	III.3.1.21
Activated Sludge		38	0 - 94	48 - 38,000	III.3.2.1
Lagoons					III.3.2.2
-aerated		7	12 - >99	44 - 510	
-non-aerated		2	86	100 - 120	

BDL, below detection limit; ND, not detected; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to zinc.

Freshwater Aquatic Life

For total recoverable zinc the criterion to protect freshwater aquatic life as derived using the Guidelines is 47 µg/L as a 24-hour average and the concentration (in µg/L) should not exceed the numerical value given by e (0.83 [ln (hardness)] +1.95) at any time. For example, at hardnesses of 50, 100, and 200 mg/L as $CaCo_3$ the concentration of total recoverable zinc should not exceed 180, 320, and 570 µg/L at any time.

Saltwater Aquatic Life

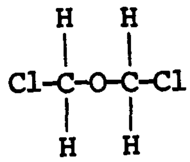
For total recoverable zinc the criterion to protect saltwater aquatic life as derived using the Guidelines is 58 µg/L as a 24-hour average and the concentration should not exceed 170 µg/L at any time.

Human Health

Sufficient data is not available for zinc to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 5 mg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: Bis(chloromethyl) ether

Formula:



Alternate Names: BCME; Bis-CME; sym-Dichloromethyl ether; Oxybis(chloromethane)

CAS #: 542-88-1

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 115
melting point, °C: -41.5
boiling point (760 torr), °C: 104
vapor pressure (22°C), torr: 30
solubility in water, mg/L: 22,000
log octanol/water partition coefficient: -0.38
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: See page I.5.1-5

Probable Fate [1-7]:

photolysis: Can occur, but cannot compete with hydrolysis in water

oxidation: Oxidation by hydroxyl radical can compete with hydrolysis in air but not in water

hydrolysis: Very rapidly hydrolyzed, independent of pH, decomposes to HCl and formaldehyde even in moist air

volatilization: Cannot compete with hydrolysis

sorption: Not important

biological processes: Not important

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF BIS(CHLOROMETHYL) ETHER

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Foundries	53	0			
Metal Finishing (a) (d)	1	1		9.0	
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	33	0			
Textile Mills (a) (c)	58	1		6.0	
Timber Products Processing					

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Mean calculated using medians.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BIS(CHLOROMETHYL) ETHER

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Ore Mining and Dressing (a)	28	0			

See Section 1.1 introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BIS(CHLOROMETHYL) ETHER

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Sludge		1	>99	ND	III.3.2.1

ND, not detected.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to chloroalkyl ethers.

Freshwater Aquatic Life

The available data for chloroalkyl ethers indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 238,000 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of chloroalkyl ethers to sensitive freshwater aquatic life.

Saltwater Aquatic Life

No saltwater organisms have been tested with any chloroalkyl ether and no statement can be made concerning acute and chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of bis(chloromethyl)ether through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 0.038 ng/L, 0.0038 ng/L, and 0.00038 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 18.4 ng/L, 1.84 ng/L, and 0.184 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of bis (2-chloroethyl) ether through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding criteria are 0.3 µg/L, 0.03 µg/L, and 0.003 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 13.6 µg/L, 1.36 µg/L, and 0.136 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the protection of human health from the toxic properties of bis (2-chloroisopropyl) ether ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 34.7 μg/L.

For the protection of human health from the toxic properties of bis (2-chloroisopropyl) ether ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 4.36 mg/L.

Compound: Bis(2-chloroethyl) ether

Formula:

```
       H H   H H
       | |   | |
    Cl-C-C-O-C-C-Cl
       | |   | |
       H H   H H
```

Alternate Names: 1,1'-Oxybis(2-chloroethane); Bis(β-chloroethyl)ether; Chlorex; 1-Chloro-2-(β-chloroethoxy) ethane

CAS #: 111-44-4

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 143.0
melting point, °C: -46.8
boiling point (760 torr), °C: 178
vapor pressure (20°C), torr: 0.71
solubility in water (25°C), mg/L: 10,200
log octanol/water partition coefficients: 1.58
Henry's law constant (25°C): 2.16×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.5.1-5

Probable Fate [1-7]:

photolysis: Direct photolysis is not important for the aquatic environment

oxidation: Photooxidation not important for the aquatic environment

hydrolysis: Much too slow to be important

volatilization: Not appreciably volatile

sorption: Little potential for sorption on solids

biological processes: No bioaccumulation noted; biodegradation not important under natural conditions; may be biodegraded in acclimated sewage systems

other reactions/interactions: Not important; principal fate uncertain

Carbon Adsorption Data, Bis (2-chloroethyl) ether (1-8):

ADSORBABILITY

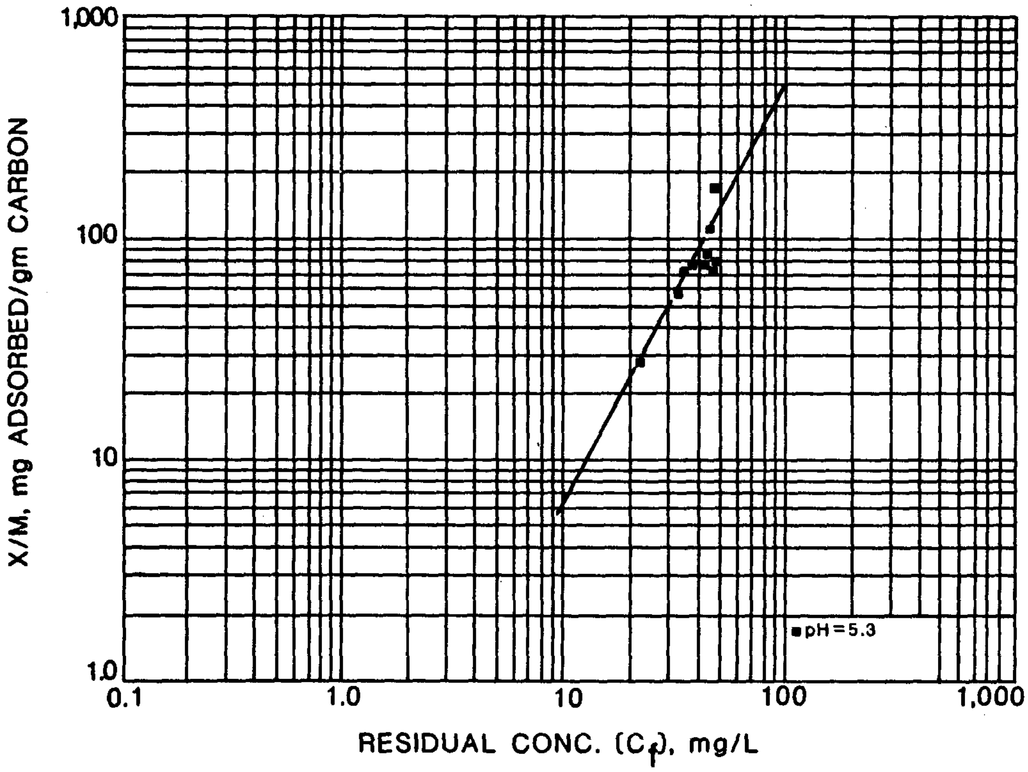
FREUNDLICH PARAMETERS	pH		
	5.3		
K	0.086		
1/n	1.84		
Corr. Coef. r	0.89		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	>100,000	>100,000	>100,000
0.1		>100,000	>100,000
0.01			>100,000

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Total Carbon

Date: 1/24/83 1.5.2-2

INDUSTRIAL OCCURRENCE OF BIS(2-CHLOROETHYL) ETHER

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Foundries	53	2	9	<10	<10
Metal Finishing (a) (c)	2	2	4.0	10	7.0
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	1,700

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BIS(2-CHLOROETHYL) ETHER

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	1		8.0	
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	710

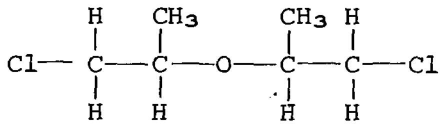
NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: Bis(2-chloroisopropyl) ether

Formula:



Alternate Names: Bis(2-chloro-1-methylethyl) ether;
2,2'-Oxybis (1-chloro-propane);
Dichlorodiisopropyl ether;
2,2'-Dichloroisopropyl ether

CAS #: 108-60-1

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 171.1
melting point, °C: -97
boiling point (760 torr), °C: 189
vapor pressure (20°C), torr: 0.85
solubility in water (temp. unknown), mg/L: 1,700
log octanol/water partition coefficient: 2.58
Henry's law constant (25°C): 1.53×10^{-4} atmos. m^3 mole $^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.5.1-5

Probable Fate [1-7]:

photolysis: Direct photolysis is probably not important

oxidation: Not environmentally significant

hydrolysis: Slow hydrolysis of carbon-chlorine bond; may be important fate mechanism

volatilization: Importance unknown

sorption: Little data available, but adsorption on organic matter possible

biological processes: No data on bioaccumulation and biodegradation in the environment. Biodegradation may occur in acclimated sewage systems.

other reactions/interactions: None of importance known; principal fate uncertain

Carbon Adsorption Data, Bis(2-chloroisopropyl)ether (1-8):

ADSORBABILITY

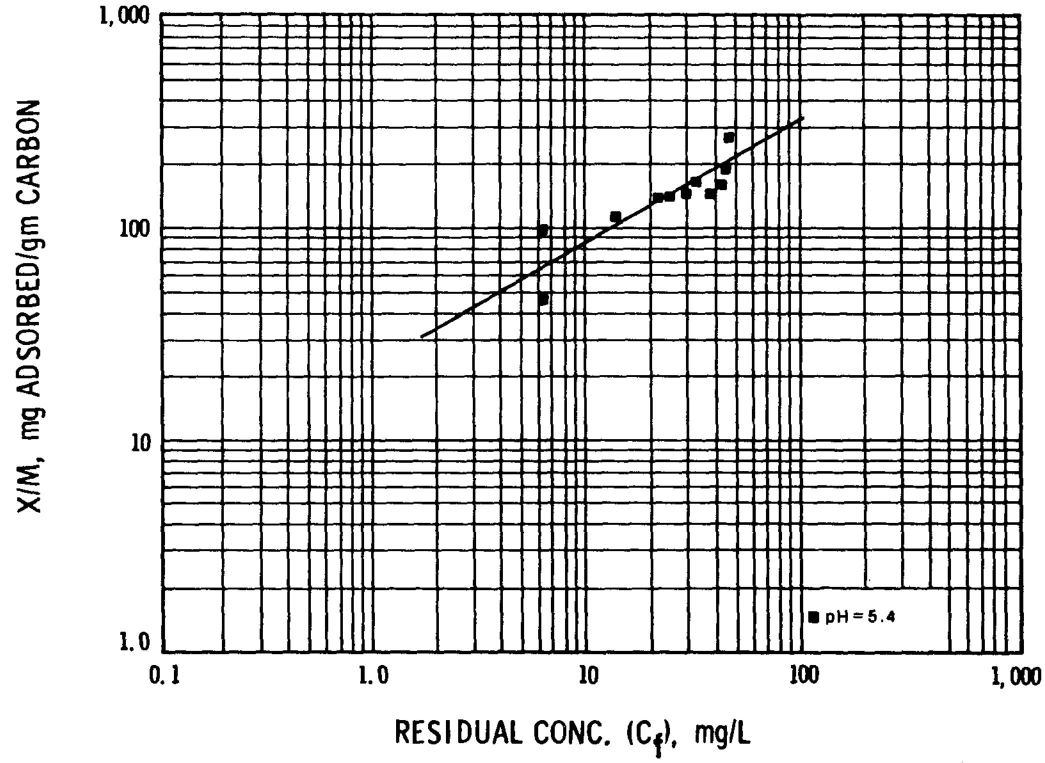
FREUNDLICH PARAMETERS	pH		
	5.4		
K	24		
1/n	0.57		
Corr. Coef. r	0.91		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	140	580	2,200
0.1		55	220
0.01			20

(a) Carbon doses in mg/L at pH 5.4



ANALYTICAL METHOD: Total Carbon

INDUSTRIAL OCCURRENCE OF BIS(2-CHLOROISOPROPYL) ETHER

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	49	0			
Leather Tanning and Finishing	18	0			
Foundries	53	0			
Metal Finishing (b) (d)	1	1		4.0	
Photographic Equipment/Supplies (c)	7	0			
Organic Chemicals and Plastics and Synthetic Resins	7	NA	NA	NA	11,000

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BIS(2-CHLOROISOPROPYL) ETHER

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	53	0			
Foundries	53	1		3.0	
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	1,300

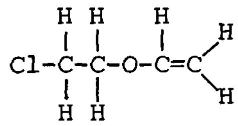
NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: 2-Chloroethyl vinyl ether

Formula:



Alternate Names: (2-Chloroethoxy) ethene;
Vinyl 2-chloroethyl ether

CAS #: 110-75-8

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 106.6
melting point, °C: -69.7
boiling point (760 torr), °C: 108
vapor pressure (20°C), torr: 26.75
solubility in water (temp. unknown), mg/L: 15,000
log octanol/water partition coefficient: 1.28
Henry's law constant (25°C): 2.16×10^{-5} atmos. m^3 mole $^{-1}$ (calculated)
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.5.4-5

Probable Fate [1-7]:

photolysis: Direct photolysis is probably not important

oxidation: Not important for aqueous environment

hydrolysis: Of minor importance if compound is adsorbed by clays or fulvic acids

volatilization: High vapor pressure indicates some volatilization

sorption: Low potential for adsorption by clays and humic materials

biological processes: Insufficient environmental data to reach conclusion. May degrade in acclimated sewage systems

other reactions/interactions: Not important

Carbon Adsorption Data, 2-Chloroethyl vinyl ether(1-8):

ADSORBABILITY

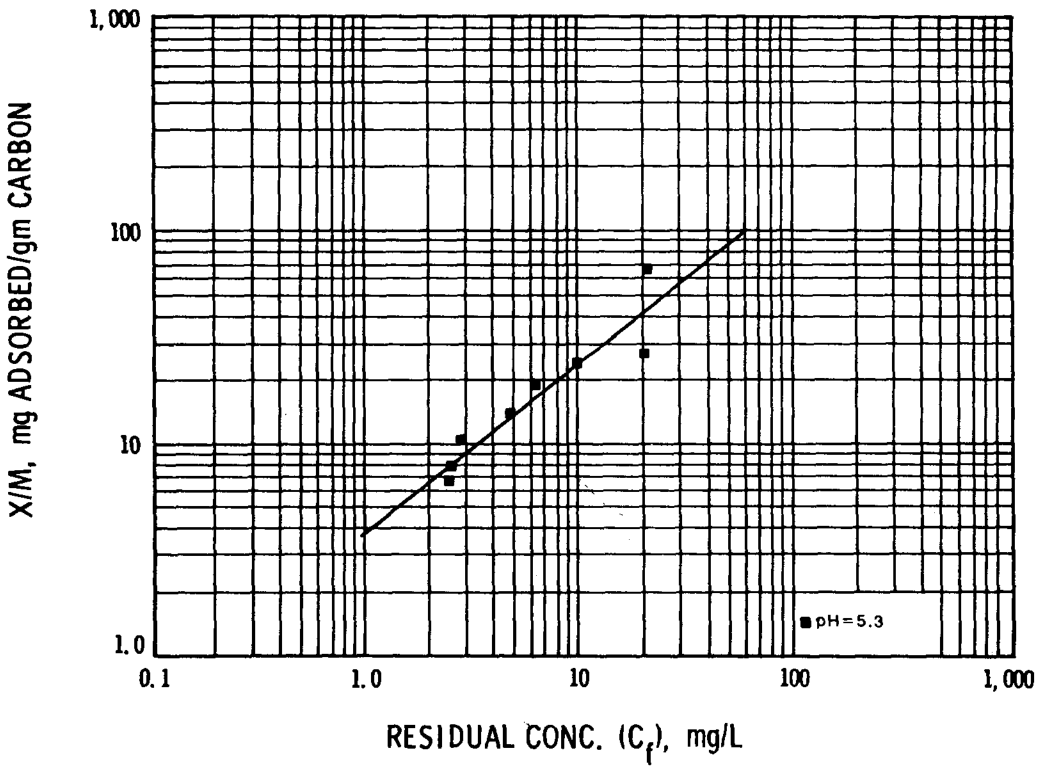
FREUNDLICH PARAMETERS	pH		
	5.3		
K	3.9		
1/n	0.80		
Corr. Coef. r	0.94		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	1,500	10,000	64,000
0.1		920	6,400
0.01			580

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Total Carbon

INDUSTRIAL OCCURRENCE OF 2-CHLOROETHYL VINYL ETHER

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Foundries	53	0			
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing	9	0			
Ore Mining and Dressing (a)	32	0			

See Section 1.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 2-CHLOROETHYL VINYL ETHER

Industry	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Nonferrous Metals Manufacturing	11	0			
Ore Mining and Dressing (a)	28	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

RESERVED

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to haloethers.

Freshwater Aquatic Life

The available data for haloethers indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 360 and 122 μg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

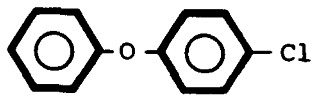
No saltwater organisms have been tested with any haloether and no statement can be made concerning acute or chronic toxicity.

Human Health

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for haloethers.

Compound: 4-Chlorophenyl phenyl ether

Formula:



Alternate Names: 1-Chloro-4-phenoxybenzene; p-Chlorophenyl phenyl ether; 4-Chlorodiphenyl ether; 4-Chlorophenyl ether

CAS #: 7005-72-3

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 203.7
melting point, °C: -8
boiling point (760 torr), °C: 284
vapor pressure (25°C), torr: 0.0027
solubility in water (25°C), mg/L: 3.3
log octanol/water partition coefficient: 4.08
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.5.4-5

Probable Fate [1-7]:

photolysis: Could be important if compound is adsorbed by humus containing sensitizers (polyfunctional aromatics)

oxidation: Too slow to be environmentally important

hydrolysis: Not environmentally significant

volatilization: Although no data available, believed to be unimportant

sorption: Adsorption by humus certain; by clays probable

biological processes: Possible bioaccumulation; gradual biodegradation in acclimated systems

other reactions/interactions: Not important

Carbon Adsorption Data, 4-Chlorophenyl phenyl ether (1-8):

ADSORBABILITY

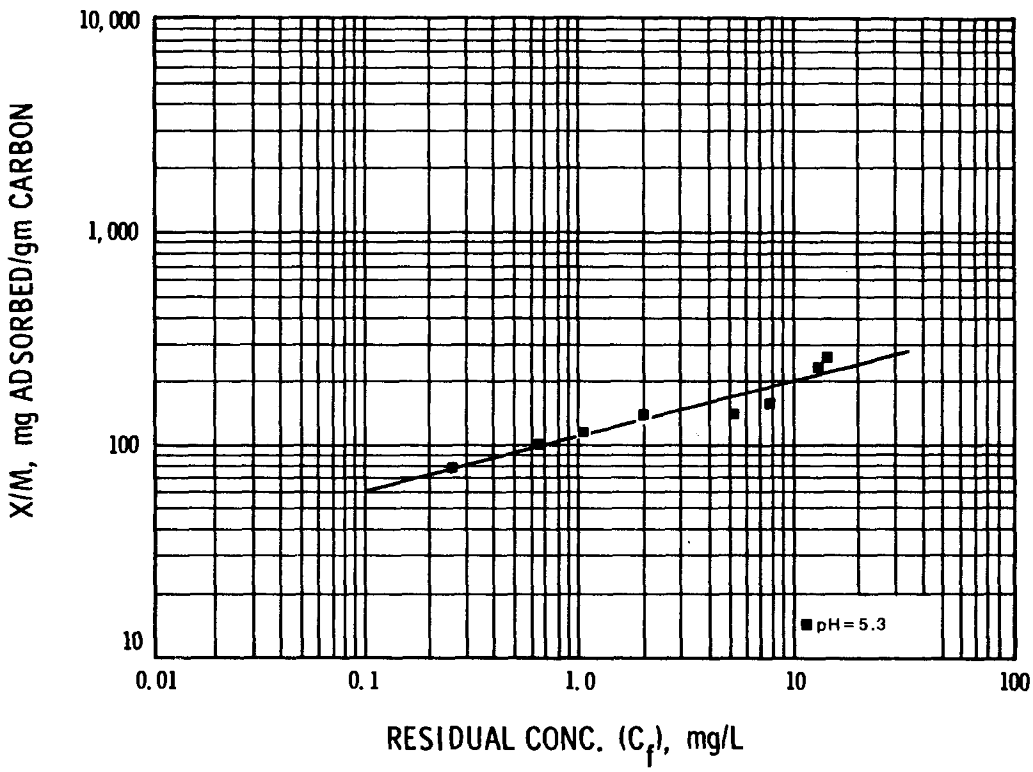
FREUNDLICH PARAMETERS	pH		
	5.3		
K	111		
1/n	0.26		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	15	30	55
0.1		2.7	5.4
0.01			0.5

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Ultraviolet Spectroscopy 225.6 nm

INDUSTRIAL OCCURRENCE OF 4-CHLOROPHENYL PHENYL ETHER

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, μg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	49	1		3.0	
Foundries	53	0			
Photographic Equipment/Supplies (c)	7	0			
Paint and Ink Formulation (b)	1	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 4-CHLOROPHENYL PHENYL ETHER

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	0			

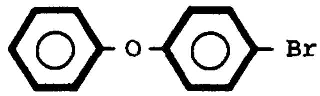
See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: 4-Bromophenyl phenyl ether

Formula:



Alternate Names: 1-Bromo-4-phenoxybenzene; p-Bromophenyl phenyl ether; 4-Bromodiphenyl ether; 4-Bromophenyl ether

CAS #: 101-55-3

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 249.1
melting point, °C: 18.7
boiling point (760 torr), °C: 310
vapor pressure (20°C), torr: 0.0015
solubility in water (20°C), mg/L: No data found
log octanol/water partition coefficient: 4.28 (calculated)
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.5.4-5

Probable Fate [1-7]:

photolysis: Could be important if adsorbed by sensitizer-containing humus

oxidation: Not environmentally significant

hydrolysis: Not environmentally significant

volatilization: Believed to be unimportant

sorption: Adsorption by humus certain; by clays probable

biological processes: Bioaccumulation possible; gradual biodegradation probable principal fate in acclimated systems

other reactions/interactions: Not important

Carbon Adsorption Data, 4-Bromophenyl phenyl ether (1-8):

ADSORBABILITY

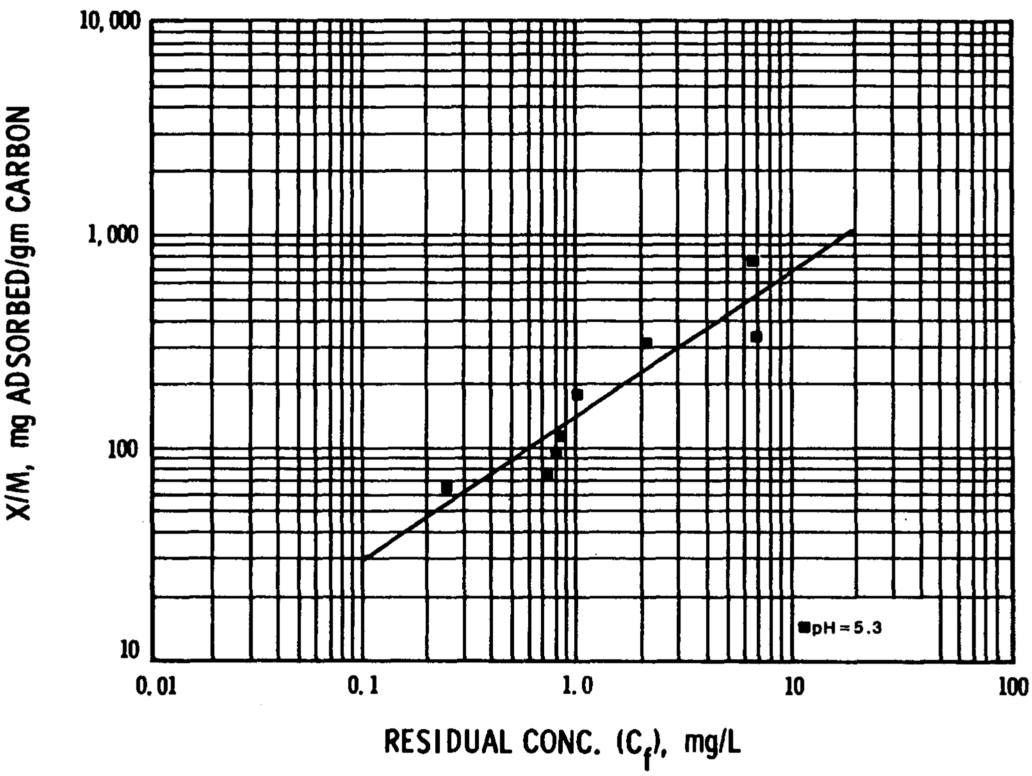
FREUNDLICH PARAMETERS	pH		
	5.3		
K	144		
1/n	0.68		
Corr. Coef. r	0.91		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	30	160	770
0.1		14	76
0.01			6.9

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Ultraviolet Spectroscopy 229.5 nm

INDUSTRIAL OCCURRENCE OF 4-BROMOPHENYL PHENYL ETHER

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Foundries	53	0			
Photographic Equipment/Supplies (b)	7	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 4-BROMOPHENYL PHENYL ETHER

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, μg/L: Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: Bis(2-chloroethoxy)methane

Formula:

```
    H H   H   H H
    | |   |   | |
 Cl-C-C-O-C-O-C-C-Cl
    | |   |   | |
    H H   H   H H
```

Alternate Names: Dichlorodiethyl methylal;
Bis(β-chloroethyl)formal;
β,β-Dichlorodiethyl formal

CAS #: 111-91-1

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 173.1
melting point, °C: -32.8
boiling point (760 torr), °C: 218
vapor pressure (20°C), torr: <0.1 (calculated)
solubility in water (temp. unknown), mg/L: 81,000
log octanol/water partition coefficient: 1.26 (calculated)
Henry's law constant (25°C): 3.78×10^{-7} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: N-not significantly degraded
water quality criteria: See page I.5.4-5

Probable Fate [1-7]:

photolysis: Not environmentally significant

oxidation: Could occur, but too slow for environmental significance

hydrolysis: Could occur, but too slow for environmental significance

volatilization: Not important for environmental fate

sorption: Information not available, but physical properties indicate little adsorption

biological processes: Information not available on biodegradation in the environment

other reactions/interactions: Not important

Carbon Adsorption Data, Bis(2-chloroethoxy)methane (1-8):

ADSORBABILITY

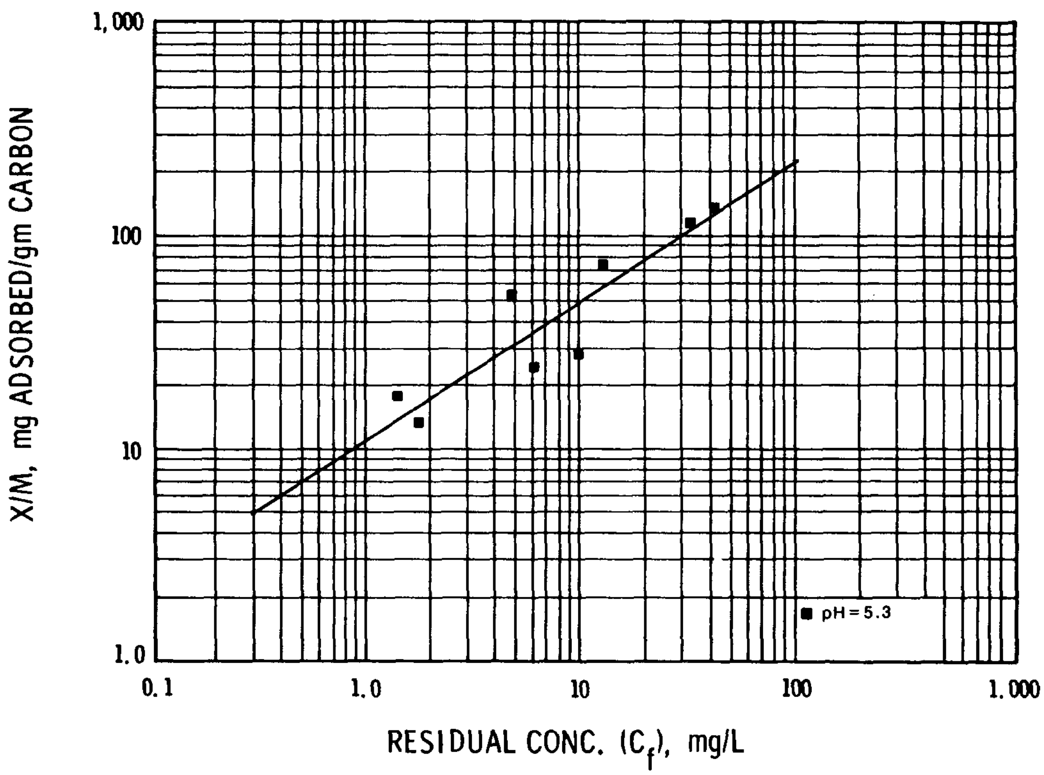
FREUNDLICH PARAMETERS	pH		
	5.3		
K	11		
1/n	0.65		
Corr. Coef. r	0.91		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, Cf mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	350	1,700	7,800
0.1		160	770
0.01			70

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Total Carbon

INDUSTRIAL OCCURRENCE OF BIS(2-CHLOROETHOXY)METHANE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	49	0			
Foundries	53	2	<10	20	<15
Metal Finishing (b) (e)	1	1		3.0	
Photographic Equipment/Supplies (d)	7	0			
Organic Chemicals and Plastics and Synthetic Resins (c)	3	NA	NA	NA	0.01
Paint and Ink Formulation (c)	1	0			

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BIS(2-CHLOROETHOXY)METHANE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	53	1	3.0		
Foundries	53	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Paint and Ink Formulation (c)	1	1		<10	

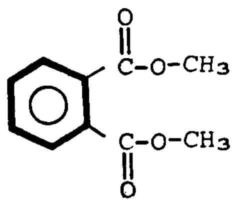
NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperwood Mills.

Compound: Dimethyl phthalate

Formula:



Alternate Names: DMP; 1,2-Benzenedicarboxylic acid, dimethyl ester;
Phthalic acid dimethyl ester;
Methyl phthalate

CAS #: 131-11-3

Physical, Chemical, and Biological Properties [1-7, 1-9, 1-28]:

molecular weight: 194.2
melting point, °C: 5.5
boiling point (760 torr), °C: 282
vapor pressure (20°C), torr: <0.01
solubility in water (25°C), mg/L: 4,320
log octanol/water partition coefficients: 2.12 (calculated)
Henry's law constant (25°C): 3.24×10^{-7} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.6.1-5

Probable Fate [1-7]:

photolysis: No direct photolysis; indirect photolysis too slow to be important

oxidation: Not important

hydrolysis*: Too slow to be important under natural conditions

volatilization: Possible, but not important

sorption*: Sorption onto particles and biota and complexation with humic substances principal transport mechanism

biological processes*: Bioaccumulation, biodegradation, and biotransformation by many organisms are very important fates

other reactions/interactions: Not important

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*Inferred from data on phthalate esters as a group.

Carbon Adsorption Data, Dimethyl phthalate (1-8):

ADSORBABILITY

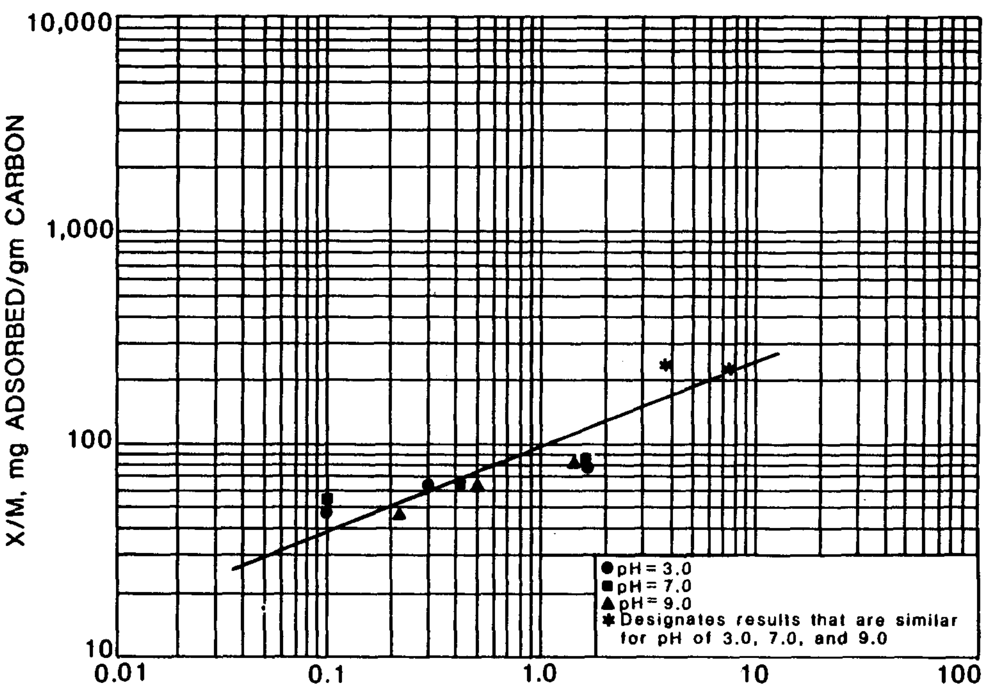
FREUNDLICH PARAMETERS	pH		
	All data pooled		
K	97		
1/n	0.41		
Corr. Coef. r	0.93		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o mg/L	0.1	0.01	0.001
1.0	24	67	180
0.1		6.1	17
0.01			1.6

(a) Carbon doses in mg/L at neutral pH



ANALYTICAL METHOD: Ultraviolet Spectroscopy 230 nm

INDUSTRIAL OCCURRENCE OF DIMETHYL PHTHALATE

	Raw wastewater				
	Number of	Number of	Detected concentrations, μg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	1		<5.0	
Coal Mining (b)	49	1		3.0	
Leather Tanning and Finishing	18	1		120	
Aluminum Forming	1	1		20	
Coil Coating (i)	78	5	0.0	110	37
Electrical/Electronic Components (c)	4	0			
Foundries	53	12	3.0	2,200	<260
Metal Finishing (b) (h)	135	72	ND	1,200	75
Photographic Equipment/Supplies (d)	15	2	5.0	7.7	6.4
Nonferrous Metals Manufacturing (f) (h)	70	6	ND	56	4.6
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	19	NA	NA	NA	510
Petroleum Refining (b)	21	0			
Rubber Processing	2	2	<9.0	<14	<12
Steam Electric Power Plants (e)	11	0			
Textile Mills (b) (g)	71	7	3.0	110	26

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 μg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Reference reports 0.0 μg/L for detections less than detection limit 10 μg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF DIMETHYL PHTHALATE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (b)	53	0			
Iron and Steel Manufacturing (a)	6	5	3.0	10	7.0
Coil Coating (h)	15	3	0.0	0.0	0.0
Foundries	53	14	<10	3,200	<280
Photographic Equipment/Supplies (c)	8	1		5.0	
Nonferrous Metals Manufacturing (e) (g)	55	6	ND	1,300	56
Ore Mining and Dressing (b)	28	3	NA	25	12
Organic Chemicals and Plastics and Synthetic Resins	19	NA	NA	NA	240
Petroleum Refining (b)	21	1		3.0	
Rubber Processing	2	2	<5.7	<14	<9.8
Steam Electric Power Plants (d)	12	1		<10	
Textile Mills (b) (f)	66	4	1.0	1.0	1.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Verification data plus surveillance and analysis program data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR DIMETHYL PHTHALATE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption -granular	1		NM	BDL	III.3.1.1
Coagulation and Flocculation		1	>99	ND	III.3.1.5
Filtration	1	1	99* - >99	ND - BDL	III.3.1.9
Reverse Osmosis	3		18 - >99*	BDL - 170	III.3.1.16
Sedimentation		6	97	BDL - 93	III.3.1.18
Ultrafiltration		1	83	22	III.3.1.21
Activated Sludge	1	8	>99 - >99	ND - 200	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to phthalate esters.

Freshwater Aquatic Life

The available data for phthalate esters indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 940 and 3 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for phthalate esters indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 2,944 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of phthalate esters to sensitive saltwater aquatic life but toxicity to one species of algae occurs at concentrations as low as 3.4 µg/L.

Human Health

For the protection of human health from the toxic properties of dimethylphthalate ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 313 mg/L.

For the protection of human health from the toxic properties of dimethylphthalate ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 2.9 g/L.

For the protection of human health from the toxic properties of diethylphthalate ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 350 mg/L.

For the protection of human health from the toxic properties of diethylphthalate ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 1.8 g/L.

For the protection of human health from the toxic properties of dibutylphthalate ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 34 mg/L.

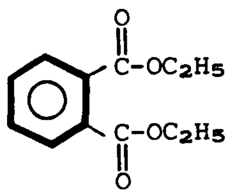
For the protection of human health from the toxic properties of dibutylphthalate ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 154 mg/L.

For the protection of human health from the toxic properties of bis (2-ethylhexyl) phthalate ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 15 mg/L.

For the protection of human health from the toxic properties of bis (2-ethylhexyl) phthalate ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 50 mg/L.

Compound: Diethyl phthalate

Formula:



Alternate Names: DEP; Ethyl phthalate;
1,2-Benzenedicarboxylic acid;
Diethyl ether

CAS #: 84-66-2

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 222.2
melting point, °C: -40.5
boiling point (760 torr), °C: 298
vapor pressure (70°C), torr: 0.05
solubility in water (25°C), mg/L: 896
log octanol/water partition coefficient: 3.22 (calculated)
Henry's law constant (25°C): 8.46×10^{-7} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.6.1-5

Probable Fate [1-7]:

photolysis: No direct photolysis; indirect photolysis too slow to be important

oxidation: Not important

hydrolysis*: No data, but believed to be too slow to be important under natural conditions

volatilization: Very little data, but volatilization is not considered as important as sorption

sorption*: Adsorption onto solids and particles and complexation with humic material (fulvic acid) are the principal transport for DEP

biological processes*: Bioaccumulation, biodegradation, and biotransformation by many organisms are very important fates

other reactions/interactions: Not important

*Inferred from data on phthalate esters as a group.

Carbon Adsorption Data, Diethyl phthalate (1-8):

ADSORBABILITY

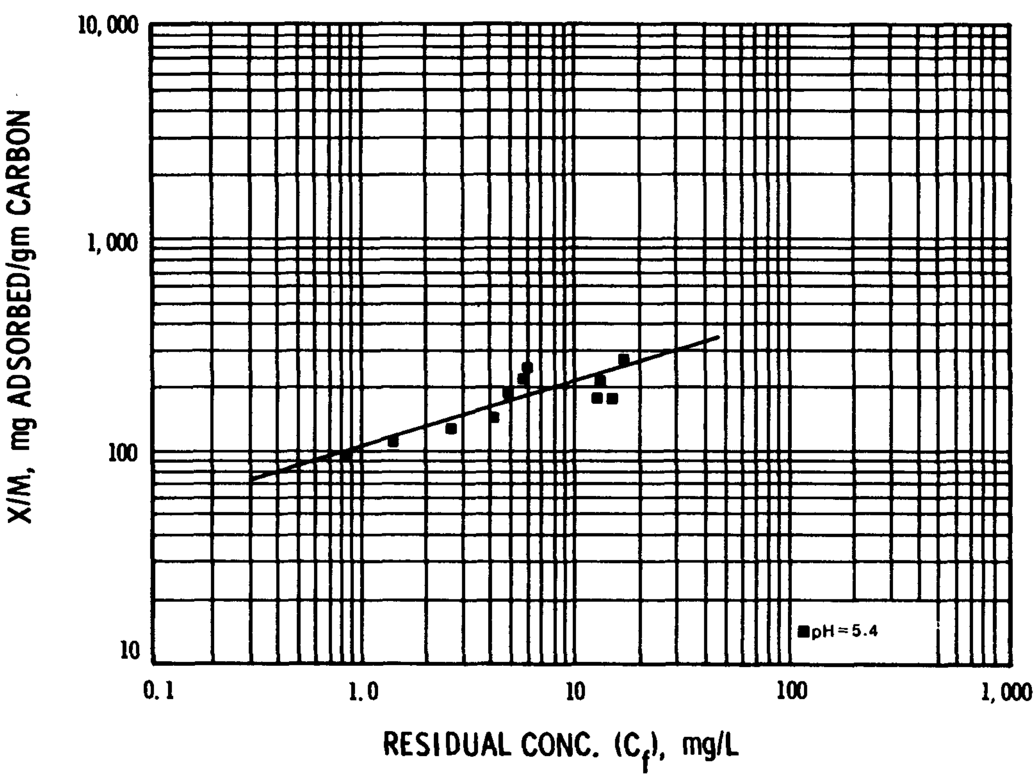
FREUNDLICH PARAMETERS	pH		
	5.4		
K	110		
1/n	0.27		
Corr. Coef. r	0.81		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	15	31	59
0.1		2.8	5.8
0.01			0.5

(a) Carbon doses in mg/L at pH 5.4



ANALYTICAL METHOD: Ultraviolet Spectroscopy 228 nm

INDUSTRIAL OCCURRENCE OF DIETHYL PHTHALATE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, μg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	22	6	<0.03	25	<9.0
Coal Mining (b)	49	11	1.0	23	5.0
Leather Tanning and Finishing	18	2	<10	<10	<10
Aluminum Forming	36	17	<0.3	3,100	<200
Battery Manufacturing (h) (i)	29	22	ND	<10	<8.3
Coil Coating (j)	78	60	0.0	450	110
Electrical/Electronic Components (c)	28	5	<10	<10	<10
Foundries	53	16	2.0	730	<110
Metal Finishing (b) (h)	115	95	ND	1,900	170
Photographic Equipment/Supplies (d) (j)	38	26	0.0	19	4.6
Nonferrous Metals Manufacturing (f) (h)	53	6	ND	83	4.7
Ore Mining and Dressing (b)	33	18	NA	90	24
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	700
Paint and Ink Formulation (c)	1	1		12	
Petroleum Refining (b)	21	1		12	
Pulp and Paperboard Mills (h)	100	34	ND	690	26
Steam Electric Power Plants (e)	11	1		50	
Textile Mills (b) (g)	71	20	1.0	150	22

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 μg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 μg/L.
(j) Reference reports 0.0 μg/L for detections less than detection limit 10 μg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF DIETHYL PHTHALATE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	0			
Coal Mining (b)	52	12	1.0	790	100
Iron and Steel Manufacturing (a)	6	4	5.0	10	7.5
Aluminum Forming	20	15	1.0	53,000	<3,600
Coil Coating (h)	16	16	0.0	330	54
Foundries	53	21	<10	10,000	<500
Photographic Equipment/Supplies (c)	12	7	1.5	14	5.4
Nonferrous Metals Manufacturing (e) (g)	44	4	ND	82	5.9
Ore Mining and Dressing (b)	28	4	NA	10	7.9
Organic Chemicals and Plastics and Synthetic Resins	8	NA	NA	NA	48
Petroleum Refining (b)	21	3	1.0	30	11
Pulp and Paperboard Mills (g)	188	13	ND	320	29
Steam Electric Power Plants (d)	12	1		10	
Textile Mills (b) (f)	66	14	1.0	12	4.0

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Verification data plus surveillance and analysis program data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR DIETHYL PHTHALATE

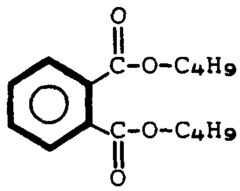
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	3	1	5	1.2 - 9.5	
Chemical Precipitation with Sedimentation					III.3.1.3
-lime		9	56 - 99	ND - 73	
-sodium carbonate		1	NM	BDL	
-sodium hydroxide		4	76 - 96*	ND - 92	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1		>99	ND	
Chemical Reduction		2	25	BDL - 75	III.3.1.4
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration	2	6	60 - >99	ND - 11,000	III.3.1.9
Flotation		1	>99	ND	III.3.1.10
Oil Separation		1	92	65	III.3.1.14
Sedimentation		7	NM	ND - 44	III.3.1.18
Ultrafiltration		2	95*	BDL - 23	III.3.1.21
Activated Sludge		18	20 - >99	ND - 69	III.3.2.1
Trickling Filters	1		NM	140	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Di-n-butyl phthalate

Formula:



Alternate Names: DBP; o-Benzenedicarboxylic acid, dibutyl ester; Benzene-o-dicarboxylic acid, di-n-butyl ester; n-Butyl phthalate; Dibutyl phthalate

CAS #: 84-74-2

Physical, Chemical, and Biological Properties [1-6, 1-7]:

molecular weight: 278.3
melting point, °C: -35
boiling point (760 torr), °C: 340
vapor pressure (115°C), torr: 0.1
solubility in water (25°C), mg/L: 13
log octanol/water partition coefficient: ~5.2 (exact value unknown due to molecular folding)
Henry's law constant: Not available
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.6.1-5

Probable Fate [1-7]:

photolysis: No direct photolysis; indirect photolysis too slow to be environmentally important

oxidation: Not important

hydrolysis*: Hydrolysis (only in surface waters) believed to be too slow to be important

volatilization: Not likely to be an important transport process

sorption*: Sorption onto particulates and complexation with organics are dominant transport processes

biological processes*: Bioaccumulated in many organisms; biodegraded rapidly in natural soil; some biotransformation; all biological processes important fates

other reactions/interactions: Not important

*Inferred from data on phthalate esters as a group.

Carbon Adsorption Data, Di-n-butyl phthalate (1-8):

ADSORBABILITY

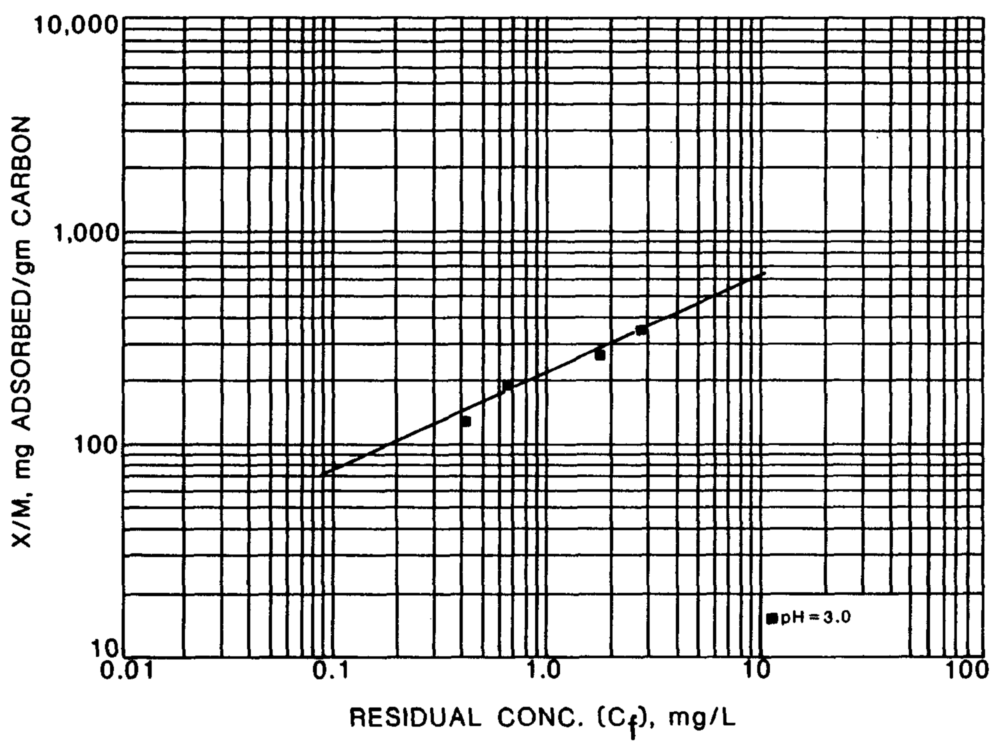
FREUNDLICH PARAMETERS	pH		
	3.0		
K	220		
1/n	0.45		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_0. mg/L	0.1	0.01	0.001
1.0	12	37	100
0.1		3.3	10
0.01			0.94

(a) Carbon doses in mg/L at pH 3.0



ANALYTICAL METHOD: Ultraviolet Spectroscopy 225 nm

INDUSTRIAL OCCURRENCE OF DI-N-BUTYL PHTHALATE

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	27	17	<0.02	820	<120
Coal Mining (b)	49	19	2.0	11	4.0
Inorganic Chemicals Manufacturing (b)	1	1		0.78	
Leather Tanning and Finishing	18	2	<10	<10	<10
Aluminum Forming	37	24	<0.3	19,000	<820
Battery Manufacturing (h) (i)	13	8	ND	<10	<10
Coil Coating (j)	78	28	0.0	170	10
Electrical/Electronic Components (c)	28	17	1.1	50	<10
Foundries	53	23	1.0	5,400	<350
Metal Finishing (b) (h)	118	106	ND	3,100	130
Photographic Equipment/Supplies (d)	56	55	0.12	1,400	63
Nonferrous Metals Manufacturing (f) (h) (k)	75	25	ND	390	25
Ore Mining and Dressing (b)	33	13	NA	56	16
Organic Chemicals and Plastics and Synthetic Resins	14	NA	NA	NA	2,300
Paint and Ink Formulation (c)	30	22	<5.0	36,000	<2,700
Petroleum Refining (b)	21	1		1.3	
Pulp and Paperboard Mills (h)	154	69	ND	230	11
Soap and Detergent Manufacturing (a)	3	3	0.5	15	9.5
Steam Electric Power Plants (e)	11	1		<10	
Textile Mills (b) (g)	71	20	1.0	67	17

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.
(j) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(k) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF DI-N-BUTYL PHTHALATE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	6	6	0.9	300	110
Coal Mining (b)	51	25	3.0	960	240
Iron and Steel Manufacturing (a)	6	6	7.0	18	11
Aluminum Forming	22	18	1.0	90,000	<5,000
Coil Coating (i)	16	12	0.0	3.5	0.58
Foundries	53	25	1.0	9,300	<410
Photographic Equipment/Supplies (d)	17	14	1.0	16	4.7
Nonferrous Metals Manufacturing (f) (h)	65	19	ND	110	17
Ore Mining and Dressing (b)	28	12	NA	140	26
Organic Chemicals and Plastics and Synthetic Resins	11	NA	NA	NA	140
Paint and Ink Formulation (c)	19	10	<5.0	1,300	<210
Petroleum Refining (b)	21	2	0.7	10	5.4
Pulp and Paperboard Mills (h)	142	28	ND	55	4.0
Steam Electric Power Plants (e)	12	1		<10	
Textile Mills (b) (g)	66	18	1.0	58	7.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR DI-N-BUTYL PHTHALATE

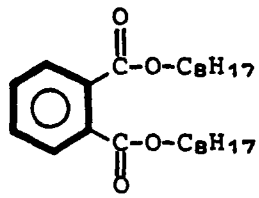
Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption					III.3.1.1
-granular	7	2	0 - 99*	BDL - 11	
Chemical Oxidation					III.3.1.2
-ozone	1		77	2.7	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		4	93* - >99	ND - 7.0	
-combined precipitants		4	>97 - >99	ND - 550	
-lime		9	NM	ND - BDL	
-sodium carbonate		1	NM	BDL	
-sodium hydroxide		4	NM	ND - BDL	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1	1	5	BDL - 5.4	
Chemical Reduction		2	NM	BDL - BDL	III.3.1.4
Coagulation and Flocculation	1	2	0 - >99	ND - 0.6	III.3.1.5
Filtration	8	10	0 - 96	0.43 - 9,300	III.3.1.9
Flotation		6	0 - >99	ND - 300	III.3.1.10
Oil Separation		1	96	49	III.3.1.14
Reverse Osmosis	6		20 - >99*	BDL - 1.0	III.3.1.16
Sedimentation		12	0 - 83	BDL - 36	III.3.1.18
Ultrafiltration		2	86 - >91	<5 - 13	III.3.1.21
Activated Sludge		11	84 - >99	ND - 58	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	>99	ND	
Trickling Filters	1		25	6.0	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Di-n-octyl phthalate

Formula:



Alternate Names: DOP; o-Benzenedicarboxylic acid, dioctyl ester; n-Dioctyl phthalate; Octyl phthalate; Dioctyl-o-benzenedicarboxylate

CAS #: 117-84-0

Physical, Chemical, and Biological Properties [1-6, 1-7]:

molecular weight: 391.0
melting point, °C: -25
boiling point (4 torr), °C: 220
vapor pressure (150°C), torr: <0.2
solubility in water (25°C), mg/L: 3
log octanol/water partition coefficient: ~9.2 (exact value unknown because of molecular folding)
Henry's law constant: Not available
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.6.1-5

Probable Fate [1-7]:

photolysis: No direct photolysis; indirect photolysis too slow to be important

oxidation: Not important

hydrolysis*: Hydrolysis only in surface waters but too slow to be important

volatilization: Not likely to be an important transport process

sorption*: Adsorption onto solids and particles and complexation with organics are important transport processes

biological processes*: Bioaccumulation by many organisms, biodegradation, and metabolization are all important fates

other reactions/interactions: Not important

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*Inferred from data on phthalate esters as a group.

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF DI-N-OCTYL PHTHALATE

	Raw wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	20	7	<5.0	410	<110
Coal Mining (b)	49	1		3.0	
Aluminum Forming	32	9	<0.5	94	<24
Battery Manufacturing (g) (h)	13	6	ND	140	10
Coil Coating (i)	78	7	0.0	760	150
Electrical/Electronic Components (c)	28	3	<10	<10	<10
Foundries	53	9	4.0	2,800	<340
Metal Finishing (b) (g)	114	70	ND	120	10
Photographic Equipment/Supplies (d)	15	3	0.84	6.2	4
Porcelain Enameling	8	0			
Explosives Manufacture	1	0			
Nonferrous Metals Manufacturing (e) (g)	76	9	ND	67	8.0
Ore Mining and Dressing (b)	10	3	NA	10	10
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	10
Paint and Ink Formulation (c)	2	1		3,600	
Textile Mills (b) (f)	66	2	1.0	10	5.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF DI-N-OCTYL PHTHALATE

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	4	3	4.0	33	16
Coal Mining (b)	53	1		3.0	
Iron and Steel Manufacturing (a)	6	1		3.0	
Aluminum Forming	22	3	20	50	32
Coil Coating (h)	16	4	0.0	0.0	0.0
Foundries	53	2	<10	73	<42
Photographic Equipment/Supplies (d)	7	5	1.0	5.0	3.0
Nonferrous Metals Manufacturing (e) (g)	60	8	ND	190	12
Ore Mining and Dressing (b)	7	3	NA	16	12
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	10
Paint and Ink Formulation (c)	1	1		<10	
Textile Mills (b) (f)	61	1		1.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR DI-N-OCTYL PHTHALATE

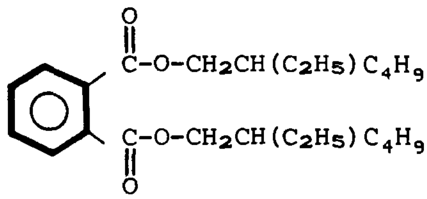
Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption					III.3.1.1
-granular		1	20	4.0	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	NM	5.0	
-lime		2	NM	ND - BDL	
Coagulation and Flocculation		2	>99	ND - ND	III.3.1.5
Filtration		4	50 - >99	ND - 4.0	III.3.1.9
Flotation		4	61 - >99	ND - 33	III.3.1.10
Ultrafiltration		1	>96	5.0	III.3.1.21
Activated Sludge	1		NM	5,000	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: Bis(2-ethylhexyl) phthalate

Formula:



Alternate Names: DEHP; Di(2-ethylhexyl) phthalate;
Bis(2-ethylhexyl) ester phthalic acid;
Di(2-ethylhexyl) orthophthalate;
Di-sec-octyl phthalate; 2-Ethylhexyl phthalate;
1,2-Benzene dicarboxylic acid; Bis(2-ethylhexyl) ester

CAS #: 117-81-7

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 391.0
melting point, °C: -50
boiling point (5 torr), °C: 387
vapor pressure (20°C), torr: 2×10^{-7}
solubility in water (25°C), mg/L: 0.4
log octanol/water partition coefficient: ~8.73 (exact value unknown because of molecular folding)
Henry's law constant: Not available
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.6.1-5

Probable Fate [1-7]:

photolysis: No direct photolysis; indirect photolysis too slow to be important

oxidation: Not important

hydrolysis: Too slow to be important (half-life of several years)

volatilization: Not a likely transport process

sorption: Sorption onto particulates and biota and complexation with humic materials are most important transport processes

biological processes: Bioaccumulation and metabolization by many organisms, and biodegradation are all very important fates

other reactions/interactions: Not important

Carbon Adsorption Data, Bis(2-ethylhexyl) phthalate (1-8):

ADSORBABILITY

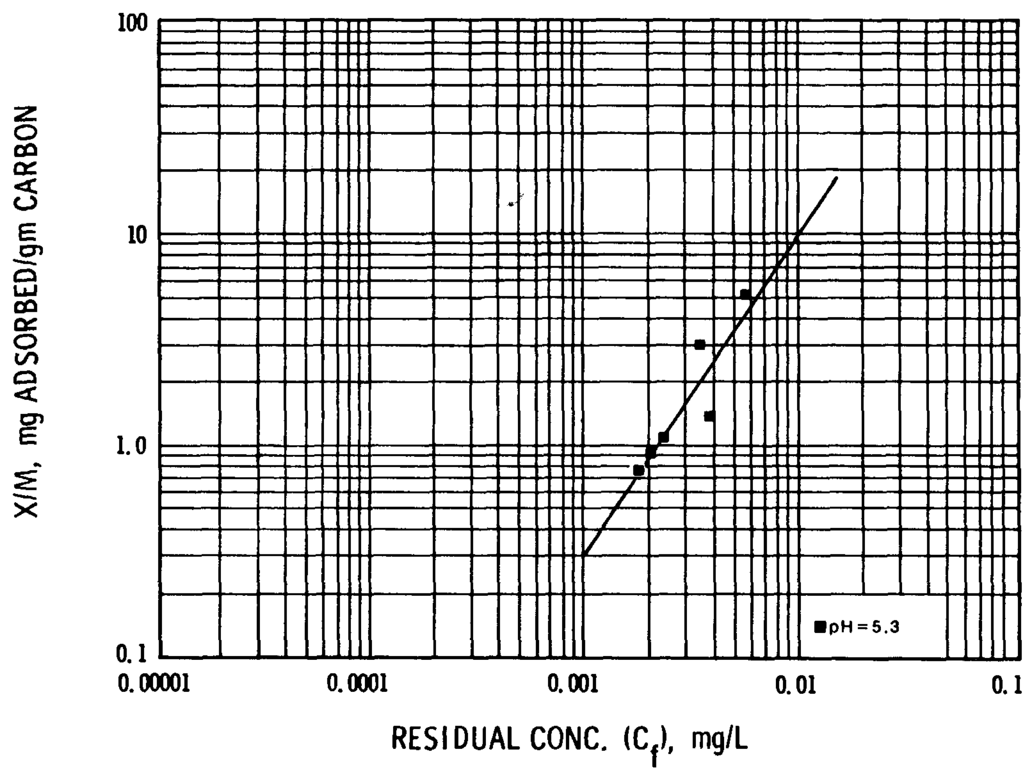
FREUNDLICH PARAMETERS	pH		
	5.3		
K	11,300		
1/n	1.5		
Corr. Coef. r	0.91		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	2.5	88	2,800
0.1		8.0	280
0.01			25

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent Extraction - G.C.

INDUSTRIAL OCCURRENCE OF BIS(2-ETHYLHEXYL) PHTHALATE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	31	27	<0.04	18,000	<2,600
Coal Mining (b)	49	21	3.0	62	16
Inorganic Chemicals Manufacturing (b)	1	1		0.75	
Leather Tanning and Finishing	18	3	32	93	59
Aluminum Forming	47	39	4.0	1,900	<120
Battery Manufacturing (h) (i)	28	28	<10	160	<38
Coil Coating (j)	78	63	0.0	1,200	100
Electrical/Electronic Components (c)	28	18	5.7	80	<20
Foundries	53	24	4.0	8.2 x 10E5	35,000
Metal Finishing (b) (h)	118	114	ND	9,300	400
Photographic Equipment/Supplies (d)	53	51	0.61	580	35
Porcelain Enameling	8	0			
Explosives Manufacturing	1	1		72	
Gum and Wood Chemicals	1	1		3,000	
Nonferrous Metals Manufacturing (f) (g)	75	54	ND	7,000	240
Ore Mining and Dressing (b)	33	15	NA	100	20
Organic Chemicals and Plastics and Synthetic Resins	57	NA	NA	NA	530
Paint and Ink Formulation (c)	30	18	<3.0	87,000	<12,000
Petroleum Refining (b)	21	5	180	700	360
Pulp and Paperboard Mills (h)	178	148	ND	2,500	53
Rubber Processing	6	6	<140	16,000	<2,900
Soap and Detergent Manufacturing (a)	1	1		20	
Steam Electric Power Plants (e)	11	1		<10	
Textile Mills (b) (g)	76	57	1.0	1,400	150
Timber Products Processing	12	12	10	1,500	240

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.
(j) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF BIS(2-ETHYLHEXYL) PHTHALATE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	10	7	22	1,000	310
Coal Mining (b)	52	36	3.0	11,000	940
Iron and Steel Manufacturing (a)	6	6	10	150	77
Leather Tanning and Finishing	6	4	2.0	34	17
Aluminum Forming	30	28	<2.0	3.0 x 10E5	<13,000
Coil Coating (i)	16	16	0.0	42	14
Foundries	53	25	2.0	16,000	1,100
Photographic Equipment/Supplies (d)	15	14	3.7	26	13
Gum and Wood Chemicals	1	1		1,900	
Nonferrous Metals Manufacturing (f) (h)	55	34	ND	1,200	100
Ore Mining and Dressing (b)	28	18	NA	12	50
Organic Chemicals and Plastics and Synthetic Resins	49	NA	NA	NA	120
Paint and Ink Formulation (c)	19	10	<5.0	80	<18
Petroleum Refining (b)	21	6	<10	2,000	<660
Pulp and Paperboard Mills (h)	163	106	ND	2,500	36
Rubber Processing	6	6	<24	<4,300	<880
Steam Electric Power Plants (e)	12	1		<10	
Textile Mills (b) (g)	94	75	1.0	760	56
Timber Products Processing	9	9	9.0	300	60

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BIS(2-ETHYLHEXYL) PHTHALATE

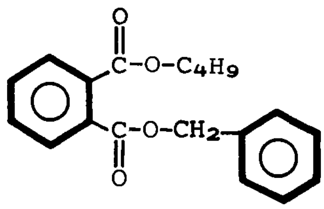
Treatment process	Number of data points Pilot scale	Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	8	3	0 - 66	3.9 - 410	
-powdered		1	99*	5.0	
Chemical Oxidation					III.3.1.2
-ozone	2		NM	90 - 110	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	4	99 - >99	ND - 67	
-barium chloride		2	95	2.4 - 15	
-combined precipitants		2	80	<10 - 80	
-lime		12	41 - 97	ND - 40	
-sodium carbonate		1	NM	BDL	
-sodium hydroxide		4	73 - 93*	BDL - 52	
-unspecified		2	50* - >97	BDL - <10	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1	1	97*	BDL - 46	
Chemical Reduction		3	NM	BDL - 84	III.3.1.4
Coagulation and Flocculation	2	3	16 - 91*	BDL - 44	III.3.1.5
Filtration	10	11	20 - 98	BLD - 16,000	III.3.1.9
Flotation		8	10 - 98	30 - 1,100	III.3.1.10
Oil Separation		2	91 - 96	44 - 130	III.3.1.14
Reverse Osmosis	6		25 - 99*	BDL - 31	III.3.1.16
Sedimentation	1	16	14 - 80	BDL - 170	III.3.1.18
Ultrafiltration		2	>95 - 99*	BDL - <10	III.3.1.21
Activated Sludge		38	15 - >99	ND - 230	III.3.2.1
Lagoons					III.3.2.2
-aerated		6	26 - >99	ND - <640	
-non-aerated		1	>99	ND	
Trickling Filters	1		83	6.0	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Butyl benzyl phthalate

Formula:



Alternate Names: BBP; Benzyl butyl phthalate

CAS #: 85-68-7

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 312.0
melting point, °C: -35
boiling point (760 torr), °C: 377
vapor pressure (25°C), torr: Not available
solubility in water (temperature unknown), mg/L: 2.9
log octanol/water partition coefficient: ~5.8 (exact value unknown because of molecular folding)
Henry's law constant: Not available
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.6.1-5

Probable Fate [1-7]:

photolysis: Direct photolysis improbable; indirect photolysis too slow to be important

oxidation: Could occur, but probably cannot compete with biodegradation

hydrolysis*: Too slow to be important

volatilization: Not a likely transport process

sorption*: Sorption onto particulates and complexation with organic substances are dominant transport processes

biological processes*: Bioaccumulated and metabolized by many organisms; biodegraded under natural conditions

other reactions/interactions: Not important

---

*Based on data for phthalate esters as a group.

Carbon Adsorption Data, Butyl benzyl phthalate (1-8):

ADSORBABILITY

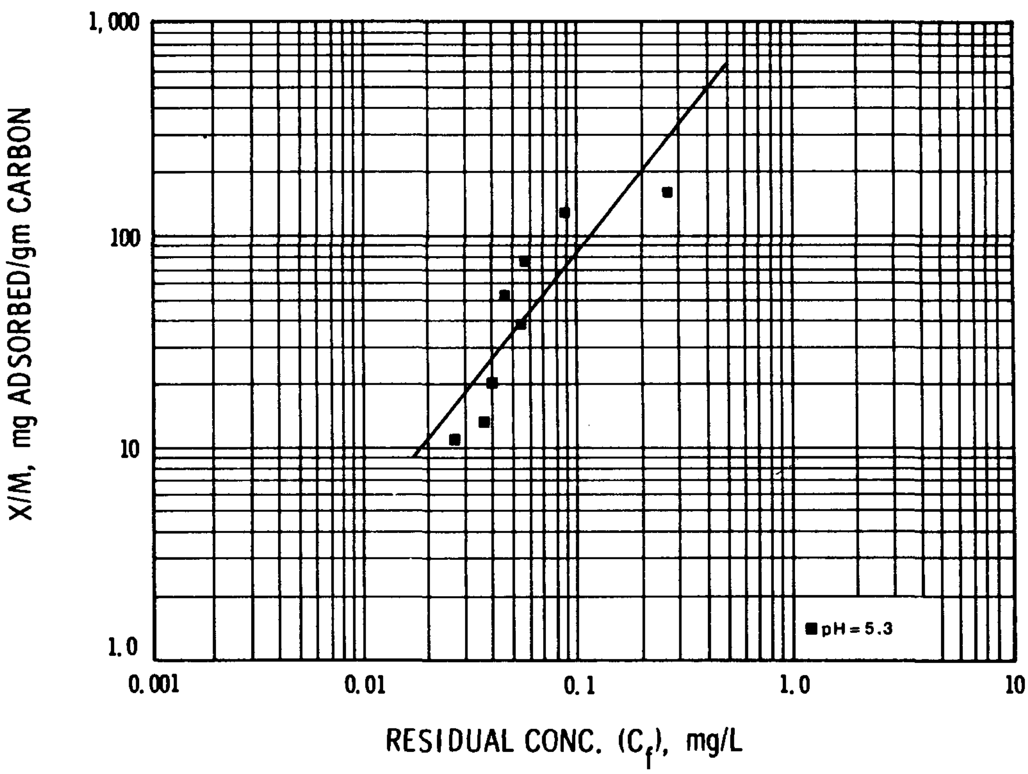
FREUNDLICH PARAMETERS	pH		
	5.3		
K	1,520		
1/n	1.26		
Corr. Coef. r	0.86		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	11	220	4,000
0.1		20	390
0.01			36

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent Extraction - G.C.

INDUSTRIAL OCCURRENCE OF BUTYL BENZYL PHTHALATE

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	18	5	<5.0	1,500	<240
Coal Mining (b)	49	4	3.0	3.0	3.0
Leather Tanning and Finishing	18	0			
Aluminum Forming	35	13	0.3	360	<69
Battery Manufacturing (g) (h)	13	7	ND	20	<10
Coil Coating (i)	78	7	0.0	360	120
Electrical/Electronic Components (c)	28	3	<10	<10	<10
Foundries	53	19	6.0	690	<85
Metal Finishing (b) (g)	102	74	ND	10,000	750
Photographic Equipment/Supplies (d)	34	26	0.18	34	5
Nonferrous Metals Manufacturing (e) (g)	82	11	ND	98	10
Ore Mining and Dressing (b)	33	2	NA	21	11
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	6.7
Paint and Ink Formulation (c)	2	1		<10	
Pulp and Paperboard Mills (g)	55	19	ND	950	110
Soap and Detergent Manufacturing (a)	11	1		<10	
Textile Mills (b) (f)	71	6	1.0	160	52

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF BUTYL BENZYL PHTHALATE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	4	3	8.0	42	30
Coal Mining (b)	53	6	3.0	3.0	3.0
Iron and Steel Manufacturing (a)	6	4	5.0	7.0	5.5
Aluminum Forming	22	6	<0.03	<90	<25
Coil Coating (i)	14	4	0.0	0.0	0.0
Foundries	53	17	4.0	62	<19
Photographic Equipment/Supplies (d)	12	7	0.33	3.0	1.4
Nonferrous Metals Manufacturing (f) (h)	57	10	ND	480	21
Ore Mining and Dressing (b)	28	4	NA	66	28
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	6.7
Paint and Ink Formulation (c)	1	0			
Pulp and Paperboard Mills (h)	43	5	ND	81	9.6
Steam Electric Power Plants (e)	12	0			
Textile Mills (b) (g)	66	5	1.0	5.0	2.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BUTYL BENZYL PHTHALATE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	2	1	53 - 99*	BDL - 17	
Chemical Oxidation					III.3.1.2
-ozone	1		98*	BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		2	99*	BDL - 36	
-lime		5	NM	ND - BDL	
-unspecified		2	>99	BDL - <10	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	BDL	
Chemical Reduction		1	NM	BDL	III.3.1.4
Coagulation and Flocculation		2	93	BDL - 3.0	III.3.1.5
Filtration	3	5	52 - >99	ND - <10	III.3.1.9
Flotation		5	97 - >99	ND - 42	III.3.1.10
Reverse Osmosis	1		98*	BDL	III.3.1.16
Sedimentation		5	95* - >99	ND - BDL	III.3.1.18
Activated Sludge		1	NM	11	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: N-nitrosodimethylamine

Formula:

$$\begin{array}{c} O \\ \| \\ N \\ | \\ CH_3NCH_3 \end{array}$$

Alternate Names: N-methyl-N-nitrosomethanamine;
Dimethylnitrosoamine

CAS #: 62-75-9

Physical, Chemical, and Biological Properties [1-7, 1-10]:

molecular weight: 74.08
melting point, °C: Not available
boiling point (760 torr), °C: 151-153
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: Miscible
log octanol/water partition coefficient: 0.06
Henry's law constant: Not available
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.7.1-5

Probable Fate [1-7]:

photolysis: Slow photolysis in aqueous solution is the principal fate

oxidation: Resistant to oxidation

hydrolysis: Does not occur under natural conditions

volatilization: Much too slow to be important

sorption: Does not occur

biological processes: No bioaccumulation; slowly degraded in sewage and soil

other reactions/interactions: Not important

Carbon Adsorption Data: Not adsorbed by activated carbon

RESERVED

INDUSTRIAL OCCURRENCE OF N-NITROSODIMETHYLAMINE

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	33	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF N-NITROSODIMETHYLAMINE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Ore Mining and Dressing (a)	28	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR N-NITROSODIMETHYLAMINE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Chemical Precipitation with Sedimentation -unspecified		1	>99	ND	III.3.1.3

ND, not detected.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to nitrosamines.

Freshwater Aquatic Life

The available data for nitrosamines indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 5,850 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrosamines to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for nitrosamines indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 3,300,000 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrosamines to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of n-nitrosodimethylamine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 14 ng/L, 1.4 ng/L, and 0.14 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 160,000 ng/L, 16,000 ng/L, and 1,600 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of n-nitrosodiethylamine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 8.0 ng/L, 0.8 ng/L, and 0.08 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 12,400 ng/L, 1,240 ng/L, and 124 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

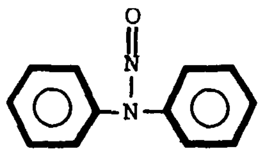
For the maximum protection of human health from the potential carcinogenic effects due to exposure in n-nitrosodi-n-butylamine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 64 ng/L, 6.4 ng/L, and 0.64 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 5,868 ng/L, 587 ng/L, and 58.7 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure in n-nitrosodiphenylamine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 49,000 ng/L, 4,900 ng/L, and 490 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 161,000 ng/L, 16,100 ng/L, and 1,610 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure in n-nitrosopyrrolidine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 160 ng/L, 16.0 ng/L, and 1.60 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 919,000 ng/L, 91,900 ng/L, and 9,190 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: N-Nitrosodiphenylamine

Formula:



Alternate Names: N-nitroso-N-phenylbenzamine; Diphenylnitrosamine

CAS #: 86-30-6

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 198.2
melting point, °C: 66.5
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: Not available
log octanol/water partition coefficient: 2.57 (calculated)
Henry's law constant: Not available
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.7.1-5

Probable Fate [1-7]:

photolysis: Photolysis may be an important fate process

oxidation: Resistant to oxidation

hydrolysis: Does not occur under natural conditions

volatilization: Not important

sorption: Probably adsorbed by organic materials but exact fate unknown

biological processes: Potential for bioaccumulation, biodegradation, and biotransformation, but quantitative data unavailable

other reactions/interactions: Not important

Carbon Adsorption Data, N-nitrosodiphenylamine (1-8):

ADSORBABILITY

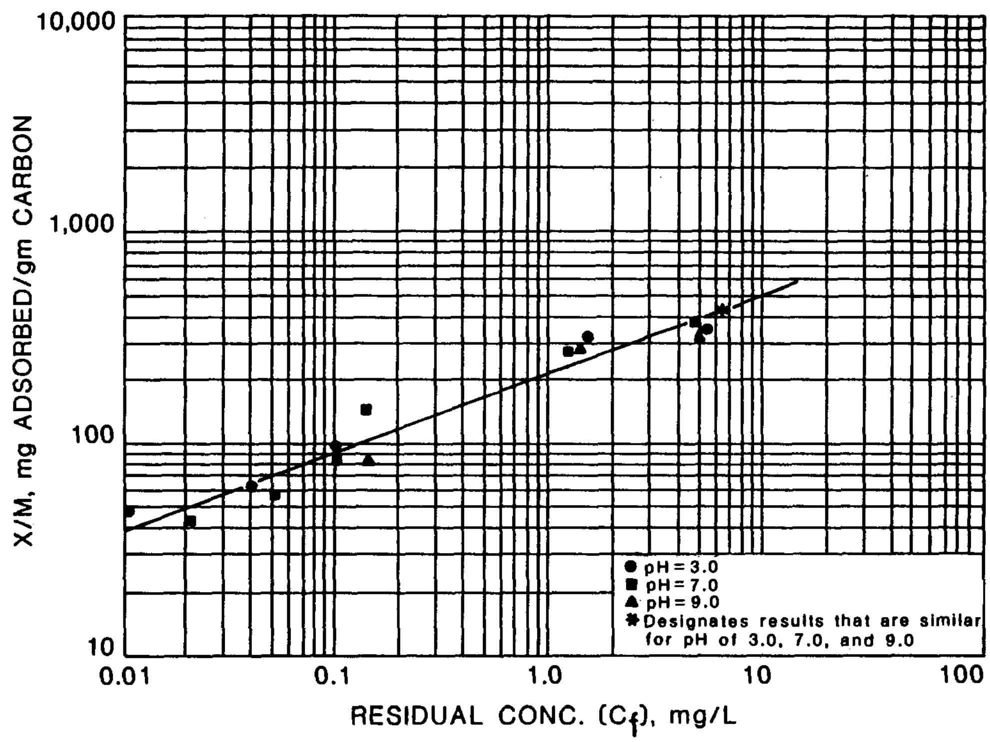
FREUNDLICH PARAMETERS	pH		
	All data pooled		
K	220		
1/n	0.37		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	9.8	25	60
0.1		2.3	5.9
0.01			0.54

(a) Carbon doses in mg/L at neutral pH



ANALYTICAL METHOD: Ultraviolet Spectroscopy 290 nm

INDUSTRIAL OCCURRENCE OF N-NITROSODIPHENYLAMINE

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	1		1,800	
Coal Mining (b)	49	1		45	
Leather Tanning and Finishing	18	1		250	
Aluminum Forming	1	1		17	
Electrical/Electronic Components (c)	3	0			
Foundries	53	5	9.0	1,400	<290
Metal Finishing (b) (f)	7	4	ND	900	410
Photographic Equipment/Supplies (d)	7	0			
Ore Mining and Dressing (b)	33	0			
Rubber Processing	1	1		5.2	
Textile Mills (b) (e)	71	5	11	130	69

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF N-NITROSODIPHENYLAMINE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	84	620	350
Coal Mining (b)	53	0			
Aluminum Forming	5	1		67	
Foundries	53	5	<10	190	<80
Ore Mining and Dressing (b)	28	0			
Rubber Processing	1	1		<2.0	

See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR N-NITROSODIPHENYLAMINE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption -granular	1		NM	0.4	III.3.1.1
Chemical Precipitation with Sedimentation -unspecified		1	>99	ND	III.3.1.3
Filtration	2	1	>99	ND - 0.4	III.3.1.9
Flotation		2	66	84 - 620	III.3.1.10
Sedimentation		1	>99	ND	III.3.1.18
Activated Sludge		2	69 - >99	ND - 1.6	III.3.2.1

ND, not detected; NM, not meaningful.

RESERVED .

Compound: N-nitroso-di-n-propylamine

Formula:

```
      O
      ||
      N
      |
C3H7-N-C3H7
```

Alternate Names: N-nitroso-N-propyl-1-propanamine;
Di-n-propylnitrosamine

CAS #: 621-64-7

Physical, Chemical, and Biological Properties [1-7]

molecular weight: 130.2
melting point, °C: Not available
boiling point (760 torr), °C: 205
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: 9,900
log octanol/water partition coefficient: 1.31 (calculated)
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.7.1-5

Probable Fate [1-7]

photolysis: Photolysis is slow but is the principal fate of the compound

oxidation: Resistant to oxidation

hydrolysis: Does not hydrolyze

volatilization: No loss by volatilization reported

sorption: No specific data but moderate adsorption by organic matter is possible

biological processes: Moderate potential for bioaccumulation; very slowly degraded in sewage

other reactions/interactions: Not important

Carbon Adsorption Data, N-nitroso-di-n-propylamine (1-8):

ADSORBABILITY

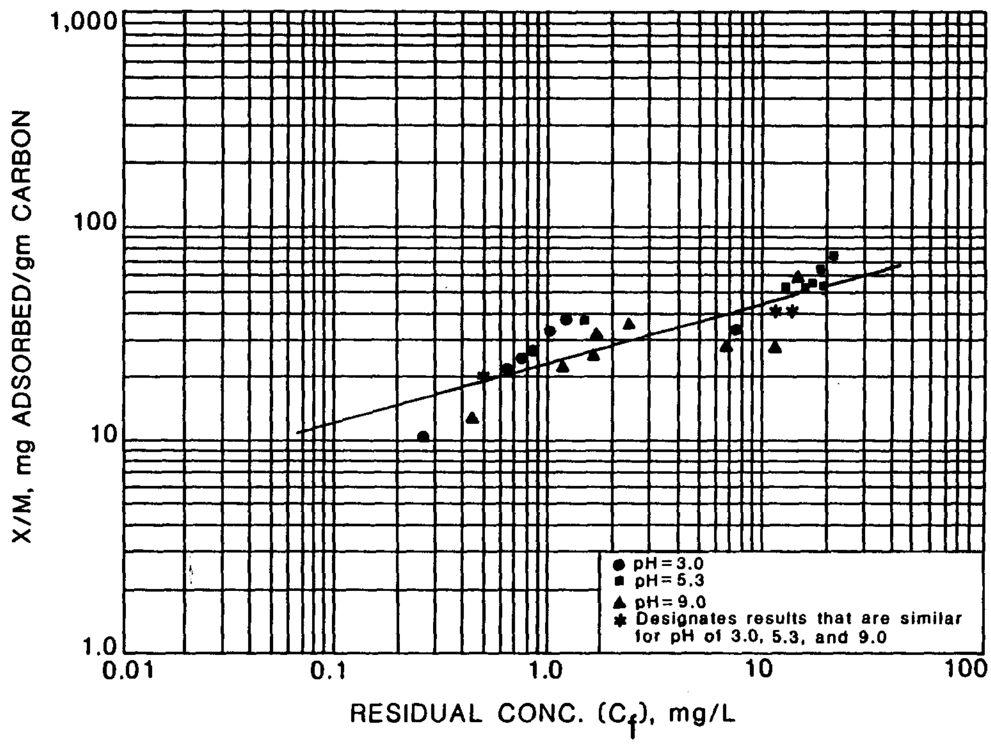
FREUNDLICH PARAMETERS	pH		
	All data pooled		
K	24.4		
1/n	0.26		
Corr. Coef. r	0.87		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	67	130	250
0.1		12	24
0.01			2.2

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Ultraviolet Spectroscopy 232.4 nm

INDUSTRIAL OCCURRENCE OF N-NITROSODI-N-PROPYLAMINE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	49	0			
Foundries	53	3	<10	210	<85
Metal Finishing (b) (c)	7	6	ND	570	140
Photographic Equipment/Supplies	7	0			
Ore Mining and Dressing (b)	33	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF N-NITROSODI-N-PROPYLAMINE

Industry	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	0			
Ore Mining and Dressing (a)	28	0			
Textile Mills (a) (b)	94	3	2.0	19	8.0
Timber Products Processing					

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR N-NITROSODI-N-PROPYLAMINE

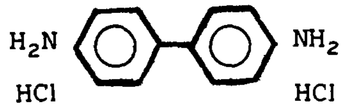
Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption -granular	1		NM	BDL	III.3.1.1
Filtration		1	>99	ND	III.3.1.9
Activated Sludge		2	NM	2.0 - 19	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: Benzidine (dihydrochloride)

Formula:



Alternate Names: 4,4'-Diaminodiphenyl;
4,4'-Biphenyldiamine;
(1,1'-Biphenyl)-4,4'-diamine

CAS #: 92-87-5

Physical, Chemical, and Biological Properties [1-11]:

molecular weight: 184.2
melting point, °C: 129
boiling point (760 torr), °C: 402
vapor pressure (25°C), torr: Not available
solubility in water (12°C), mg/L: 400
log octanol/water partition coefficients: 1.81
Henry's law constant: Not available
biodegradability: D-degradable
water quality criteria: See page I.7.4-5

Probable Fate [1-11]:

photolysis: Possible but actual significance uncertain

oxidation: Oxidation by metal cations very fast; also, reactions with oxygen and/or hydroperoxy radical are very important

hydrolysis: Not important in th environment

volatilization: Not likely to occur in aquatic environment

sorption: Readily adsorbed by clay minerals and metal cation complexes

biological processes: No bioaccumulation; slowly biodegraded in acclimated sewage systems. Toxicity to microorganisms at high (>100 mg/L) concentrations

other reactions/interactions: Not important

Carbon Adsorption Data, Benzidine, (Benzidine dihydrochloride) (1-8):

ADSORBABILITY

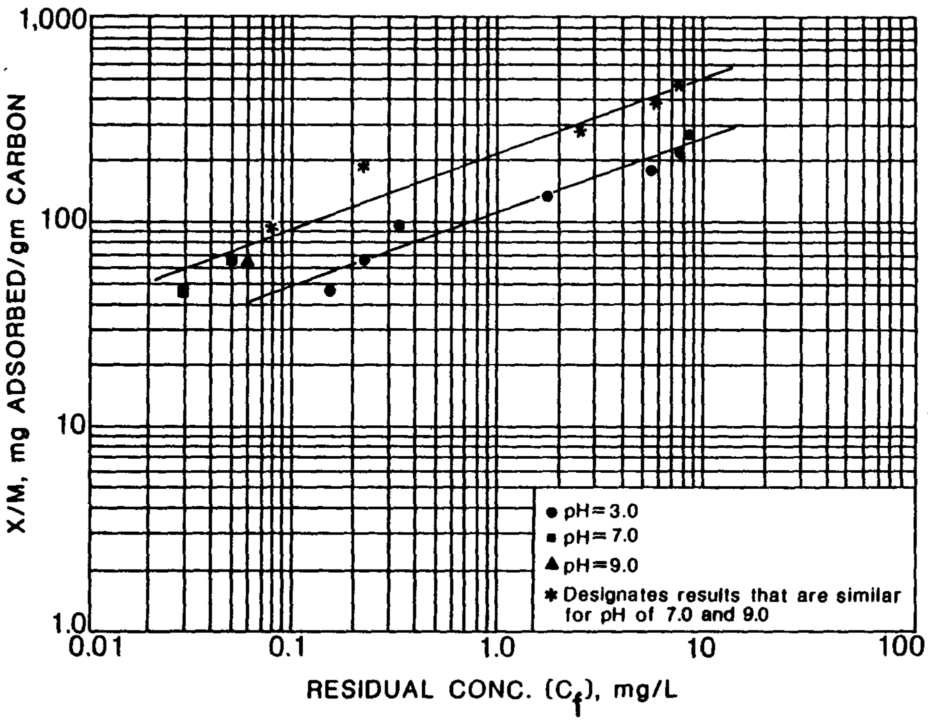
FREUNDLICH PARAMETERS	pH		
	3.0	pH 7 and 9 pooled	
K	110	220	
1/n	0.35	0.37	
Corr. Coef. r	0.97	0.97	

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_0, mg/L	0.1	0.01	0.001
1.0	9.4	24	58
0.1		2.2	5.7
0.01			0.52

(a) Carbon doses in mg/L at neutral pH.



ANALYTICAL METHOD: Ultraviolet Spectroscopy 277 nm

REMARKS: OSHA regulated carcinogen. Values based on the dihydrochloride compound of benzidine.

Date: 1/24/83

INDUSTRIAL OCCURRENCE OF BENZIDENE

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Leather Tanning and Finishing	18	1		27	
Electrical/Electronic Components (b)	3	1		<10	
Foundries	53	1		<10	
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (e)	20	0	ND	6.0	1.2
Ore Mining and Dressing (a)	33	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BENZIDINE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	1		<10	
Nonferrous Metals Manufacturing	8	0			
Ore Mining and Dressing (a)	28	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BENZIDINE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Sludge	1		NM	200	III.3.2.1

NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to benzidine.

Freshwater Aquatic Life

The available data for benzidine indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 2,500 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of benzidine to sensitive freshwater aquatic life.

Saltwater Aquatic Life

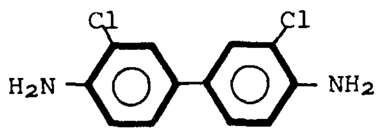
No saltwater organisms have been tested with benzidine and no statement can be made concerning acute and chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcin ogenic effects due to exposure of benzidine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 1.2 ng/L, 0.12 ng/L, and 0.01 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 5.3 ng/L, 0.53 ng/L, and 0.05 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: 3,3'-Dichlorobenzidine

Formula:



Alternate Names: 3,3'-Dichloro-4,4'-diamino-(1,1'-biphenyl)

CAS #: 91-94-1

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 253.1
melting point, °C: 132
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (22°C), mg/L: 4.0 (as dihydrochloride)
log octanol/water partition coefficient: 3.02 (calculated)
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: See page I.7.5-5

Probable Fate [1-7]:

photolysis*: Possible, but exact importance unknown

oxidation*: Oxidized (especially by metal cations) like benzidine but not quite as easily

hydrolysis: Not important environmentally

volatilization*: Essentially nonvolatile

sorption*: Adsorption by clay minerals, possibly most important transport process

biological processes: Bioaccumulated by aquatic organisms; resistant to biodegradation but may degrade in sewage systems in a manner similar to benzidine

other reactions/interactions: Not important

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*Based on data for unsubstituted benzidine.

Carbon Adsorption Data, 3,3'-Dichlorobenzidine (1-8):

ADSORBABILITY

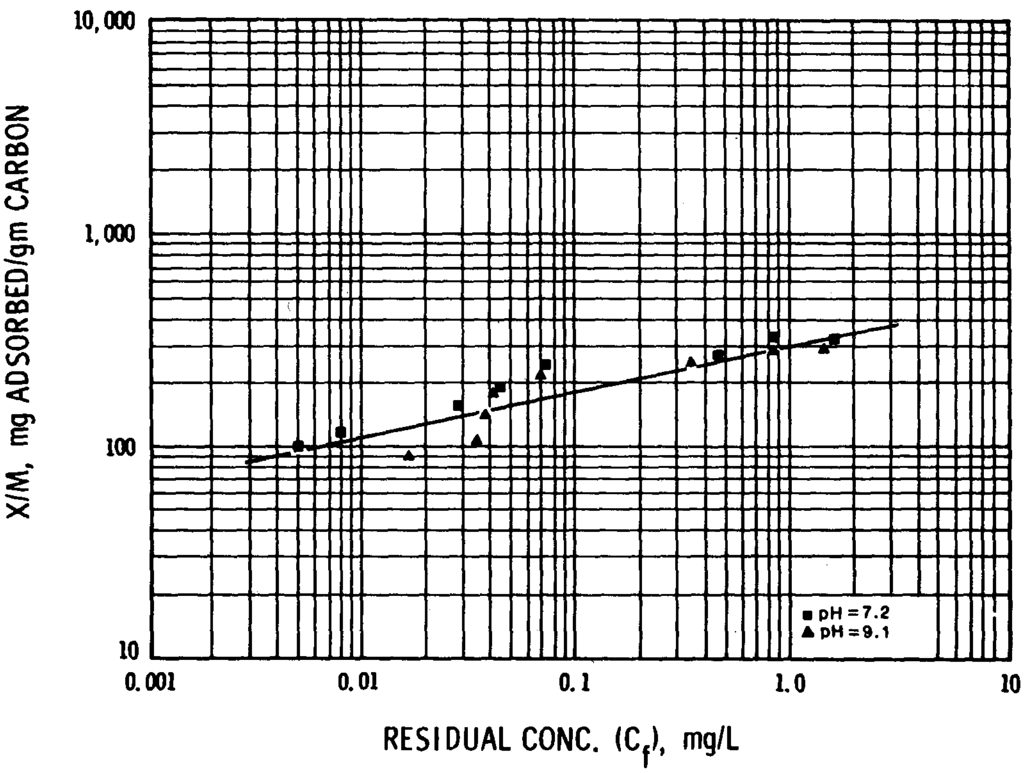
FREUNDLICH PARAMETERS	pH		
	All data pooled		
K	300		
1/n	0.20		
Corr. Coef. r	0.92		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	4.8	8.3	13
0.1		0.8	1.3
0.01			0.1

(a) Carbon doses in mg/L at pH 7.2



ANALYTICAL METHOD: Ultraviolet Spectroscopy 282 nm

REMARKS: OSHA regulated carcinogen

INDUSTRIAL OCCURRENCE OF 3-3'-DICHLOROBENZIDINE

	Raw wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Coal Mining (a)	48	0			
Leather Tanning and Finishing	18	0			
Foundries	53	0			
Metal Finishing (a) (e)	7	4	ND	0.07	0.02
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (c) (d) (e)	15	0	ND	2.0	3.0
Ore Mining and Dressing (a)	32	0			
Paint and Ink Formulation (b)	1	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 3,3'-DICHLOROBENZIDINE

Industry	Treated wastewater Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	52	1		3.0	
Foundries	53	0			
Nonferrous Metals Manufacturing (c) (d)	18	0	ND	2.0	0.2
Ore Mining and Dressing (a)	28	0			
Paint and Ink Formulation (b)	1	1		<10	

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

RESERVED

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to dichlorobenzidines.

Freshwater Aquatic Life

The data base available for dichlorobenzidines and freshwater organisms is limited to one test on bioconcentration of 3,3'-dichlorobenzidine and no statement can be made concerning acute or chronic toxicity.

Saltwater Aquatic Life

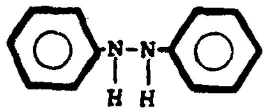
No saltwater organisms have been tested with any dichlorobenzidine and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of dichlorobenzidine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 0.103 µg/L, 0.0103 µg/L, and 0.00103 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 0.204 µg/L, 0.0204 µg/L, and 0.00204 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: 1,2-Diphenylhydrazine

Formula:



Alternate Names: Hydrazobenzene; N,N'-Bianiline

CAS #: 122-66-7

Physical, Chemical, and Biological Properties [1-7, 1-8, 1-10]:

molecular weight: 184.2
melting point, °C: 131
boiling point (760 torr), °C: Decomposes near melting point
vapor pressure (25°C), torr: Not available
solubility in water (temp. unknown), mg/L: 221
log octanol/water partition coefficients: 3.03
Henry's law constant: Not available
biodegradability: A-Significant degradation, gradual adaptation
water quality criteria: See page I.7.6-5

Probable Fate [1-7]:

photolysis: Slow photoreduction to aniline possibly leads to destruction of compound

oxidation: Reversible oxidation by molecular oxygen to azobenzene occurs; further oxidation unknown if any

hydrolysis: Only possible in bisulfite wastes of a paper mill or coal mine

volatilization: Neither 1,2-Diphenylhydrazine nor the oxidized form, azobenzene, have a tendency to volatilize

sorption: Sorption onto particulates is the main transport process for the compound

biological processes: No data, but bioaccumulation possible; biodegradation is likely in acclimated sewage systems

other reactions/interactions: Intramolecular rearrangement to form benzidine occurs in strongly acidic solution; 1,2-Diphenylhydrazine rapidly oxidized to azobenzene in aerated solutions and is reversible

Carbon Adsorption Data, 1,2-Diphenylhydrazine (1-8):

ADSORBABILITY

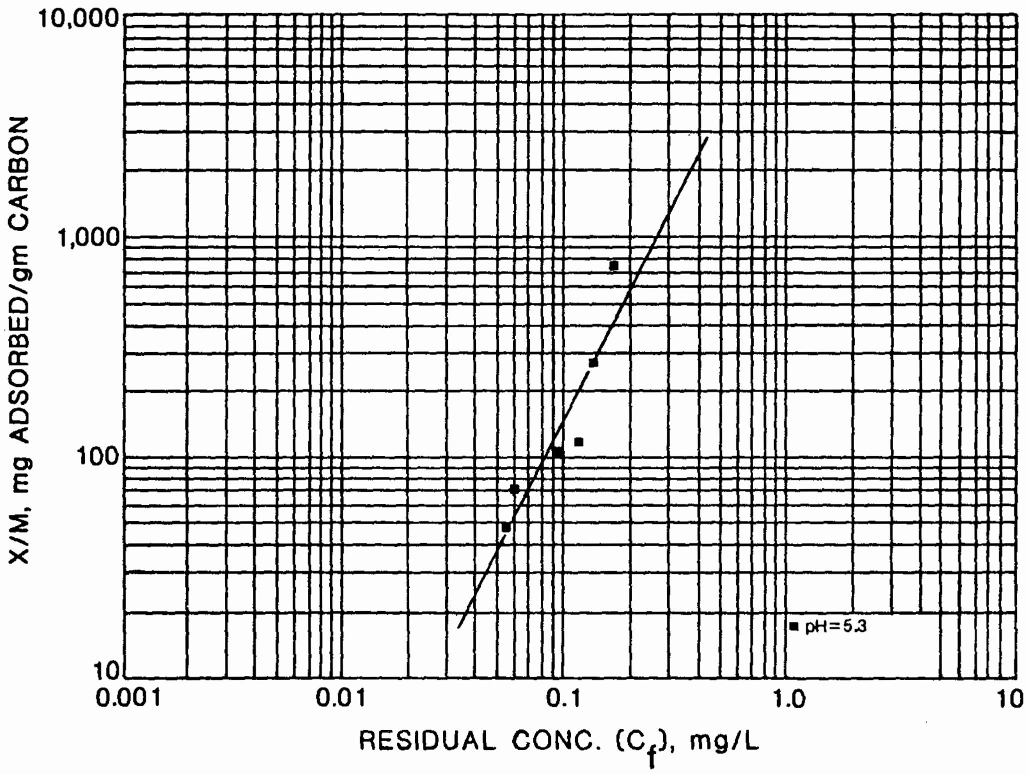
FREUNDLICH PARAMETERS	pH		
	5.3		
K	16,000		
1/n	2.0		
Corr. Coef. r	0.95		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	5.7	630	63,000
0.1		57	6,200
0.01			570

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Total Organic Carbon

REMARKS: Rapid oxidation to azobenzene. Azobenzene solubility is 0.25 mg/1.

Date: 1/24/83

INDUSTRIAL OCCURRENCE OF 1,2-DIPHENYLHYDRAZINE

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, μg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	49	1		3.0	
Leather Tanning and Finishing	18	0			
Electrical/Electronic Components (b)	28	1		<10	
Foundries	53	2	<10	<10	<10
Metal Finishing (a) (e)	2	2	5.0	12	9.0
Photographic Equipment/Supplies (c)	7	0			
Ore Mining and Dressing (a)	32	0			
Paint and Ink Formulation (b)	1	1		7,600	
Textile Mills (a) (d)	68	1		22	

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 1,2-DIPHENYLHYDRAZINE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	4	<10	<10	<10
Ore Mining and Dressing (b)	28	0			
Paint and Ink Formulation (b)	1	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,2-DIPHENYLHYDRAZINE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Solvent Extraction		1	36	3,000	III.3.1.20

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to 1,2-diphenylhydrazine.

Freshwater Aquatic Life

The available data for 1,2-diphenylhydrazine indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 270 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of 1,2-diphenylhydrazine to sensitive freshwater aquatic life.

Saltwater Aquatic Life

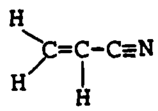
No saltwater organisms have been tested with 1,2-diphenylhydrazine and no statement can be made concerning acute and chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 1,2-diphenylhydrazine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 422 ng/L, 42 ng/L, and 4 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 5.6 µg/L, 0.56 µg/L, and 0.056 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Acrylonitrile

Formula:



Alternate Names: Vinyl cyanide;
Cyanoethylene;
Propenonitrile

CAS #: 107-13-1

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 53.06
melting point, °C: -82
boiling point (760 torr), °C: 78.5
vapor pressure (22.8°C), torr: 100 (calculated)
solubility in water (20°C), mg/L: 73,500
log octanol/water partition coefficient: -0.14 (calculated)
Henry's law constant (15°C): 6.66×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.7.7-5

Probable Fate [1-7]:

photolysis: No direct photolysis

oxidation: Free radical oxidation too slow to be important

hydrolysis: Not important in the environment

volatilization: High vapor pressure indicates volatilization may be a major transport process

sorption: Possible adsorption onto clay particles

biological processes: Little, if any bioaccumulation; biodegradation in acclimated sewage systems

other reactions/interactions: Conversion to CNS^- ion occurs with basic catalysts

Carbon Adsorption Data, Acrylonitrile (1-8):

ADSORBABILITY

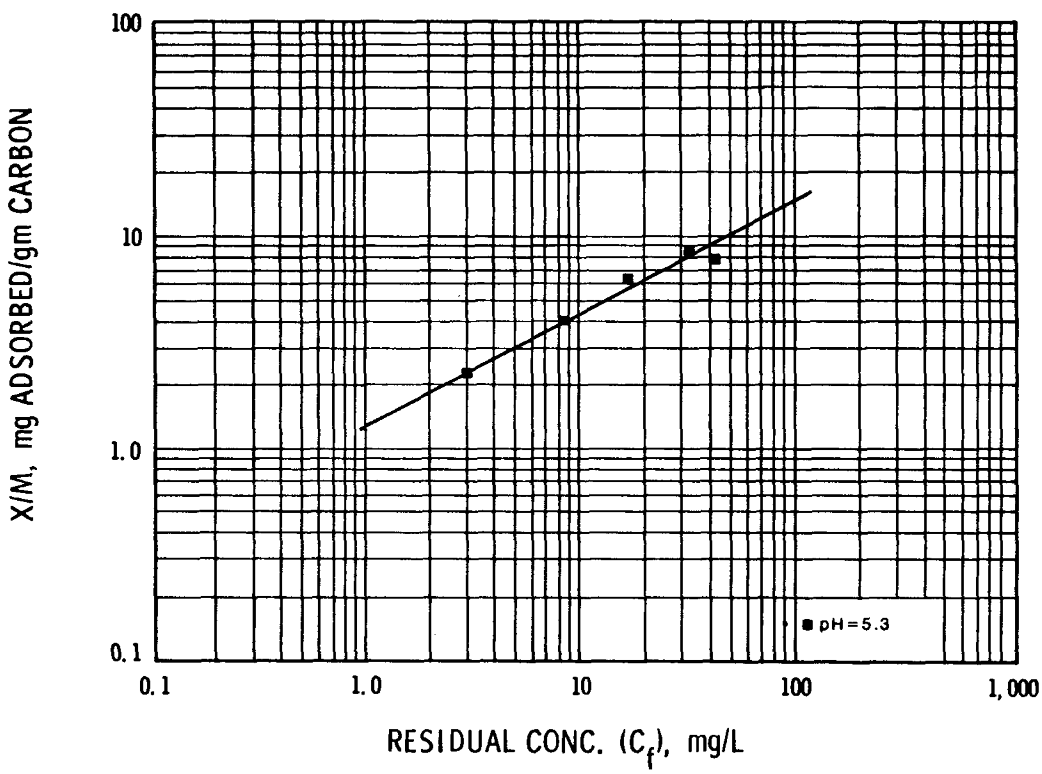
FREUNDLICH PARAMETERS	pH		
	5.3		
K	1.4		
1/n	0.51		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	2,200	7,700	25,000
0.1		700	2,500
0.01			230

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Total Carbon

INDUSTRIAL OCCURRENCE OF ACRYLONITRILE

Industry	Raw wastewater Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (b)	47	0			
Iron and Steel Manufacturing (a)	5	4	21	4,700	2,100
Foundries	53	0			
Photographic Equipment/Supplies (c)	7	0			
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	26	NA	NA	NA	46,000
Rubber Processing	1	1		32	
Textile Mills (a) (d)	78	2	90	1,600	840

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ACRYLONITRILE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	5	2	190	3,000	1,600
Foundries	53	1		23	
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	93
Rubber Processing	1	1		<23	
Textile Mills (b) (c)	80	1		400	

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

RESERVED

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to Acrylonitrile.

Freshwater Aquatic Life

The available data for acrylonitrile indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 7,550 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of acrylonitrile to sensitive freshwater aquatic life but mortality occurs at concentrations as low as 2,600 µg/L with a fish species exposed for 30 days.

Saltwater Aquatic Life

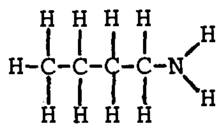
Only one saltwater species has been tested with acrylonitrile and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of acrylonitrile through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 0.58 µg/L, 0.058 µg/L and 0.006 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 6.5 µg/L, 0.65 µg/L, and 0.065 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Butylamine

Formula:



Alternate Names: 1-Aminobutane

CAS #: 109-73-9

Physical, Chemical, and Biological Properties [1-4, 1-6]:

molecular weight: 73.14
melting point, °C: -49.1
boiling point (760 torr), °C: 77.8
vapor pressure (20°C), torr: 72
solubility in water (25°C), mg/L: Not available
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Degradation by Aerobacter at 3°C of 200 mg/L concentration was 100% in 7 hours
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

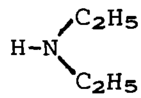
other reactions/interactions:

Carbon Adsorption Data [1-8]: Not adsorbed by activated carbon

RESERVED

Compound: Diethylamine

Formula:



Alternate Names: None

CAS #: 109-89-7

Physical, Chemical, and Biological Properties [1-4, 1-6, -128]:

molecular weight: 73.14
melting point, °C: -48 to -50
boiling point (760 torr), °C: 56.3
vapor pressure (20°C), torr: 200
solubility in water (14°C), mg/L: 815,000
log octanol/water partition coefficient: Not available
Henry's law constant (50°C): 1.10×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

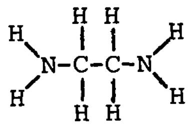
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Ethylenediamine

Formula:



Alternate Names: Diaminoethane;
1,2-Ethanediamine;
1,2-Diaminoethane

CAS #: 107-15-3

Physical, Chemical, and Biological Properties [1-4, 1-6, 1-9, 1-12]:

molecular weight: 60.11
melting point, °C: 8.5
boiling point (760 torr), °C: 116
vapor pressure (21°C), torr: 10
solubility in water (25°C), mg/L: Freely soluble, forms hydrate
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 98% ethylenediamine removal (measured as COD removal) obtained at 20°C in activated sludge at a rate of 9.8 mg COD/g dry inoculum/hr
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

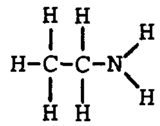
other reactions/interactions:

Carbon Adsorption Data: Not adsorbed by activated carbon

RESERVED

Compound: Monoethylamine

Formula:



Alternate Names: Ethylamine; Aminoethane

CAS #: 75-04-7

Physical, Chemical, and Biological Properties [1-4, 1-6]:

molecular weight: 45.09
melting point, °C: -81
boiling point (760 torr), °C: 16.6
vapor pressure (20°C), torr: 910
solubility in water (25°C), mg/L: Miscible
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

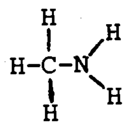
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Monomethylamine

Formula:



Alternate Names: Methylamine; Aminomethane; Carbinamine; Mercurialin; Methanamine

CAS #: 74-89-5

Physical, Chemical, and Biological Properties [1-13]

molecular weight: 31.06
melting point, °C: -95.3
boiling point (760 torr), °C: -6.3
vapor pressure (21°C), torr: 2,160
solubility in water (25°C), mg/L: At 760 torr, 1 volume of water dissolves 959 volumes of gas
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

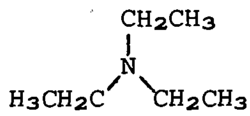
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Triethylamine

Formula:



Alternate Names: None

CAS #: 121-44-8

Physical, Chemical, and Biological Properties [1-6]:

molecular weight: 101.2
melting point, °C: -115
boilng point (760 torr), °C: 90
vapor pressure (25°C), torr: 50
solubility in water (20°C), mg/L: 15,000
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Degradation by Aerobacter at 30°C of 200 mg/L concentration was 100% in 11 hours
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

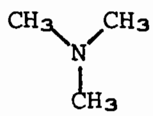
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Trimethylamine

Formula:



Alternate Names: None

CAS #: 75-50-3

Physical, Chemical, and Biological Properties [1-6, 1-14]:

molecular weight: 59.11
melting point, °C: -117 to -124
boiling point (760 torr), °C: 3.5
vapor pressure (20°C), torr: 1,440
solubility in water (19°C), mg/L: 410,000
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

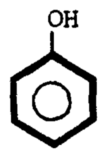
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Phenol

Formula:



Alternate Names: Carbolic acid; Hydroxybenzene; Phenyl hydroxide; Phenic acid; Phenyl hydrate

CAS #: 108-95-2

Physical, Chemical, and Biological Properties [1-7, 1-12, 1-15]:

molecular weight: 94.11
melting point, °C: 40.9
boiling point (760 torr), °C: 182
solubility in water (25°C), mg/L: 93,000
log octanol/water partition coefficient: 1.46
Henry's law constant (25°C): $.13 \times 10^{-6}$ atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.8.1-5

Probable Fate [1-7]:

photolysis: Some photooxidation occurs but is not environmentally important

oxidation: Metal-catalyzed oxidation may take place in highly aerated waters

hydrolysis: Not important

volatilization: Very little, if any, volatilization of phenol occurs

sorption: Not important

biological processes: No bioaccumulation, but very extensive biodegradation in natural waters and sewage

other reactions/interactions: Chlorination of water may produce chlorophenols

Carbon Adsorption Data, Phenol (1-8):

ADSORBABILITY

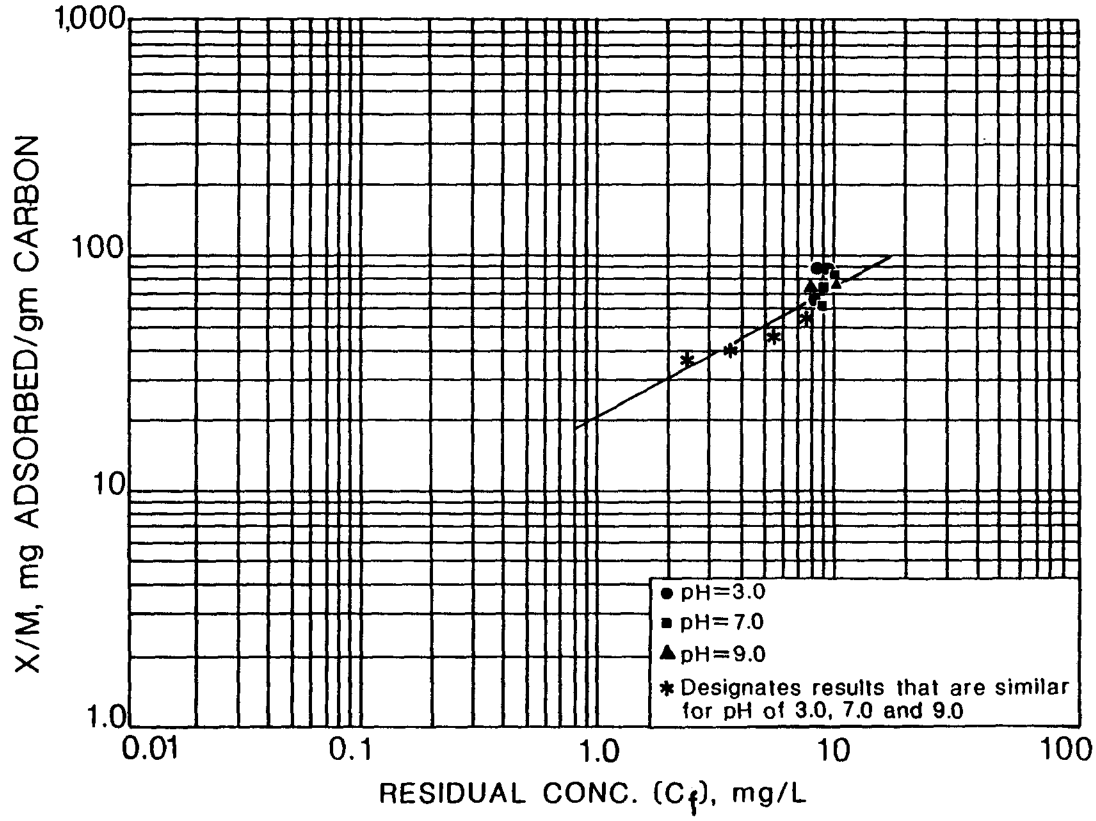
FREUNDLICH PARAMETERS	pH		
	All data pooled		
K	21		
1/n	0.54		
Corr. Coef. r	0.89		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	150	570	2,000
0.1		52	200
0.01			18

(a) Carbon doses in mg/L at neutral pH



ANALYTICAL METHOD: Ultraviolet Spectroscopy 288 nm.

INDUSTRIAL OCCURRENCE OF PHENOL

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Auto and Other Laundries (a)	31	15	<0.07	1,900	<240
Coal Mining (b)	46	6	3.0	16	5.0
Inorganic Chemicals Manufacturing (b)	1	1		160	
Iron and Steel Manufacturing (c)	18	14	39	6.7 x 10E5	95,000
Leather Tanning and Finishing	18	14	<10	25,000	<3,600
Aluminum Forming	35	16	<0.3	9,900	<640
Battery Manufacturing (h) (i)	3	1	ND	<10	<10
Coil Coating	25	0			
Electrical/Electronic Components (c)	28	19	<10	3,500	<460
Foundries	53	20	6.0	30,000	<4,200
Metal Finishing (b) (h)	59	44	ND	6,600	620
Photographic Equipment/Supplies (d)	50	31	0.09	120	7.7
Explosives Manufacturing	4	4	15	70	42
Gum and Wood Chemicals	2	2	450	630	540
Pharmaceutical Manufacturing	8	8	10	6,400	1,400
Nonferrous Metals Manufacturing (f) (h)	6	1	ND	70	12
Ore Mining and Dressing (b)	33	2	NA	160	120
Organic Chemicals and Plastics and Synthetic Resins	76	NA	NA	NA	40,000
Paint and Ink Formulation (c)	29	14	<5.0	3,800	<500
Petroleum Refining (b)	21	13	13	34,000	>3,400
Pulp and Paperboard Mills (h)	178	153	ND	1,400	93
Rubber Processing	6	6	7.3	26,000	4,500
Soap and Detergent Manufacturing (a)	5	5	7.1	4,400	900
Steam Electric Power Plants (e)	11	1		4.5	
Textile Mills (b) (g)	77	57	1.0	4,900	160
Timber Products Processing	9	5	1,400	87,000	28,000

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF PHENOL

Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
	Treated wastewater				
Auto and Other Laundries (a)	9	9	7.0	53,000	6,000
Coal Mining (b)	51	8	3.0	3.0	3.0
Inorganic Chemicals Manufacturing (b)	1	0			
Iron and Steel Manufacturing (a)	19	18	4.0	53,000	<3,400
Leather Tanning and Finishing	6	3	60	1,400	630
Aluminum Forming	21	14	2.0	9,700	<1,300
Coil Coating (h)	4	1		0.0	
Foundries	53	18	1.0	14,000	<1,100
Photographic Equipment/Supplies (d)	19	10	0.25	5.0	2.0
Gum and Wood Chemicals	2	2	850	>16,000	>8,400
Pharmaceutical Manufacturing	4	4	3.0	10	5.2
Nonferrous Metals Manufacturing (g)	4	0			
Ore Mining and Dressing (b)	28	3	NA	210	92
Organic Chemicals and Plastics and Synthetic Resins	56	NA	NA	NA	110
Paint and Ink Formulation (c)	19	11	<5.0	1,200	<140
Petroleum Refining (b)	21	2	<10	<10	<10
Pulp and Paperboard Mills (g)	163	80	ND	1,700	67
Rubber Processing	6	6	5.3	4,900	<830
Steam Electric Power Plants (e)	12	1		2.0	
Textile Mills (b) (f)	95	24	1.0	100	16
Timber Products Processing	5	5	10	16,000	3,200

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Reference reports 0.0 µg/L for detections less than detection limits 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR PHENOL

Treatment process	Number of data points Pilot scale	Full scale	Range of removal, %	Range of effluent conc., Ig/	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	5	2	18 - 98*	BDL - 49	
-powdered		1	93*	5.0	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		4	>99	ND - <10	
-combined precipitants		3	>33 - 96	<10 - 140	
-lime		1	69*	BDL	
-sodium carbonate		1	NM	ND	
-unspecified		1	NM	74	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	13	
Coagulation and Flocculation	2	1	91	BDL - 3.0	III.3.1.5
Filtration	6	7	22 - >99	ND - 34,000	III.3.1.9
Flotation		9	0 - 80	5 - 2,400	III.3.1.10
Oil Separation		2	>99	ND - 820	III.3.1.14
Reverse Osmosis	3		80	0.2 - 0.7	III.3.1.16
Sedimentation		7	33 - >99	BDL - 670	III.3.1.18
Solvent Extraction	12	1	3 - >99	77 - 9.6 x 10E6	III.3.1.20
Ultrafiltration		2	NM	55 - 9,700	III.3.1.21
Activated Sludge	1	30	8 - >99	ND - 1,400	III.3.2.1
Lagoons					III.3.2.2
-aerated		5	25 - >99	ND - 24	
Rotating Biological Contactor	2		56 - 63	1.6 x 10E5 - 1.6 x 10E5	III.3.2.4
Trickling Filters	1		NM	37	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to phenol.

Freshwater Aquatic Life

The available data for phenol indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 10,200 and 2,560 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

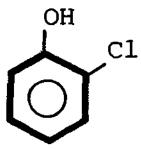
The available data for phenol indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 5,800 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of phenol to sensitive saltwater aquatic life.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for phenol. Based on available toxicity data, for the protection of public health, the derived level is 3.5 mg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.3 mg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: 2-Chlorophenol

Formula:



Alternate Names: o-Chlorophenol

CAS #: 95-57-8

Physical, Chemical, and Biological Properties [1-7, 1-12, 1-28]:

molecular weight: 128.6
melting point, °C: 8.4
boiling point (760 torr), °C: 176
vapor pressure (20°C), torr: 2.2 (calculated)
solubility in water (20°C), mg/L: 28,500
log octanol/water partition coefficient: 2.17
Henry's law constant (25°C): 8.28×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.8.2-5

Probable Fate [1-7]:

photolysis: Photolysis occurs in aqueous alkali, but environmental importance is unknown

oxidation: Could occur, but probably cannot compete with biodegradation

hydrolysis: Not important

volatilization: Probably occurs, but not fast enough to be important

sorption: Slight potential for adsorption by lipophilic and clay materials

biological processes: No bioaccumulation; slowly degraded in aquatic and soil environments

other reactions/interactions: Chlorination of water could further chlorinate 2-chlorophenol

Carbon Adsorption Data, 2-Chlorophenol (1-8):

ADSORBABILITY

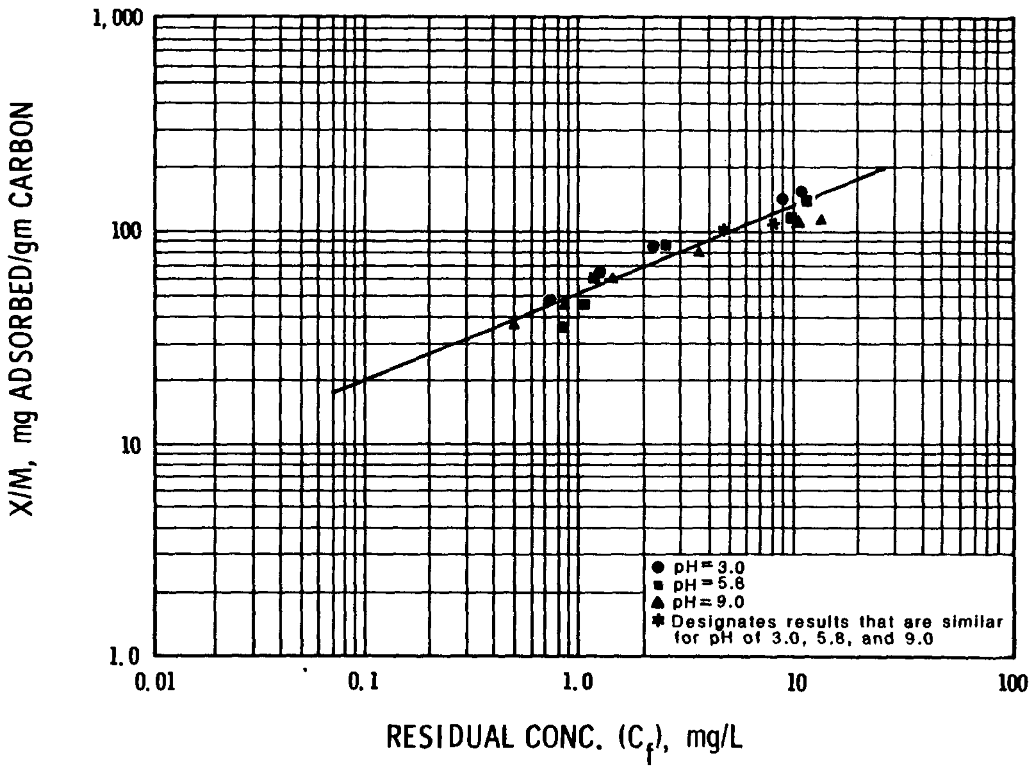
FREUNDLICH PARAMETERS	pH		
	All data pooled		
K	51.0		
1/n	0.41		
Corr. Coef. r	0.97		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	45	130	330
0.1		12	33
0.01			3.0

(a) Carbon doses in mg/L at pH 5.8



ANALYTICAL METHOD: Ultraviolet Spectroscopy 273.5 nm

INDUSTRIAL OCCURRENCE OF 2-CHLOROPHENOL

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	5	2	0.3	1.0	0.65
Coal Mining (b)	46	1		86	
Iron and Steel Manufacturing (a)	6	2	21	36,000	18,000
Aluminum Forming	19	4	<10	130	<43
Electrical/Electronic Components (c)	28	13	1.5	90	<14
Foundries	53	9	<10	210	<65
Metal Finishing (b) (f)	2	2	76	620	350
Photographic Equipment/Supplies (d)	7	0			
Pharmaceutical Manufacturing	3	3	10	25	14
Ore Mining and Dressing (b)	32	0			
Organic Chemicals and Plastics and Synthetic Resins	22	NA	NA	NA	2,700
Petroleum Refining (b)	21	1		320	
Pulp and Paperboard Mills (f)	15	3	ND	120	33
Soap and Detergent Manufacturing (a)	1	1		96	
Textile Mills (b) (e)	68	2	10	130	71
Timber Products Processing	9	5	10	42	17

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF 2-CHLOROPHENOL

	Treated wastewater				
			Detected concentrations, μg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	3	1		2.0	
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	4	0			
Aluminum Forming	23	6	<3.0	620	<100
Foundries	53	10	<10	85	<20
Pharmaceutical Manufacturing	1	1		10	
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	14	NA	NA	NA	140
Petroleum Refining (b)	21	0			
Pulp and Paperboard Mills (d)	15	3	ND	50	14
Textile Mills (b) (c)	65	1		10	
Timber Products Processing	5	5	4.0	10	8.8

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Mean calculated using medians.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 2-CHLOROPHENOL

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	0	2.0	III.3.1.9
Flotation		1	NM	2.0	III.3.1.10
Oil Separation		1	>99	ND	III.3.1.14
Sedimentation		2	>99	ND - BDL	III.3.1.18
Activated Sludge	1	2	92 - >99	ND - 100	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to 2-chlorophenol.

Freshwater Aquatic Life

The available data for 2-chlorophenol indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 4,380 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of 2-chlorophenol to sensitive freshwater aquatic life but flavor impairment occurs in one species of fish at concentrations as low as 2,000 µg/L.

Saltwater Aquatic Life

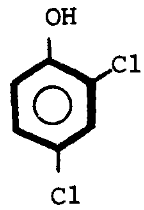
No saltwater organisms have been tested with 2-chlorophenol and no statement can be made concerning acute and chronic toxicity.

Human Health

Sufficient data are not available for 2-chlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.1 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: 2,4-Dichlorophenol

Formula:



Alternate Names: 2,4-DCP

CAS #: 120-83-2

Physical, Chemical, and Biological Properties [1-7, 1-12, 1-28]:

molecular weight: 163.0
melting point, °C: 45
boiling point (760 torr), °C: 210
vapor pressure (20°C), torr: 0.12 (calculated)
solubility in water (20°C), mg/L: 4,500
log octanol/water partition coefficient: 2.75
Henry's law constant (25°C): 6.66×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.8.3-5

Probable Fate [1-7]:

photolysis: Photolysis possible, but cannot compete with microbial biodegradation

oxidation: Any oxidation which occurs is too slow to be important

hydrolysis: Not important

volatilization: No data, but not expected to be important

sorption: Sorption will not remove significant amounts of 2,4-dichlorophenol

biological processes: Rapid microbial degradation is the principal fate of 2,4-DCP

other reactions/interactions: Chlorination of water may produce further chlorination of 2,4-DCP

Carbon Adsorption Data, 2,4-Dichlorophenol (1-8):

ADSORBABILITY

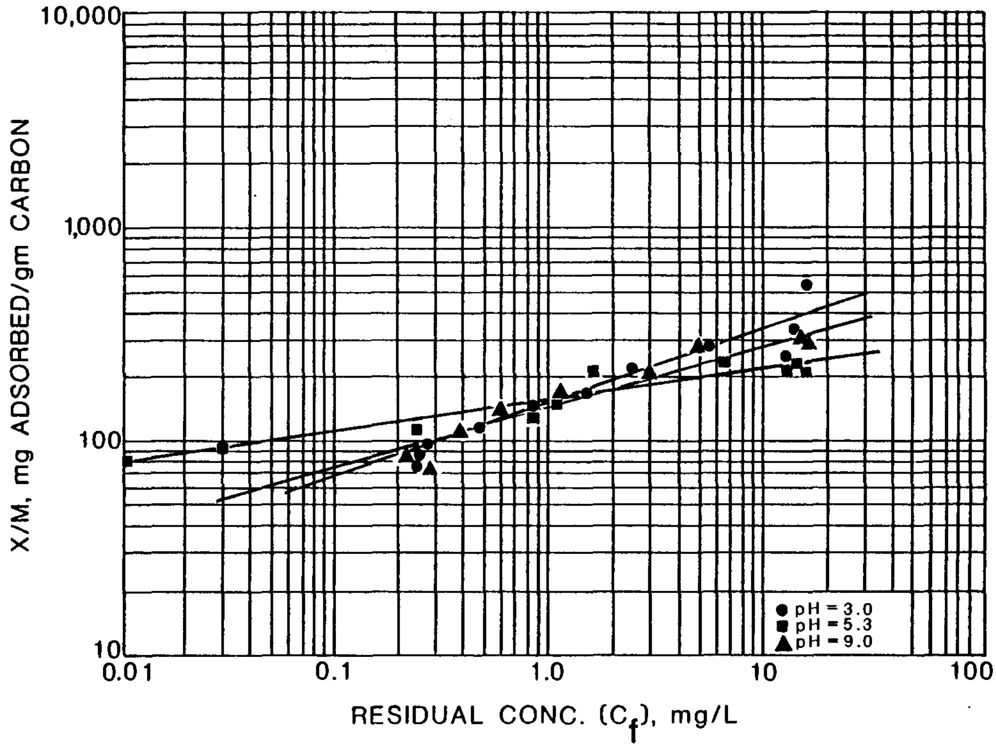
FREUNDLICH PARAMETERS	pH		
	3.0	5.3	9.0
K	147	157	141
1/n	0.35	0.15	0.29
Corr. Coef. r	0.96	0.96	0.96

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	8.0	12	17
0.1		1.1	1.7
0.01			0.2

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Ultraviolet Spectroscopy 241.2 nm at pH 11

INDUSTRIAL OCCURRENCE OF 2,4-DICHLOROPHENOL

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	5	3	1.0	10	<5.3
Coal Mining (b)	46	0			
Iron and Steel Manufacturing (a)	7	1		240	
Leather Tanning and Finishing	18	1		110	
Aluminum Forming	1	1		38	
Electrical/Electronic Components (c)	28	2	10	17	14
Foundries	53	15	7.0	5,700	<720
Metal Finishing (b) (f)	2	2	10	68	39
Photographic Equipment/Supplies (d)	17	3	0.09	3.0	1.4
Pharmaceutical Manufacturing	1	1		10	
Ore Mining and Dressing (b)	32	1		10	
Organic Chemicals and Plastics and Synthetic Resins	15	NA	NA	NA	180
Paint and Ink Formulation (c)	1	0			
Petroleum Refining (b)	24	0			
Pulp and Paperboard Mills (f)	49	22	ND	220	15
Textile Mills (b) (e)	71	2	20	41	31
Timber Products Processing	9	5	10	6,600	2,400

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF 2,4-DICHLOROPHENOL

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	3	1		2.0	
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	7	2	7.0	44	26
Aluminum Forming	6	0			
Foundries	53	14	<10	220	<33
Photographic Equipment/Supplies (d)	8	3	1.5	1.5	1.5
Pharmaceutical Manufacturing	1	1		10	
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	14	NA	NA	NA	21
Paint and Ink Formulation (c)	1	1		<10	
Petroleum Refining (b)	21	1		10	
Pulp and Paperboard Mills (e)	49	20	ND	130	7.9

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 2,4-DICHLOROPHENOL

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	2		NM	BDL - BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-sodium carbonate		1	>99	ND	
Filtration	3	2	67 - >99	ND - 2.0	III.3.1.9
Flotation		1	NM	6.0	III.3.1.10
Sedimentation		2	98	10 - 48	III.3.1.18
Activated Sludge	1		>99	ND	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to 2,4-dichlorophenol.

Freshwater Aquatic Life

The available data for 2,4-dichlorophenol indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 2,020 and 365 μg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Mortality to early life stages of one species of fish occurs at concentrations as low as 70 μg/L.

Saltwater Aquatic Life

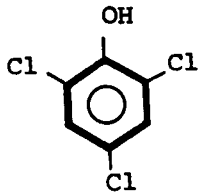
Only one test has been conducted with saltwater organisms on 2,4-dichlorophenol and no statement can be made concerning acute or chronic toxicity.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for 2,4-dichlorophenol. Based on available toxicity data, for the protection of public health, the derived level is 3.09 mg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.3 μg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: 2,4,6-Trichlorophenol

Formula:



Alternate Names: None

CAS #: 88-06-2

Physical, Chemical, and Biological Properties [1-6, 1-7, 1-28]:

molecular weight: 197.4
melting point, °C: 68
boiling point (760 torr), °C: 244
vapor pressure (76.5°C), torr: 1.0
solubility in water (25°C), mg/L: 800
log octanol/water partition coefficient: 3.38
Henry's law constant (25°C): 7.2×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.8.4-5

Probable Fate [1-7]:

photolysis: Reported in experiments, but environmental significance unknown

oxidation: Too slow to be important

hydrolysis: Not important

volatilization: Not important

sorption: High potential for sorption by organic and clay materials; rate unknown

biological processes: Biodegradation very important, but exact rate uncertain due to variations between data

other reactions/interactions: Not important

Carbon Adsorption Data, 2,4,6-Trichlorophenol (1-8):

ADSORBABILITY

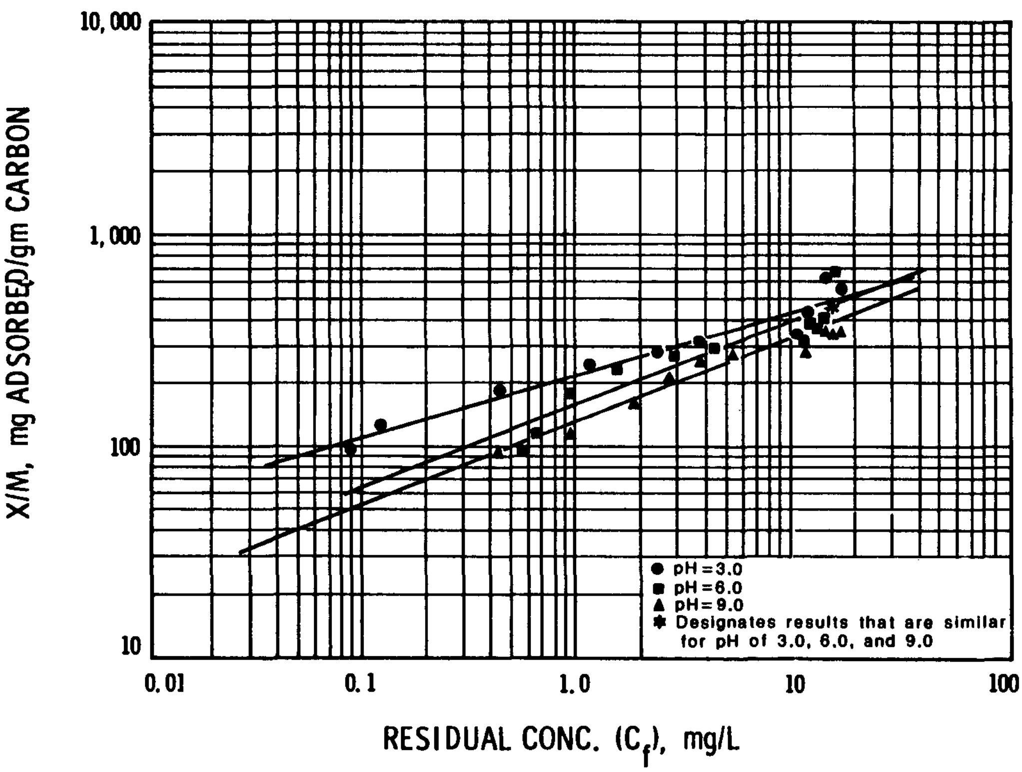
FREUNDLICH PARAMETERS	pH		
	3.0	6.0	9.0
K	219.0	155.1	130.1
1/n	0.29	0.40	0.39
Corr. Coef. r	0.97	0.94	0.98

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	15	41	105
0.1		3.7	10.4
0.01			0.9

(a) Carbon doses in mg/L at pH 6.0



ANALYTICAL METHOD: Ultraviolet Spectroscopy 312.6 nm

INDUSTRIAL OCCURRENCE OF 2,4,6-TRICHLOROPHENOL

	Raw wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	46	0			
Iron and Steel Manufacturing (a)	6	1		400	
Leather Tanning and Finishing	18	11	<10	5,900	<2,200
Aluminum Forming	4	1		22	
Electrical/Electronic Components (c)	1	1		13	
Foundries	53	14	<10	1,400	<230
Metal Finishing (b) (f)	7	5	ND	1,800	370
Photographic Equipment/Supplies (d)	17	3	0.78	1,500	500
Pharmaceutical Manufacturing	2	1		10	
Nonferrous Metals Manufacturing	9	0			
Ore Mining and Dressing (b)	32	1		12	
Organic Chemicals and Plastics and Synthetic Resins	22	NA	NA	NA	190
Paint and Ink Formulation (c)	1	1		<10	
Pulp and Paperboard Mills (f)	88	50	ND	420	51
Soap and Detergent Manufacturing (a)	1	1		7.3	
Textile Mills (b) (e)	76	7	1.0	94	29
Timber Products Processing	9	5	10	530	160

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF 2,4,6-TRICHLOROPHENOL

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, μg/L, Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	1		3.0	
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	5	0			
Leather Tanning and Finishing	6	4	<10	4,300	<1,000
Aluminum Forming	20	9	<3.0	1,800	<260
Foundries	53	14	2.0	600	<110
Photographic Equipment/Supplies (d)	8	1		220	
Pharmaceutical Manufacturing	2	1		10	
Nonferrous Metals Manufacturing	11	0			
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	16	NA	NA	NA	320
Paint and Ink Formulation (c)	1	0			
Pulp and Paperboard Mills (f)	88	37	ND	450	48
Textile Mills (b) (e)	94	2	2.0	21	12
Timber Products Processing	5	5	5.0	10	8.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 2,4,6-TRICHLOROPHENOL

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	80	69	III.3.1.9
Flotation		1	NM	3.0	III.3.1.10
Oil Separation		1	>99	ND	III.3.1.14
Sedimentation		4	37* - >99	ND - 2.0	III.3.1.18
Solvent Extraction		1	>99	ND	III.3.1.20
Ultrafiltration		1	99	ND	III.3.1.21
Activated Sludge	1	11	>37 - >99	ND - 4,300	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	>99	ND	
Trickling Filters	1		NM	2.0	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to chlorinated phenols.

Freshwater Aquatic Life

The available freshwater data for chlorinated phenols indicate that toxicity generally increases with increasing chlorination, and that acute toxicity occurs at concentrations as low as 30 µg/L for 4-chloro-3-methylphenol to greater than 500,000 µg/L for other compounds. Chronic toxicity occurs at concentrations as low as 970 µg/L for 2,4,6-trichlorophenol. Acute and chronic toxicity would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available saltwater data for chlorinated phenols indicate that toxicity generally increases with increasing chlorination and that acute toxicity occurs at concentrations as low as 440 µg/L for 2,3,5,6-tetrachlorophenol and 29,700 µg/L for 4-chlorophenol. Acute toxicity would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of chlorinated phenols to sensitive saltwater aquatic life.

Human Health

Sufficient data is not available for 3-monochlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.1 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 4-monochlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.1 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 2,3-dichlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.04 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 2,5-dichlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.5 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 2,6-dichlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.2 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 3,4-dichlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.3 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 2,3,4,6-tetrachlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1.0 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

For comparison purposes, two approaches were used to derive criterion levels for 2,4,5-trichlorophenol. Based on available toxicity data, for the protection of public health, the derived level is 2.6 mg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1.0 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 2,4,6-trichlorophenol through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 12 µg/L, 1.2 µg/L, and 0.12 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 36 µg/L, 3.6 µg/L, and 0.36 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgement on an "acceptable" risk level.

Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 2.0 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

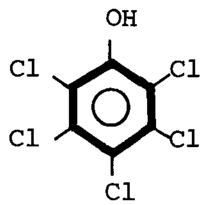
Sufficient data is not available for 2-methyl-4-chlorophenol to derive a level which would protect against any potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1,800 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 3-methyl-4-chlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 3,000 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 3-methyl-6-chlorophenol to drive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 20 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: Pentachlorophenol

Formula:



Alternate Names: PCP;
Chlorophen;
Pentachlorol

CAS #: 87-86-5

Physical, Chemical, and Biological Properties [1-6, 1-7, 1-28]:

molecular weight: 266.4
melting point, °C: 190
boiling point (760 torr), °C: 310
vapor pressure (20°C), torr: 0.00011 (calculated)
solubility in water (20°C), mg/L: 14
log octanol/water partition coefficient: 5.01
Henry's law constant (25°C): 8.82×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.8.5-5

Probable Fate [1-7]:

photolysis: Forms a variety of products; very important fate

oxidation: Can occur, but relatively unimportant

hydrolysis: Not important

volatilization: Not important

sorption: Sorption by organic materials provides storage and transport process

biological processes: Strongly bioaccumulated by many organisms; biodegraded gradually by microbes

other reactions/interactions: Not important

Carbon Adsorption Data, Pentachlorophenol (1-8):

ADSORBABILITY

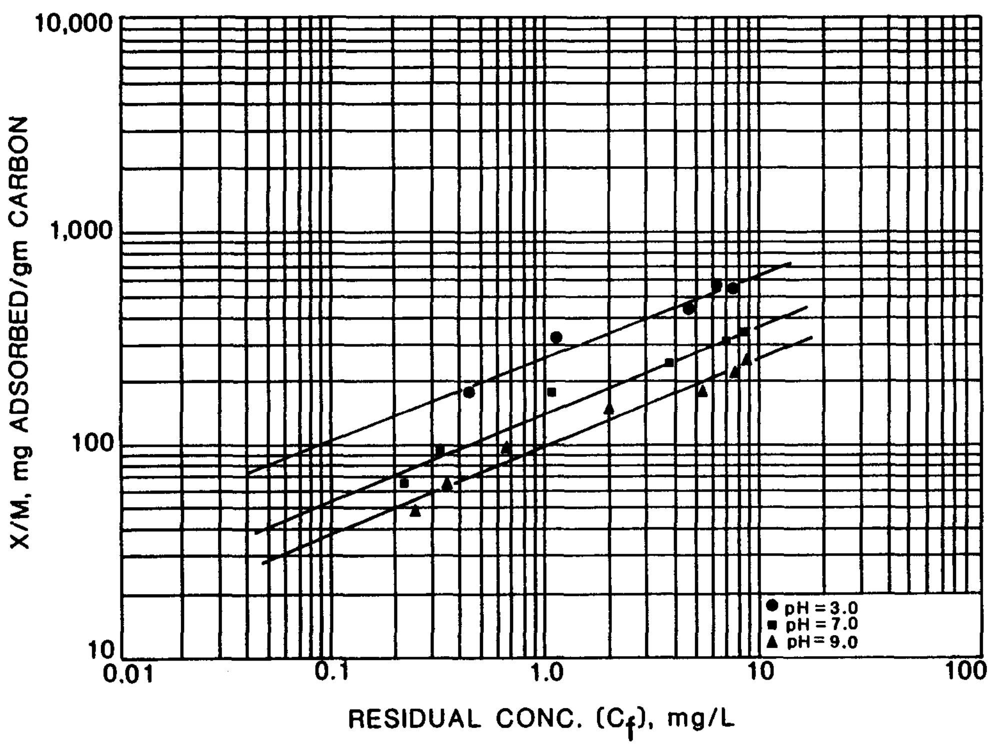
FREUNDLICH PARAMETERS	pH		
	3.0	7.0	9.0
K	260	150	100
1/n	0.39	0.42	0.41
Corr. Coef. r	0.98	0.98	0.98

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	16	47	130
0.1		4.3	12
0.01			1.1

(a) Carbon doses in mg/L at neutral pH



ANALYTICAL METHOD: Ultraviolet Spectroscopy 247 nm , basic pH

INDUSTRIAL OCCURRENCE OF PENTACHLOROPHENOL

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	1		3.0	
Coal Mining (b)	46	0			
Inorganic Chemicals Manufacturing (b)	1	1		370	
Iron and Steel Manufacturing (a)	7	3	3.0	790	280
Leather Tanning and Finishing	18	6	10	6,200	2,900
Battery Manufacturing (h) (i)	8	1	ND	40	<5.0
Electrical/Electronic Components (c)	1	1		250	
Foundries	53	13	<10	1,600	<170
Metal Finishing (b) (h)	18	11	ND	50,000	4,000
Photographic Equipment/Supplies (d)	17	7	0.2	680	150
Pharmaceutical Manufacturing	2	1		10	
Nonferrous Metals Manufacturing (f) (h)	17	1	ND	17	1.5
Ore Mining and Dressing (b)	33	1		10	
Organic Chemicals and Plastics and Synthetic Resins	18	NA	NA	NA	1,900
Paint and Ink Formulation (c)	27	8	<5.0	14,000	<2,500
Petroleum Refining (b)	21	0			
Pulp and Paperboard Mills (h)	114	44	ND	1,200	72
Soap and Detergent Manufacturing (a)	2	2	3.9	150	77
Steam Electric Power Plants (e)	11	1		3.8	
Textile Mills (b) (g)	76	20	1.0	310	56
Timber Products Processing	9	9	1,200	1.6 x 10E5	33,000

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF PENTACHLOROPHENOL

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	3	3	10	27	17
Coal Mining (b)	51	1		3.0	
Inorganic Chemicals Manufacturing (b)	1	0			
Iron and Steel Manufacturing (a)	14	5	3.0	25	10
Leather Tanning and Finishing	6	4	12	3,100	860
Aluminum Forming	1	1		1,800	
Foundries	53	7	<10	140	<33
Photographic Equipment/Supplies (d)	8	1		88	
Pharmaceutical Manufacturing	2	1		110	
Nonferrous Metals Manufacturing	13	0			
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	12	NA	NA	NA	4.6
Paint and Ink Formulation (c)	19	5	<5.0	480	<120
Petroleum Refining (b)	21	0			
Pulp and Paperboard Mills (g)	102	23	ND	1,400	86
Steam Electric Power Plants (e)	12	1		6.5	
Textile Mills (b) (f)	94	10	1.0	66	21
Timber Products Processing	9	9	32	17,000	4,500

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR PENTACHLOROPHENOL

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Activated Carbon Adsorption -granular	2	1	59 - 98*	BDL - 49	III.3.1.1
Chemical Precipitation with Sedimentation -combined precipitants		2	99	<10 - 100	III.3.1.3
Coagulation and Flocculation	1		NM	BDL	III.3.1.5
Filtration	2	4	>99 - >99	ND - 12	III.3.1.9
Flotation		4	19	8.0 - 30	III.3.1.10
Sedimentation		3	55 - >99	ND - 24	III.3.1.18
Ultrafiltration		1	NM	<5.0	III.3.1.21
Activated Sludge	1	17	67 - >99	ND - 3,100	III.3.2.1
Lagoons -aerated		2	>99	ND - ND	III.3.2.2
Trickling Filters	1		NM	3.0	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to pentachlorophenol.

Freshwater Aquatic Life

The available data for pentachlorophenol indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 55 and 3.2 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

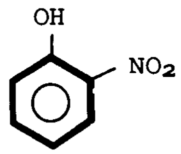
The available data for pentachlorophenol indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 53 and 34 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for pentachlorophenol. Based on available toxicity data, for the protection of public health, the derived level is 1.01 mg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 30 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: 2-Nitrophenol

Formula:



Alternate Names: o-Nitrophenol;
2-Hydroxy-nitrobenzene

CAS #: 88-75-5

Physical, Chemical, and Biological Properties [1-7, 1-21, 1-28]:

molecular weight: 139.11
melting point, °C: 45.3
boiling point (760 torr), °C: 216
vapor pressure (49.3°C), torr: 1.0
solubility in water (20°C), mg/L: 2,100
log octanol/water partition coefficient: 1.76
Henry's law constant (25°C): 1.44×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.8.6-5

Probable Fate [1-7]:

photolysis: Slow photolysis is very probable fate

oxidation: Oxidation by hydroxyl radical attack; no rate available

hydrolysis: Slight potential for hydrolysis after adsorption by clay materials

volatilization: Volatilization occurs, but is not important

sorption: Adsorbed to a moderate degree by clay minerals

biological processes: No bioaccumulation; resistant to biodegradation under natural conditions and inhibits microbial growth at higher concentrations; may degrade in acclimated sewage systems

other reactions/interactions: Not important

Carbon Adsorption Data, 2-Nitrophenol (1-8):

ADSORBABILITY

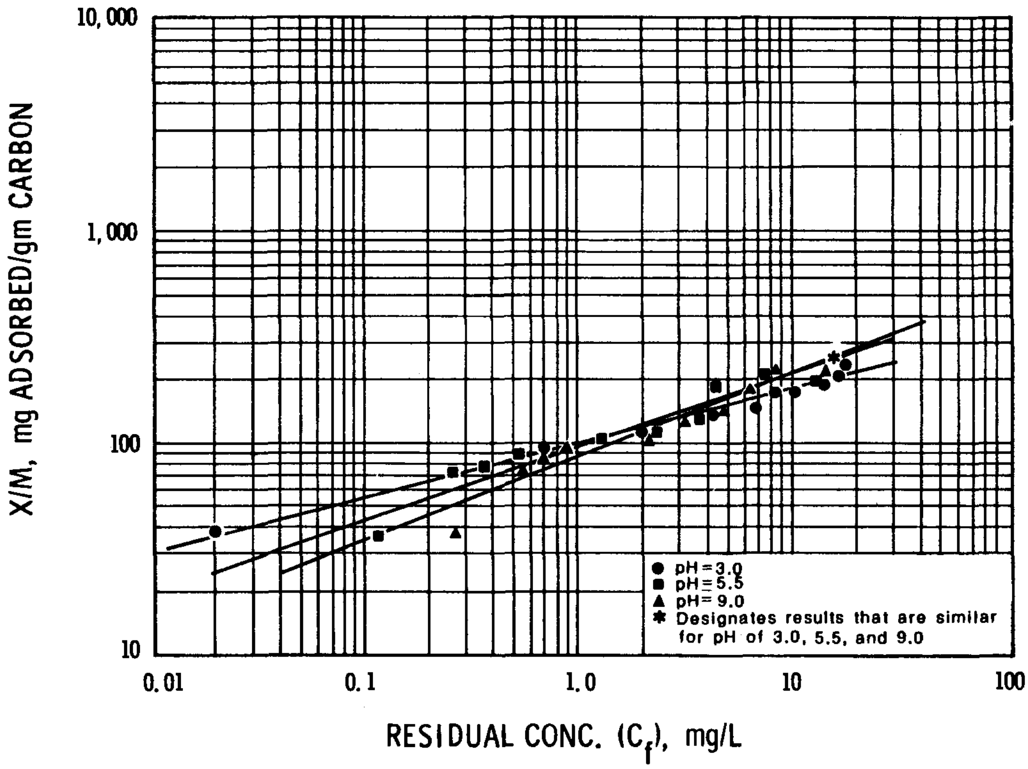
FREUNDLICH PARAMETERS	pH		
	3.0	5.5	9.0
K	101	99	85
1/n	0.26	0.34	0.39
Corr. Coef. r	0.99	0.97	0.97

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	20	47	100
0.1		4.3	10
0.01			1.0

(a) Carbon doses in mg/L at pH 5.5



ANALYTICAL METHOD: Ultraviolet Spectroscopy 278.6 nm

INDUSTRIAL OCCURRENCE OF 2-NITROPHENOL

	Raw wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	0			
Coal Mining (b)	46	1		17	
Iron and Steel Manufacturing (a)	6	2	60	70,000	35,000
Electrical/Electronic Components (c)	28	16	6	100	<22
Foundries	53	12	<10	330	<44
Metal Finishing (b) (f)	14	9	ND	320	40
Photographic Equipment/Supplies (d)	7	2	5	32	19
Pharmaceutical Manufacturing	1	1		14	
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	11	NA	NA	NA	1,300
Petroleum Refining (b)	21	1		1,400	
Rubber Processing	1	1		<10	
Textile Mills (b) (e)	68	1		60	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 2-NITROPHENOL

			Treated wastewater		
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	0			
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	4	1		21	
Foundries	53	5	<10	40	<20
Pharmaceutical Manufacturing	1	1		10	
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	12	NA	NA	NA	130
Petroleum Refining (b)	21	0			
Rubber Processing	1	1		<5.0	
Textile Mills (b) (c)	63	1		4.0	

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 2-NITROPHENOL

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption -granular		1	NM	3.0	III.3.1.1
Sedimentation		1	>99	ND	III.3.1.18
Ultrafiltration		1	>99	21	III.3.1.21
Activated Sludge		3	>99 - >99	ND - BDL	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to nitrophenols.

Freshwater Aquatic Life

The available data for nitrophenols indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 230 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrophenols to sensitive freshwater aquatic life but toxicity to one species of algae occurs at concentrations as low as 150 µg/L.

Saltwater Aquatic Life

The available data for nitrophenols indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 4,850 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrophenols to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of 2,4-dinitro-o-cresol ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 13.4 µg/L.

For the protection of human health from the toxic properties of 2,4-dinitro-o-cresol ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 765 µg/L.

For the protection of human health from the toxic properties of dinitrophenol ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 70 µg/L.

For the protection of human health from the toxic properties of dinitrophenol ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 14.3 mg/L.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for mononitrophenol.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for tri-nitrophenol.

Compound: 4-Nitrophenol

Formula:

Alternate Names: p-Nitrophenol;
4-Hydroxynitrobenzene

CAS #: 100-07-7

Physical, Chemical, and Biological Properties [1-7, 1-12, 1-14]:

molecular weight: 139.1
melting point, °C: 115(sublimes)
boiling point (760 torr), °C: 279 (decomposes)
vapor pressure (146°C), torr: 2.2
solubility in water (25°C), mg/L: 16,000
log octanol/water partition coefficient: 1.91
Henry's law constant: Not available
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.8.6-5

Probable Fate [1-7]:

photolysis: Photolysis is slow, but might be the only degradative process which occurs

oxidation: Attack by hydroxyl radicals at C-2 and C-4 positions occurs, but no rate is available

hydrolysis: Slight possibility of hydrolysis to 1,4-benzoquinone after sorption by clay minerals

volatilization: Not important

sorption: Slight potential for irreversible sorption by clay minerals

biological processes: No bioaccumulation; slowly degraded under natural conditions and inhibits microbial growth at higher concentrations; may degrade in acclimated sewage systems

other reactions/interactions: Not important

Carbon Adsorption Data, 4-Nitrophenol (1-8):

ADSORBABILITY

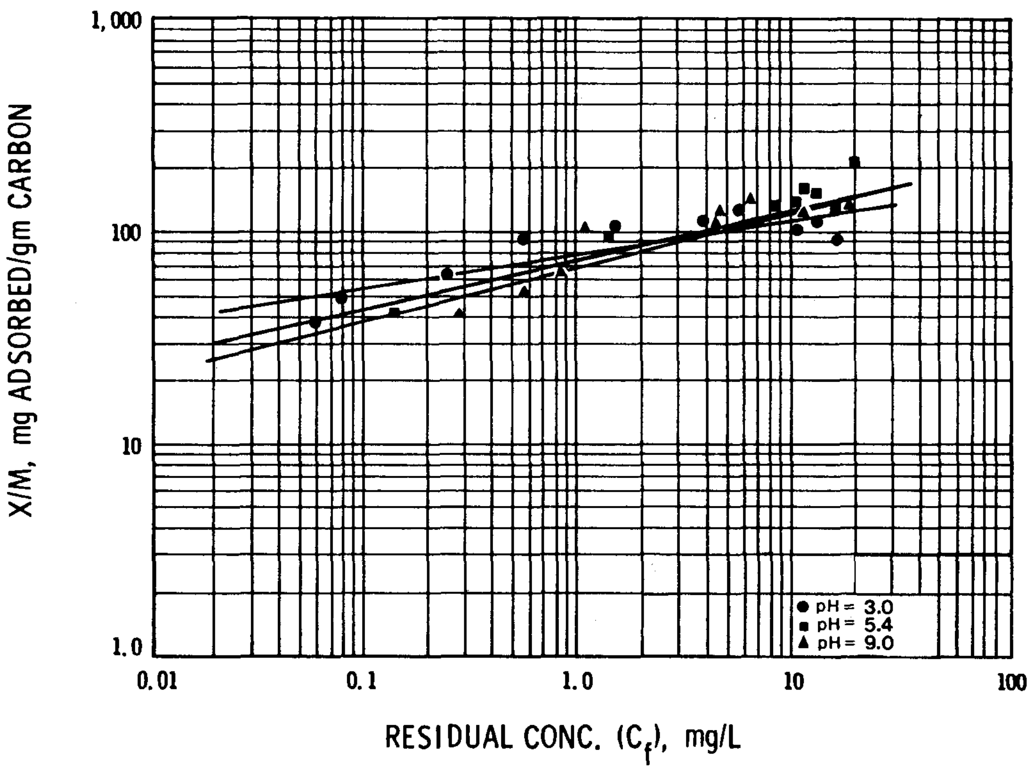
FREUNDLICH PARAMETERS	pH		
	3.0	5.4	9.0
K	80.2	76.2	71.2
1/n	0.17	0.25	0.28
Corr. Coef. r	0.86	0.92	0.93

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	21	41	74
0.1		3.7	7.3
0.01			0.7

(a) Carbon doses in mg/L at pH 5.4



ANALYTICAL METHOD: Ultraviolet Spectroscopy 316.8 nm

INDUSTRIAL OCCURRENCE OF 4-NITROPHENOL

	Raw wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Coal Mining (b)	46	0			
Iron and Steel Manufacturing (a)	2	2	7	31	19
Aluminum Forming	19	1		18	
Electrical/Electronic Components (c)	28	3	<10	180	<78
Foundries	53	7	<10	1,600	<250
Metal Finishing (b) (f)	12	7	ND	20	4.0
Photographic Equipment/Supplies (d)	7	1		57	
Pharmaceutical Manufacturing	1	1		10	
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	14	NA	NA	NA	860
Petroleum Refining (b)	21	3	20	5,800	2,400
Textile Mills (b) (e)	68	3	65	240	140

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 4-NITROPHENOL

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	3	0			
Foundries	53	5	6.0	20	<11
Pharmaceutical Manufacturing	1	1		10	
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	14	NA	NA	NA	190
Petroleum Refining (b)	21	1		<10	

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 4-NITROPHENOL

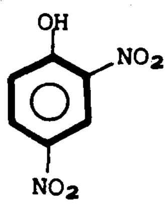
Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Ultrafiltration		1	NM	18	III.3.1.21
Activated Sludge		3	66 - >99	ND - 570	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	>23	<10	

ND, not detected; NM, not meaningful.

RESERVED

Compound: 2,4-Dinitrophenol

Formula:



Alternate Names: Aldifen;
2,4-DNP

CAS #: 51-28-5

Physical, Chemical, and Biological Properties [1-7, 1-12, 1-14]:

molecular weight: 184.1
melting point, °C: 114
boiling point (760 torr), °C: Sublimes
vapor pressure (25°C), torr: Not available
solubility in water (18°C), mg/L: 5,600
log octanol/water partition coefficient: 1.53
Henry's law constant: Not available
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.8.6-5

Probable Fate [1-7]:

photolysis: Degradation by slow photolysis may be principal fate

oxidation: Oxidation by hydroxy radicals could occur, but no environmental rate is available

hydrolysis: Slight possibility for hydrolysis after adsorption by clay minerals

volatilization: Not important

sorption: Slight potential for sorption by clay minerals

biological processes: No bioaccumulation; uncertain amount of biodegradation under natural conditions

other reactions/interactions: Not important

Carbon Adsorption Data, 2,4-Dinitrophenol (1-8):

ADSORBABILITY

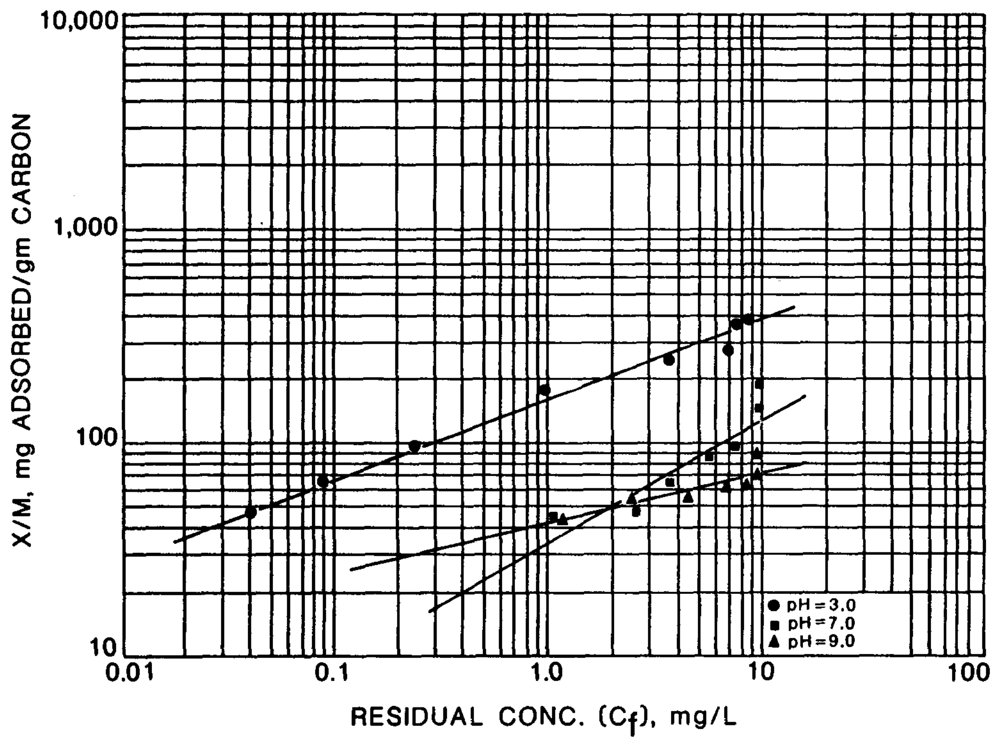
FREUNDLICH PARAMETERS	pH		
	3.0	7.0	9.0
K	160	33	41
1/n	0.37	0.61	0.25
Corr. Coef. r	0.99	0.89	0.87

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	110	500	2,100
0.1		45	200
0.01			18

(a) Carbon doses in mg/L at neutral pH



ANALYTICAL METHOD: Ultraviolet Spectroscopy 260 nm

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF 2,4-DINITROPHENOL

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Aluminum Forming	1	1		23	
Foundries	53	12	6.0	900	<100
Metal Finishing (a) (c)	5	4	ND	10,000	2,500
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	7	NA	NA	NA	760
Petroleum Refining (a)	21	3	110	11,000	4,600

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 2,4-DINITROPHENOL

Industry	Number of samples	Number of detections	Treated wastewater — Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	51	1		3.0	
Aluminum Forming	6	1		37	
Foundries	53	6	4.0	21	<11
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	7	NA	NA	NA	45
Petroleum Refining (a)	21	0			

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 2,4-DINITROPHENOL

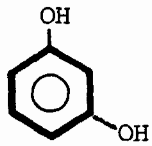
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Chemical Precipitation with Sedimentation -unspecified		1	>99	ND	III.3.1.3
Ultrafiltration		1	NM	47	III.3.1.21

ND, not detected; NM, not meaningful.

RESERVED

Compound: Resorcinol

Formula:



Alternate Names: m-Hydroxyphenol; 1,3-Dihydroxybenzene; 1,3-Benzenediol; Resorcin

CAS #: 108-46-3

Physical, Chemical, and Biological Properties [1-6, 1-12, 1-28]:

molecular weight: 110.1
melting point, °C: 276-280
boiling point (760 torr), °C: 281 (volatilizes at lower temp.)
vapor pressure (138°C), torr: 5
solubility in water (30°C), mg/L: 2,290,000
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 1.22×10^{-10} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: 90% resorcinol removal (measured as COD removal) obtained at 20°C in activated sludge at a rate of 58 mg COD/g dry inoculum/hr
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Resorcinol (1-8, 1-16):

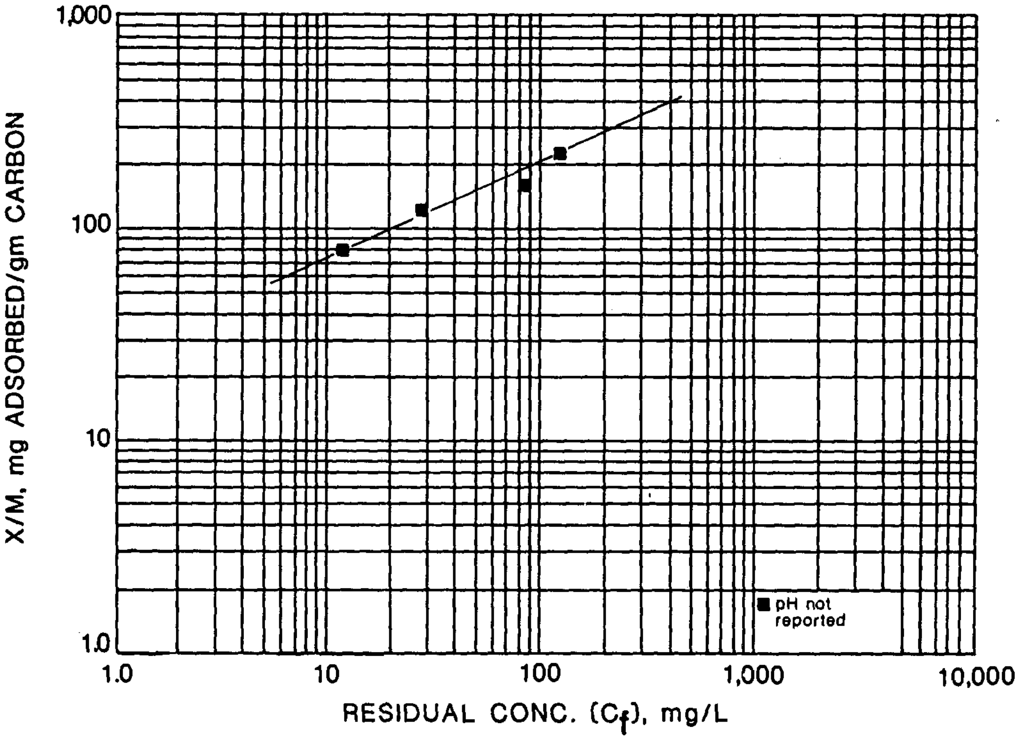
ADSORBABILITY

FREUNDLICH PARAMETERS	pH		
	Not reported		
K	31		
1/n	0.41		
Corr. Coef. r	0.97		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	75	210	550
0.1		19	54
0.01			5.0



ANALYTICAL METHOD: Not reported.

INDUSTRIAL OCCURRENCE OF RESORCINOL

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Foundries	53	0			

See Section I.1 Introduction for additional information.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF RESORCINOL

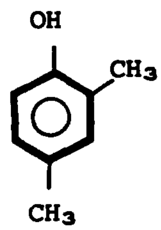
Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, μg/L: Minimum	Maximum	Mean
Foundries	53	0			

See Section I.1 Introduction for additional information.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: 2,4-Dimethylphenol

Formula:



Alternate Names: 2,4-Xylenol;
1-Hydroxy-2,4-dimethylbenzene

CAS #: 105-67-9

Physical, Chemical, and Biological Properties [1-7, 1-12, 1-28]:

molecular weight: 122.2
melting point, °C: 24.5
boiling point (760 torr), °C: 211
solubility in water (20°C), mg/L: ~ 1,000 (estimated)
log octanol/water partition coefficient: 2.50
Henry's law constant (25°C): 2.52×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.8.10-5

Probable Fate [1-7]:

photolysis: Photooxidation definitely occurs, but rate and importance are unknown

oxidation: Metal-catalyzed oxidation may occur in aerated surface waters

hydrolysis: Not important

volatilization: Not important

sorption: Slight potential for adsorption onto organic materials

biological processes: Available data are conflicting and inconclusive, but biodegradation can occur

other reactions/interactions: Chlorine present in H_2O could chlorinate the compound

Carbon Adsorption Data, 2,4-Dimethylphenol (1-8):

ADSORBABILITY

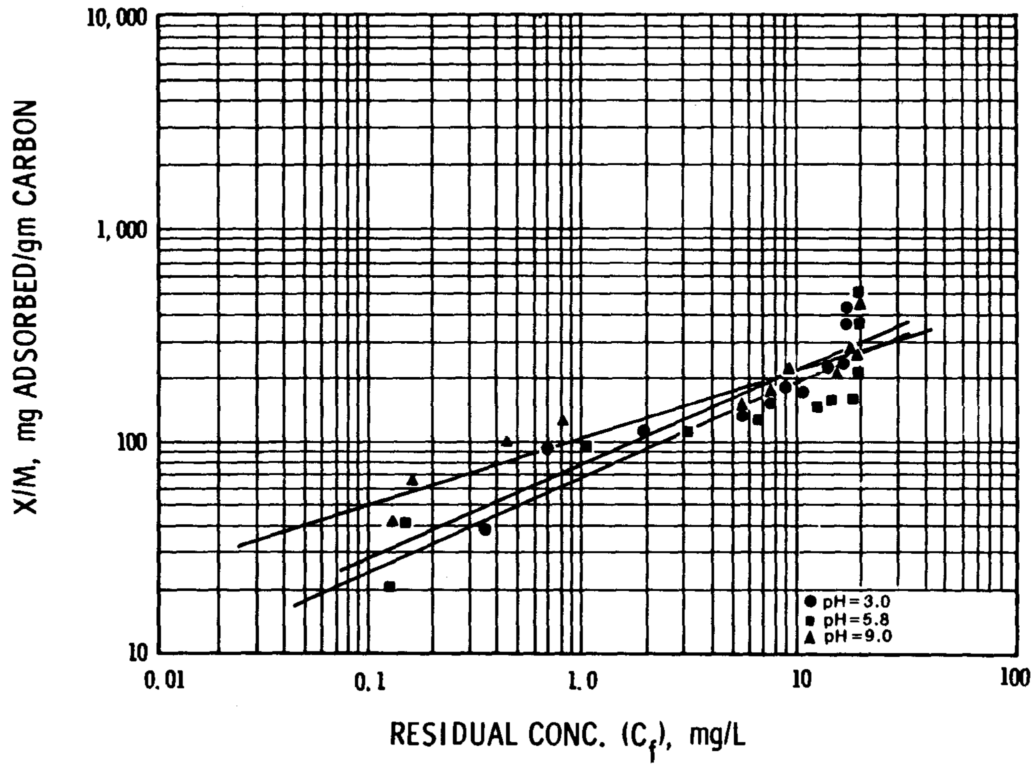
FREUNDLICH PARAMETERS	pH		
	3.0	5.8	9.0
K	78	70	108
1/n	0.44	0.44	0.33
Corr. Coef. r	0.93	0.92	0.93

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	36	110	300
0.1		9.8	30
0.01			2.7

(a) Carbon doses in mg/L at pH 5.8



ANALYTICAL METHOD: Ultraviolet Spectroscopy 238 nm at pH 11

Date: 1/24/83

INDUSTRIAL OCCURRENCE OF 2,4-DIMETHYLPHENOL

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	19	4	2.0	460	130
Coal Mining (b)	46	3	18	24	21
Iron and Steel Manufacturing (a)	18	10	1	84,000	<12,000
Leather Tanning and Finishing	18	2	<10	<10	<10
Aluminum Forming	19	2	<0.3	19	<9.6
Coil Coating	13	0			
Electrical/Electronic Components (c)	4	0			
Foundries	53	21	5.0	12,000	<680
Metal Finishing (b) (g)	16	11	ND	31,000	2,800
Photographic Equipment/Supplies (d)	17	8	1.0	170	260
Pharmaceutical Manufacturing	1	1	10		
Nonferrous Metals Manufacturing (e) (g)	2	1	ND	14	7.0
Ore Mining and Dressing (b)	32	1		140	
Organic Chemicals and Plastics and Synthetic Resins	16	NA	NA	NA	5,000
Petroleum Refining (b)	21	8	71	18,000	>4,000
Rubber Processing	1	1		58,000	
Textile Mills (b) (f)	68	3	2.0	190	65

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 2,4-DIMETHYLPHENOL

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	3	1		29	
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	16	6	4.0	160	<36
Coil Coating	3	1		11	
Foundries	53	18	2.0	490	<72
Pharmaceutical Manufacturing	1	1		10	
Nonferrous Metals Manufacturing	2	0			
Ore Mining and Dressing (b)	28	1		270	
Organic Chemicals and Plastics and Synthetic Resins	17	NA	NA	NA	12
Petroleum Refining (b)	21	1		<10	
Rubber Processing	1	1		15,000	
Textile Mills (b) (c)	62	3	1.0	9.0	6.0
Timber Products Processing	5	5	5.0	140	35

NA, not available. See Section 1.1 for introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 2,4-DIMETHYLPHENOL

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption					III.3.1.1
-granular	2		NM	BDL - 0.9	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	88*	BDL	
-lime		1	48	11	
Filtration	1	1	NM	BDL - 29	III.3.1.9
Flotation		2	>99	ND - 28	III.3.1.10
Sedimentation		1	>99	ND	III.3.1.18
Solvent Extraction		1	>99	ND	III.3.1.20
Activated Sludge	1	5	>99	ND - 9.0	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to 2,4-dimethylphenol.

Freshwater Aquatic Life

The available data for 2,4-dimethylphenol indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 2,120 μg/L, and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of dimethylphenol to sensitive freshwater aquatic life.

Saltwater Aquatic Life

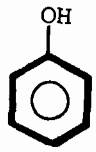
No saltwater organisms have been tested with 2,4-dimethylphenol and no statement can be made concerning acute and chronic toxicity.

Human Health

Sufficient data are not available for 2,4-dimethylphenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 400 μg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: Total phenols

Formula: Derivatives of phenol



Alternate Names: Hydroxybenzenes;
Phenoyl hydroxides

CAS #: See sections on individual phenols

Physical, Chemical, and Biological Properties:

See sections on individual phenols.

Probable Fate [1-7]:

photolysis: Photooxidation is important only for phenol, pentachlorophenol, nitrophenols, and possibly alkyl phenols

oxidation: Can occur, but probably cannot compete with biodegradation

hydrolysis: Probably not important for any phenols

volatilization: Phenols are volatilized very little

sorption: Important for highly chlorinated phenols and possibly for nitrophenols

biological processes: Biodegradation is very important for chlorophenols, but not for nitrophenols

other reactions/interactions: Chlorination by chlorine present in H_2O

Carbon Adsorption Data:

See sections on individual phenols.

RESERVED

INDUSTRIAL OCCURRENCE OF TOTAL PHENOLS

Industry	Raw wastewater Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	37	37	<1.0	1,500	<220
Leather Tanning and Finishing	18	18	180	9,500	3,300
Battery Manufacturing (d) (e)	64	48	ND	250	36
Coil Coating	78	57	0.48	270	47
Foundries	53	0			
Metal Finishing (b) (d)	36	35	ND	49,000	2,400
Porcelain Enameling	35	32	0.39	290	21
Nonferrous Metals Manufacturing (f)	36	36	0.1	20,000	860
Steam Electric Power Plants (c)	10	4	6.0	38	16

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Verification data plus surveillance and analysis program data.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Detections may include values less than 5 µg/L.
(f) Minimum, maximum, and mean are flow weighted averages.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF TOTAL PHENOLS

	Treated wastewater				
	Number of	Number of	Detected concentrations, μg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	11	11	<1.0	1,000	<310
Aluminum Forming	4	4	0.01	0.01	0.01
Coil Coating (c)	18	17	0.0	33	10
Foundries	53	0			
Porcelain Enameling	18	17	3.0	82	28
Gum and Wood Chemicals	5	5	29	47,000	11,000
Nonferrous Metals Manufacturing (d)	30	30	3.0	25,000	<1,200
Steam Electric Power Plants (b)	12	8	6.0	40	18

See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Verification data plus surveillance and analysis program data.
(c) Reference reports 0.0 μg/L for detections less than detection limit 10 μg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR TOTAL PHENOLS

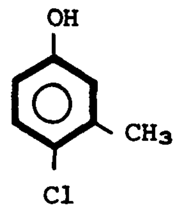
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	11	2	0 - >90	BDL - 580	
-powdered	4		99 - >99	<10 - 58	
Chemical Oxidation					III.3.1.2
-ozone	2		50 - 99	10 - 130	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	7	25 - 56	28 - 2.2 x 10E5	
-combined precipitants		5	23 - 92	12 - 1,300	
-lime		14	0 - >99	ND - 330	
-sodium carbonate		2	NM	5.0 - 80	
-sodium hydroxide		2	90	20 - 66	
-unspecified		1	58	300	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	33	20	
Coagulation and Flocculation	2	3	0 - 26	13 - 340	III.3.1.5
Filtration	12	10	0 - 67	1.0 - 64,000	III.3.1.9
Flotation		10	3 - >94	<1.0 - 23,000	III.3.1.10
Oil Separation		4	0 - 43	20 - 1,600	III.3.1.14
Reverse Osmosis	6		5 - 81	<1.0 - 20	III.3.1.16
Sedimentation	2	30	0 - >99	5 - 2.6 x 10E5	III.3.1.18
Activated Sludge		27	11 - >99	7.0 - 280	III.3.2.1
Lagoons					III.3.2.2
-aerated		5	33 - >99	3.0 - 29,000	
-non-aerated		2	40	30 - 50	

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: ρ-Chloro-m-cresol

Formula:



Alternate Names: 4-Chloro-m-cresol;
4-Chloro-3-methylphenol;
2-Chloro-5-hydroxytoluene

CAS #: 59-50-7

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 142
melting point, °C: 66
boiling point (760 torr), °C: 235
vapor pressure (25°C), torr: Not available
solubility in water (20°C), mg/L: 3,850
log octanol/water partition coefficient: 2.95
Henry's law constant: Not available
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Based on data for 4-chlorophenol, intramolecular photolysis may be a very important fate

oxidation: Can occur, but probably cannot compete with biodegradation

hydrolysis: Resistant to aqueous hydrolysis

volatilization: Not important

sorption: Data inconclusive, but potential for adsorption by organic particulates exists

biological processes: No data on bioaccumulation but is likely to occur; biodegradation data not applicable to environment; compound readily biodegraded in acclimated aerobic sewage systems; resistant to anaerobic biodegradation

other reactions/interactions: Can be chlorinated further by chlorine present in H_2O

Carbon Adsorption Data, p-Chloro-m-cresol (1-8):

ADSORBABILITY

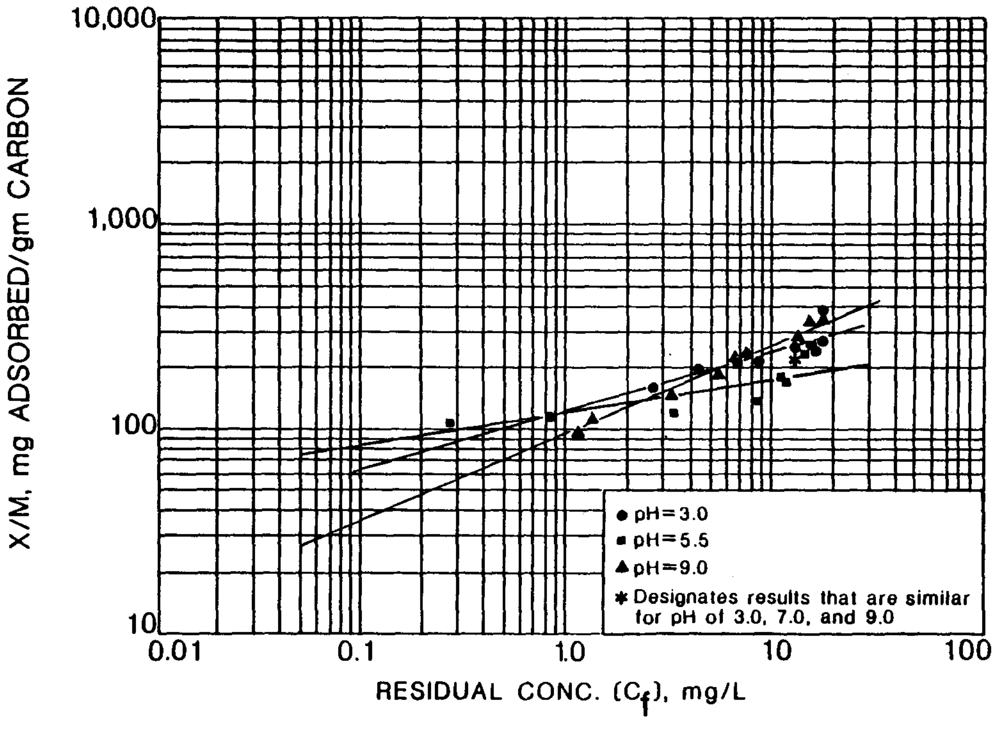
FREUNDLICH PARAMETERS	pH		
	3.0	5.5	9.0
K	122	124	99
1/n	0.29	0.16	0.42
Corr. Coef. r	0.90	0.87	0.97

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	11	17	25
0.1		1.6	2.5
0.01			0.2

(a) Carbon doses in mg/L at pH 5.5



ANALYTICAL METHOD: Ultraviolet spectroscopy 225.9 nm

INDUSTRIAL OCCURRENCE OF P-CHLORO-M-CRESOL

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Auto and Other Laundries (a)	13	1		<10	
Coal Mining (b)	46	0			
Iron and Steel Manufacturing (a)	5	2	7.0	4,300	2,200
Aluminum Forming	2	1		28	
Foundries	53	13	<10	280	<69
Metal Finishing (b) (e)	17	13	ND	8.0 x 10E5	46,000
Photographic Equipment/Supplies (c)	17	5	0.22	11	3.1
Ore Mining and Dressing (b)	32	0			
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	0.01
Petroleum Refining (b)	21	0			
Soap and Detergent Manufacturing (a)	1	1		2.9	
Textile Mills (b) (d)	76	3	5.0	29	14

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF P-CHLORO-M-CRESOL

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	5	2	<3.0	64	<34
Aluminum Forming	1	0			
Foundries	53	4	<10	63	<36
Photographic Equipment/Supplies (c)	8	0			
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	0.01
Petroleum Refining (b)	21	2	<10	10	<10
Textile Mills (b) (d)	94	7	1.0	32	8.0

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR P-CHLORO-M CRESOL

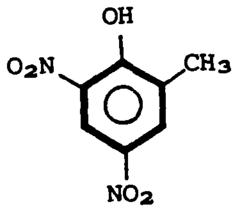
Treatment process	Number of data points Pilot scale	Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption -granular	2		92*	BDL - BDL	III.3.1.1
Chemical Precipitation with Sedimentation -alum		1	44	62	III.3.1.3
Filtration	3		NM	BDL - 1.1	III.3.1.9
Sedimentation		1	NM	10	III.3.1.18
Solvent Extraction		1	>99	ND	III.3.1.20
Activated Sludge		4	>99 - >99	ND - 1.6	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: 4,6-Dinitro-o-cresol

Formula:



Alternate Names: DNOC; 2,4-Dinitro-6-methyl-phenol

CAS #: 534-52-1

Physical, Chemical, and Biological Properties [1-6, 1-7, 1-8]:

molecular weight: 198.1
melting point, °C: 85.8
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (temp. unknown), mg/L: 250
log octanol/water partition coefficient: 2.85
Henry's law constant: 1.4×10^{-6} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Gradual photooxidation should occur, but relative importance uncertain

oxidation: Hydroxyl radicals may displace nitro groups

hydrolysis: Hydrolysis may occur after adsorption by clay minerals

volatilization: Not important

sorption: Adsorption by clay should be an important transport process

biological processes: Toxicity rules out bioaccumulation; biodegradation occurs in soil, possibly in water

other reactions/interactions: Not important

Carbon Adsorption Data, 4,6-Dinitro-o-cresol (1-8):

ADSORBABILITY

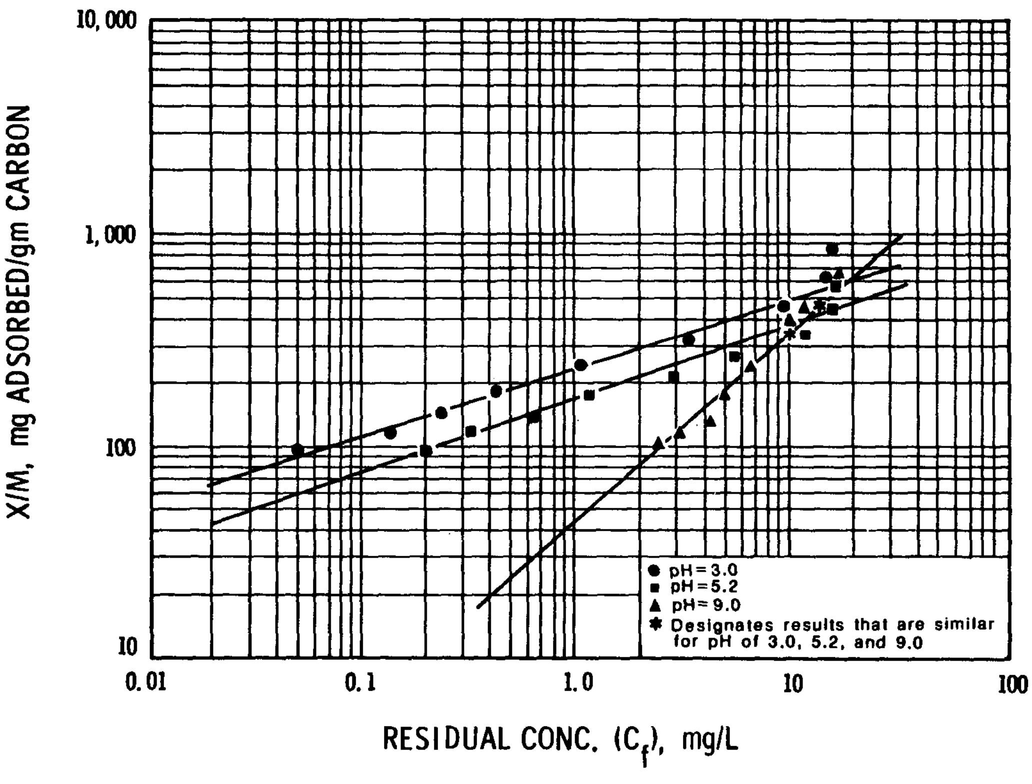
FREUNDLICH PARAMETERS	pH		
	3.0	5.2	9.0
K	237	169	42.7
1/n	0.32	0.35	0.90
Corr. Coef. r	0.97	0.98	0.99

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, Cf mg/L

Co. mg/L	0.1	0.01	0.001
1.0	12	28	63
0.1		2.7	6.2
0.01			0.6

(a) Carbon doses in mg/L at pH 5.2



ANALYTICAL METHOD: Ultraviolet Spectroscopy 271 nm

INDUSTRIAL OCCURRENCE OF 4,6-DINITRO-O-CRESOL

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	46	1		190	
Iron and Steel Manufacturing (a)	8	3	44	970	650
Aluminum Forming	1	1		24	
Foundries	53	11	<10	70	<28
Metal Finishing (b) (d)	4	3	ND	5,700	1,900
Photographic Equipment/Supplies (c)	7	0			
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Petroleum Refining (b)	21	1		60	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 4,6-DINITRO-O-CRESOL

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	51	1		3.0	
Iron and Steel Manufacturing (a)	9	2	<5.0	<10	<7.5
Aluminum Forming	6	0			
Foundries	53	10	7.0	88	<24
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Petroleum Refining (b)	21	0			

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 4,6-DINITRO-O-CRESOL

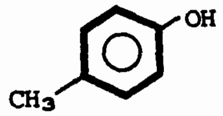
Treatment process	Number of data points Pilot scale	 Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Sedimentation		2	>99	ND - BDL	III.3.1.18
Solvent Extraction		1	>99	ND	III.3.1.20

BDL, below detection limit; ND, not detected.

RESERVED

<u>Compound</u>: Cresol

<u>Formula</u>:



<u>Alternate Names</u>: Cresylic acid; Cresyol;
Tricresol; Methylphenol;
Hydroxytoluene

<u>CAS #</u>: 1319-77-3

<u>Physical, Chemical, and Biological Properties</u> [1-12, 1-13, 1-28]:

molecular weight: 108.1
melting point, °C: 10.9-35.5
boiling point (760 torr), °C: 185-205
vapor pressure (38-53°C), torr: 1
solubility in water (40°C), mg/L: 24,000-31,000
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 1.4×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: 96% cresol removal (measured as COD removal) obtained at 20°C in activated sludge at a rate of 55 mg COD/g dry inoculum/hr
water quality criteria: Not included

<u>Probable Fate</u>: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Cresol (1-8, 1-16):

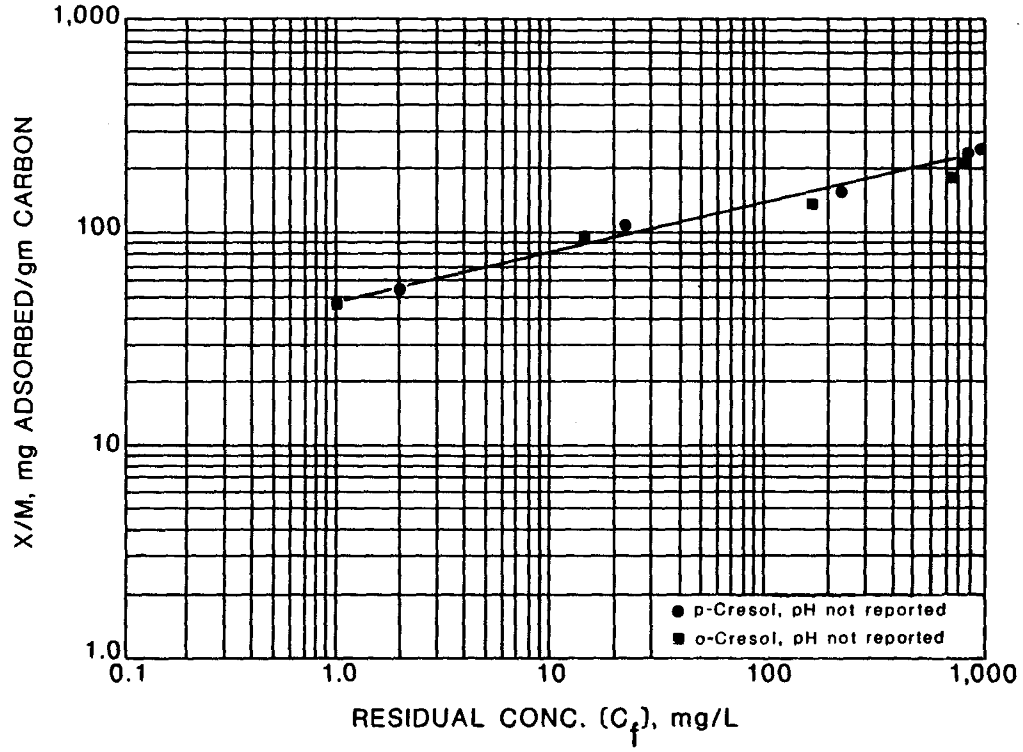
ADSORBABILITY

FREUNDLICH PARAMETERS	pH		
	Not reported		
K	49.5		
1/n	0.22		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	30	0.55	92
0.1		5.0	9.1
0.01			0.8



ANALYTICAL METHOD: Not specified

INDUSTRIAL OCCURRENCE OF CRESOL

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Foundries	53	0			

See Section I.1 Introduction for additional information.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF CRESOL

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Foundries	53	0			

See Section I.1 Introduction for additional information.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CRESOL

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Solvent Extraction	9		83 - >99	2.3 - 3.3 x 10E5	III.3.1.20

RESERVED

Compound: Benzene

Formula:

Alternate Names: Benzol;
Cyclohexatriene

CAS #: 71-43-2

Physical, Chemical, and Biological Properties [1-6, 1-7, 1-15]:

molecular weight: 78.12
melting point, °C: 5.5
boiling point (760 torr), °C: 80.1
vapor pressure (25°C), torr: 95.2
solubility in water (25°C), mg/L: 1,780-1,800
log octanol/water partition coefficient: 2.13
Henry's law constant (25°C): 5.55×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.9.1-5

Probable Fate [1-7]:

photolysis: Photooxidation of volatilized benzene is the only form of photolysis which occurs

oxidation: No aqueous oxidation occurs, but volatilized benzene is photooxidized at a rapid rate

hydrolysis: Not important

volatilization: Rapid volatilization (half-life = 4.81 hr) is the primary transport process for benzene

sorption: Information lacking; some sorption potential on organic materials

biological processes: Low potential for bioaccumulation; metabolized to catechols by many organisms; biodegraded at a slow rate

other reactions/interactions: Not important

Carbon Adsorption Data, Benzene (1-8):

ADSORBABILITY

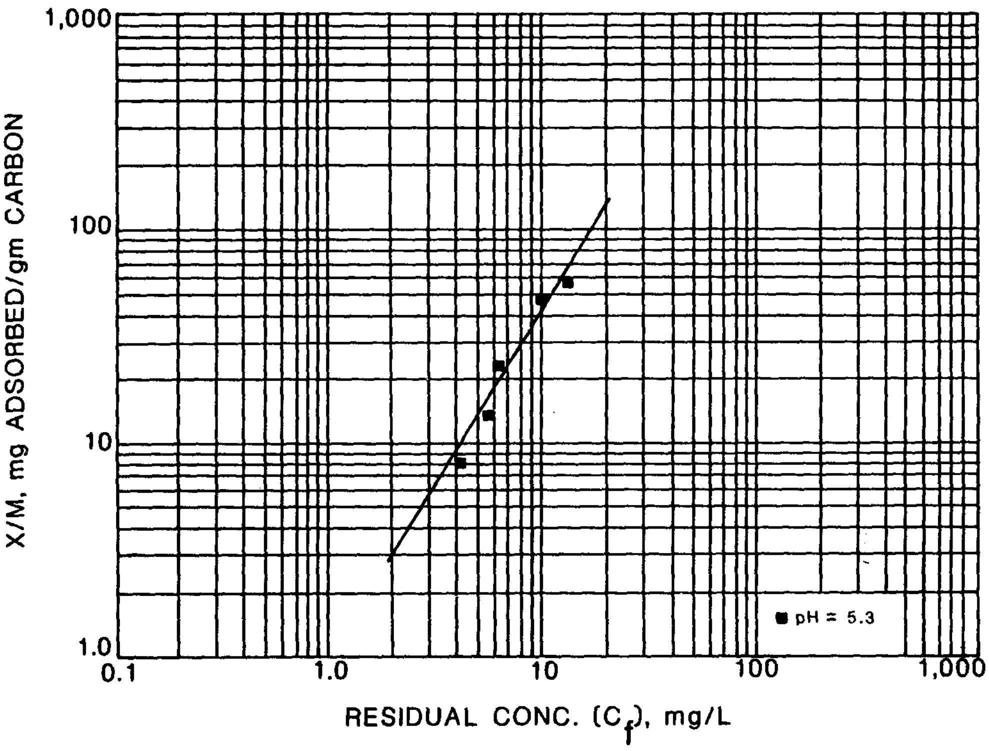
FREUNDLICH PARAMETERS	pH		
	5.3		
K	1.0		
1/n	1.6		
Corr. Coef. r	0.97		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	35,000	>100,000	>100,000
0.1		>100,000	>100,000
0.01			>100,000

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Ultraviolet Spectroscopy 245.6 nm.

INDUSTRIAL OCCURRENCE OF BENZENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	19	14	<0.2	23,000	<3,200
Coal Mining (b)	47	13	2.0	73	24
Inorganic Chemicals Manufacturing (b)	1	1		0.4	
Iron and Steel Manufacturing (a)	12	10	7.0	46,000	<12,000
Leather Tanning and Finishing	18	13	5.0	150	22
Aluminum Forming	32	20	<0.3	2,100	<110
Electrical/Electronic Components (c)	28	7	<1.0	<10	<8.7
Foundries	53	20	7.0	150	<26
Metal Finishing (b) (h)	34	28	ND	110	7.5
Photographic Equipment/Supplies (d)	47	25	0.03	2,100	190
Gum and Wood Chemicals	3	3	120	140	130
Pharmaceutical Manufacturing	6	6	10	10,000	1,700
Nonferrous Metals Manufacturing (f) (h)	95	10	ND	160	12
Ore Mining and Dressing (b)	33	10	NA	10	4.9
Organic Chemicals and Plastics and Synthetic Resins	63	NA	NA	NA	22,000
Paint and Ink Formulation (c)	30	23	<28	9,900	<1,600
Petroleum Refining (b)	16	12	12	2,400	<470
Pulp and Paperboard Mills (h)	139	31	ND	150	3.6
Rubber Processing	4	4	<10	3,300	<850
Soap and Detergent Manufacturing (a)	2	2	0.1	0.7	0.4
Steam Electric Power Plants (e)	11	3	1.2	<10	<4.5
Textile Mills (b) (g)	78	22	1.0	200	30
Timber Products Processing	5	5	3.0	2,800	1,100

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF BENZENE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	5.0	200	100
Coal Mining (b)	51	21	ND	16	4.0
Iron and Steel Manufacturing (a)	17	14	5.0	1.2 x 10E5	<9,500
Leather Tanning and Finishing	6	4	<10	<10	<10
Aluminum Forming	22	18	<0.3	40	<5.6
Foundries	53	19	<10	850	<59
Photographic Equipment/Supplies (d)	13	9	0.05	21	3.4
Gum and Wood Chemicals	4	4	120	440	240
Pharmaceutical Manufacturing	4	4	3.0	10	8.2
Nonferrous Metals Manufacturing (f) (h)	81	8	ND	59	4.0
Ore Mining and Dressing (b)	28	3	NA	11	8.3
Organic Chemicals and Plastics and Synthetic Resins	42	NA	NA	NA	26
Paint and Ink Formulation (c)	19	13	<10	3,800	<680
Petroleum Refining (b)	16	8	<1.0	12	<7.8
Pulp and Paperboard Mills (h)	130	26	ND	96	1.4
Rubber Processing	4	4	<0.1	<110	<30
Steam Electric Power Plants (e)	12	3	2.0	<10	<4.7
Textile Mills (b) (g)	96	15	1.0	64	11
Timber Products Processing	5	5	3.0	33	17

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BENZENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	3	1	64 - 90	BDL - 210	
Chemical Oxidation					III.3.1.2
-ozone	1		80*	BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		3	>99	ND - 310	
-combined precipitants		4	50 - >99	46 - 3,800	
-lime		2	>99	ND - 1.0	
-sodium hydroxide		1	>99	2.0	
-unspecified		1	35	720	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1		NM	BDL	
Chemical Reduction		1		1.0*	III.3.1.4
Coagulation and Flocculation		2	>99	ND - BDL	III.3.1.5
Filtration	4	4	29 - >99	ND - 200	III.3.1.9
Flotation		4	33	5.0 - 200	III.3.1.10
Oil Separation		2	NM	ND - BDL	III.3.1.14
Reverse Osmosis	2		50 - 80	0.4 - 1.0	III.3.1.16
Sedimentation		5	>33 - 56	BDL - 96	III.3.1.18
Solvent Extraction	6	1	58 - 97	2,400 - 12,000	III.3.1.20
Ultrafiltration	1		>99	ND	III.3.1.21
Activated Sludge	1	9	75 - >99	ND - 64	III.3.2.1
Lagoons					III.3.2.2
-aerated		5	0 - >95	<5.0 - 120	

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to benzene.

Freshwater Aquatic Life

The available data for benzene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 5,300 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of benzene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for benzene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 5,100 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of benzene to sensitive saltwater aquatic life, but adverse effects occur at concentrations as low as 700 µg/L with a fish species exposed for 168 days.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of benzene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 6.6 µg/L, 0.66 µg/L, and 0.066 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 400 µg/L, 40.0 µg/L, and 4.0 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Chlorobenzene

Formula:

Alternate Names: Monochlorobenzene;
Benzene chloride;

CAS #: 108-90-7

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 112.6
melting point, °C: -45
boiling point (760 torr), °C: 132
vapor pressure (25°C), torr: Conflicting data reported
solubility in water (25°C), mg/L: 488
log octanol/water partition coefficient: 2.84
Henry's law constant (25°C): 3.93×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.9.7-5

Probable Fate [1-7]:

photolysis: Information not available

oxidation: No data on aqueous oxidation

hydrolysis: Unlikely to occur under environmental conditions

volatilization: Volatilization is the main transport process

sorption: Chlorobenzene is presumably sorbed by organic particulate materials

biological processes: High potential for bioaccumulation and magnification; biodegradation very slow under environmental conditions, may be biodegraded in acclimated sewage systems

other reactions/interactions: There is a low probability of further chlorinating chlorobenzene by reaction with chlorine-containing water

Carbon Adsorption Data, Chlorobenzene

ADSORBABILITY

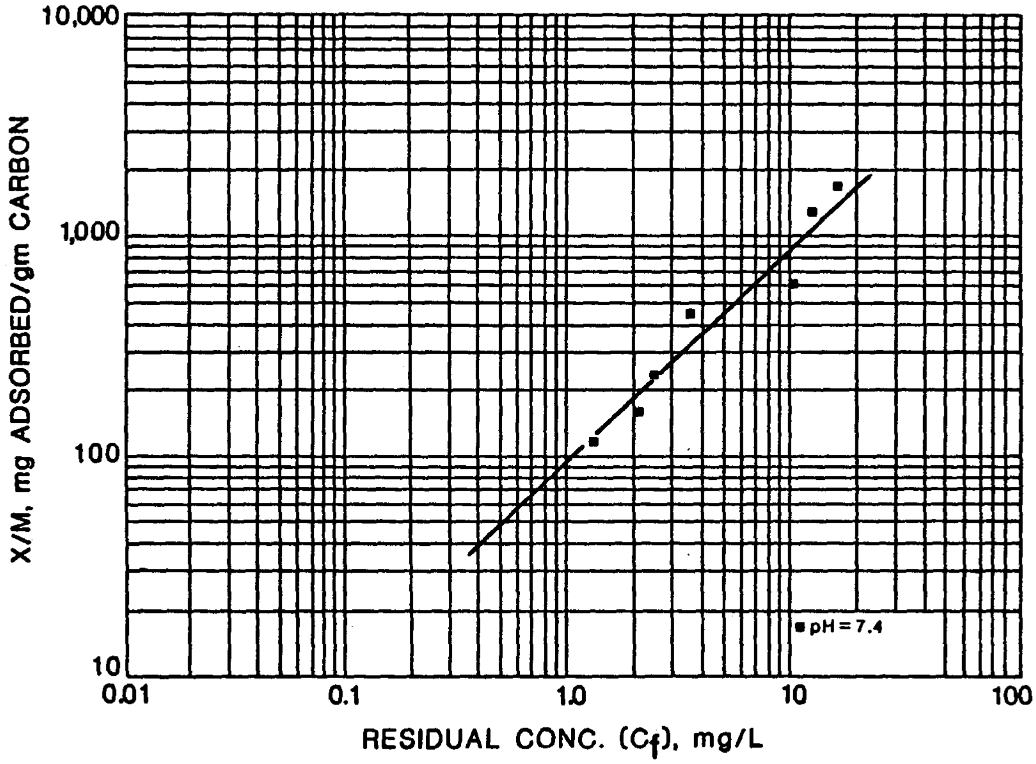
FREUNDLICH PARAMETERS	pH		
	7.4		
K	91		
1/n	0.99		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	92	970	9,400
0.1		88	930
0.01			84

(a) Carbon doses in mg/L at pH 7.4



ANALYTICAL METHOD: Ultraviolet spectroscopy 209 nm

Date: 1/24/83

INDUSTRIAL OCCURRENCE OF CHLOROBENZENE

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	3	2	<0.2	12	<6.1
Coal Mining (b)	46	1		12	
Leather Tanning and Finishing	18	1		10	
Electrical/Electronic Components (c)	28	3	<10	<10	<10
Foundries	53	3	<10	250	<90
Metal Finishing (b) (g)	6	4	ND	610	160
Photographic Equipment/Supplies (d) (h)	18	4	0.0	27	5.9
Pharmaceutical Manufacturing	2	2	100	1.2 x 10E5	60,000
Nonferrous Metals Manufacturing (e) (g)	68	0	ND	9.0	1.6
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	19	NA	NA	NA	4,000
Paint and Ink Formulation (c)	1	1		530	
Pulp and Paperboard Mills (g)	6	3	ND	47	22
Soap and Detergent Manufacturing (a)	2	2	0.6	22	11
Textile Mills (b) (f)	73	16	1.0	300	30
Timber Products Processing					

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF CHLOROBENZENE

	Treated wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	50	0			
Foundries	53	1		460	
Photographic Equipment/Supplies (d)	8	1		5.0	
Pharmaceutical Manufacturing	1	1		10	
Nonferrous Metals Manufacturing (e) (g) (h)	43	1	ND	65	4
Ore Mining and Dressing (b)	28	1		5.0	
Organic Chemicals and Plastics and Synthetic Resins	16	NA	NA	NA	170
Paint and Ink Formulation (c)	1	0			
Pulp and Paperboard Mills	6	0			
Textile Mills (b) (f)	69	5	2.0	26	8.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CHLOROBENZENE

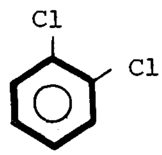
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption -granular	1		98*	BDL	III.3.1.1
Filtration	2	1	98	0.1 - 470	III.3.1.9
Flotation		1	NM	57	III.3.1.10
Activated Sludge	1	7	0 - >99	ND - 100	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: 1,2-Dichlorobenzene

Formula:



Alternate Names: o-Dichlorobenzene;
Orthodichlorobenzene;
Dowtherm E

CAS #: 95-50-1

Physical, Chemical, and Biological Properties [1-6, 1-7, 1-15]:

molecular weight: 147.0
melting point, °C: -17.0
boiling point (760 torr), °C: 180
vapor pressure (25°C), torr: 1.5
solubility in water (25°C), mg/L: 145
log octanol/water partition coefficient: 3.38
Henry's law constant (25°C): 1.94×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.9.3-5

Probable Fate [1-7]:

photolysis: Probably occurs slowly

oxidation: Resistant to autooxidation by peroxy radical in water

hydrolysis: Not important

volatilization: Relatively rapid volatilization occurs

sorption: Significant amount of adsorption by organic materials should occur in environment

biological processes: Bioaccumulated more than chlorobenzene; sufficiently resistant to biodegradation to make volatilization more important

other reactions/interactions: Not important

Carbon Adsorption Data, 1,2-Dichlorobenzene (1-8):

ADSORBABILITY

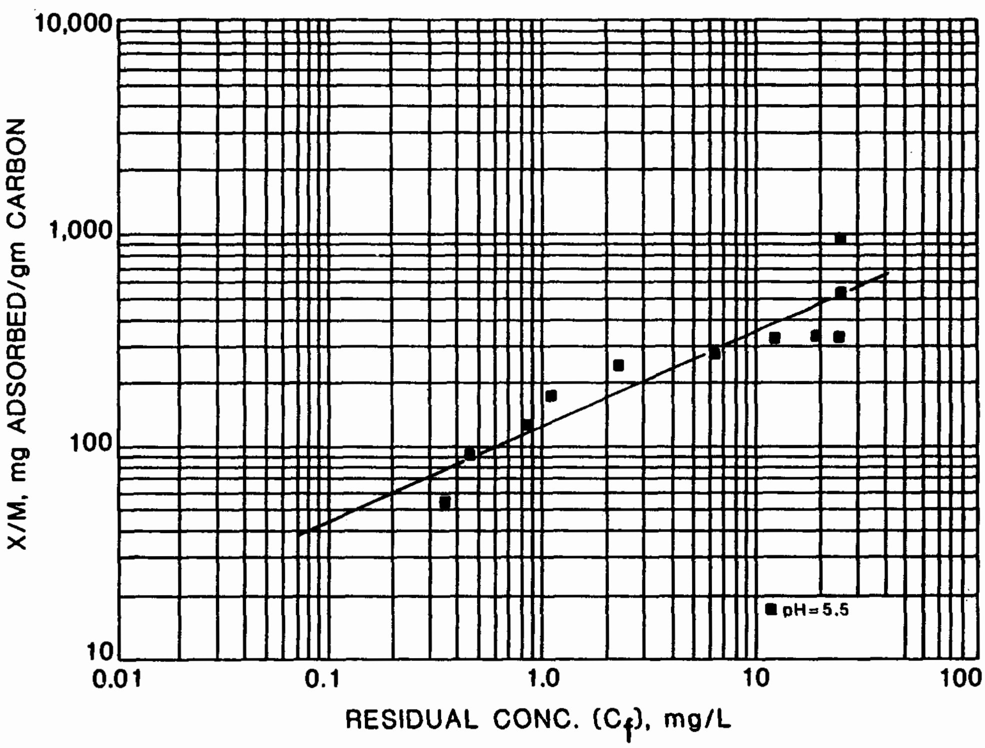
FREUNDLICH PARAMETERS	pH		
	5.5		
K	129		
1/n	0.43		
Corr. Coef. r	0.92		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	19	57	160
0.1		5.2	15
0.01			1.4

(a) Carbon doses in mg/L at pH 5.5



ANALYTICAL METHOD: Ultraviolet Spectroscopy 214 nm.

INDUSTRIAL OCCURRENCE OF 1,2-DICHLOROBENZENE

Industry	Number of samples	Number of detections	Raw wastewater — Detected concentrations, μg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	1		<5.0	
Coal Mining (b)	49	2	3.0	18	11
Leather Tanning and Finishing	18	6	36	260	120
Electrical/Electronic Components (c)	28	14	8.9	1.9 x 10E5	<14,000
Foundries	53	1		<10	
Photographic Equipment/Supplies (d)	19	1		24	
Ore Mining and Dressing	32	0			
Organic Chemicals and Plastics and Synthetic Resins	10	NA	NA	NA	2,000
Paint and Ink Formulation (c)	1	1	<10		
Petroleum Refining (b)	21	0			
Steam Electric Power Plants (e)	11	1		5.3	
Textile Mills (b) (f)	76	15	1	460	85

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 1,2-DICHLOROBENZENE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	18	260	140
Coal Mining (b)	53	2	3.0	18	11
Leather Tanning and Finishing	6	2	<10	69	<40
Foundries	53	0			
Photographic Equipment/Supplies (c)	1	0			
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	10	NA	NA	NA	50
Petroleum Refining (b)	21	0			
Steam Electric Power Plants (d)	11	0			
Textile Mills (b) (e)	94	18	1.0	20	4.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Verification data plus surveillance and analysis program data.
(e) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,2-DICHLOROBENZENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	3		99*	BDL - 5.4	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1		>99	ND	
Coagulation and Flocculation	2		99*	BDL - 13	III.3.1.5
Filtration	3		44 - 55	0.5 - 5.8	III.3.1.9
Oil Separation		1	>99	ND	III.3.1.14
Activated Sludge		14	69 - >99	ND - 69	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	>99	ND	

BDL, below detection limit; ND, not detected; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to dichlorobenzenes.

Freshwater Aquatic Life

The available data for dichlorobenzenes indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 1,120 and 763 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for dichlorobenzenes indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 1,970 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of dichlorobenzenes to sensitive saltwater aquatic life.

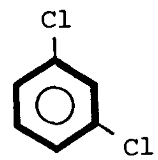
Human Health

For the protection of human health from the toxic properties of dichlorobenzenes (all isomers) ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 400 µg/L.

For the protection of human health from the toxic properties of dichlorobenzenes (all isomers) ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 2.6 mg/L.

Compound: 1,3-Dichlorobenzene

Formula:



Alternate Names: m-Dichlorobenzene;
Metadichlorobenzene

CAS #: 541-73-1

Physical, Chemical, and Biological Properties [1-6, 1-7, 1-15]:

molecular weight: 147.0
melting point, °C: 24.7
boiling point (760 torr), °C: 173
vapor pressure (25°C), torr: 2.28 (calculated)
solubility in water (25°C), mg/L: 123
log octanol/water partition coefficient: 3.38
Henry's law constant (25°C): 2.63×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.9.3-5

Probable Fate [1-7]:

photolysis: Probably occurs slowly

oxidation: No data on aqueous oxidation

hydrolysis: Not important

volatilization: Volatilizes at a relatively rapid rate

sorption: Presumably sorbed by organic materials

biological processes: Bioaccumulates more than chlorobenzene; too resistant to biodegradation to compete with volatilization

other reactions/interactions: Not important

Carbon Adsorption Data, 1,3-Dichlorobenzene (1-8):

ADSORBABILITY

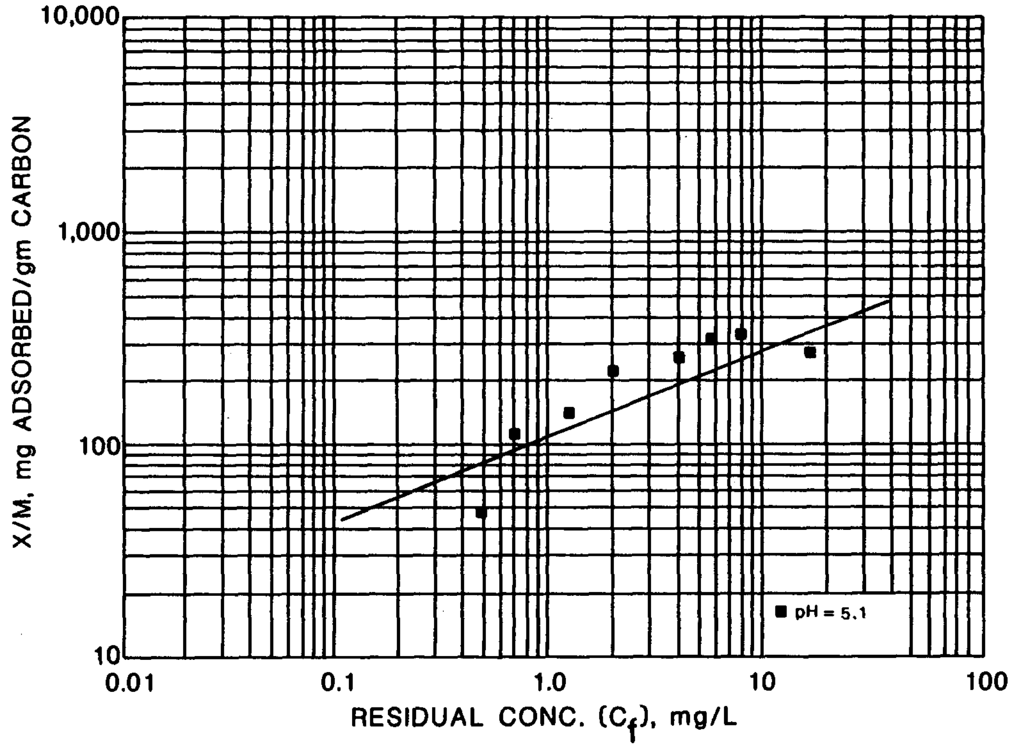
FREUNDLICH PARAMETERS	pH		
	5.1		
K	118		
1/n	0.45		
Corr. Coef. r	0.86		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	22	68	200
0.1		6.2	19
0.01			1.8

(a) Carbon doses in mg/L at pH 5.1



ANALYTICAL METHOD: Ultraviolet Spectroscopy 214 nm.

INDUSTRIAL OCCURRENCE OF 1,3-DICHLOROBENZENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, μg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a) (g)	2	1		1,100	
Coal Mining (b)	49	0			
Leather Tanning and Finishing	18	1		<10	
Electrical/Electronic Components (c)	28	10	2.7	15,000	<1,500
Foundries	53	1		<10	
Photographic Equipment/Supplies (d)	7	1		3.7	
Ore Mining and Dressing (b)	32	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Steam Electric Power Plants (e)	11	1		2.4	
Textile Mills (b) (f)	68	4	10	1,700	700

NA, not available. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Mean calculated using medians.
(g) Data reported are for total dichlorobenzenes.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 1,3-DICHLOROBENZENE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (b)	53	0			
Iron and Steel Manufacturing (a)	6	0			
Foundries	53	0			
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Steam Electric Power Plants (c)	12	1		2.4	
Textile Mills (b) (d)	63	2	13	33	23

NA, not available; See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Verification data plus surveillance and analysis program data.
(d) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,3-DICHLOROBENZENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Coagulation and Flocculation		1	>99	ND	III.3.1.5
Oil Separation		1	>99	ND	III.3.1.14
Activated Sludge		1	NM	BDL	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: 1,4-Dichlorobenzene

Formula:

Alternate Names: ρ-Dichlorobenzene;
Paradichlorobenzene;
Paramoth

CAS #: 106-46-7

Physical, Chemical, and Biological Properties [1-6, 1-7, 1-15]:

molecular weight: 147.0
melting point, °C: 53.1
boiling point (760 torr), °C: 174 (Sublimes at ordinary temperatures)
vapor pressure (25°C), torr: 1.18 (calculated)
solubility in water (25°C), mg/L: 79
log octanol/water partition coefficient: 3.39
Henry's law constant (25°C): 2.88×10^{-3} atmos. m^3 $mole^{-3}$ (calculated)
biodegradability: T-significant degradation in initial culture but decreasing in subsequent subculture indicating possible toxicity.
water quality criteria: See page I.9.3-5

Probable Fate [1-7]:

photolysis: Probably occurs slowly

oxidation: Resistant to autooxidation by peroxy radical in water

hydrolysis: Not important

volatilization: Volatilizes at a relatively rapid rate

sorption: Data not available but physical parameters suggest substantial sorption on suspended solids

biological processes: Bioaccumulates more than chlorobenzene; too resistant to biodegradation to compete with volatilization

other reactions/interactions: Not important

Carbon Adsorption Data, 1,4-Dichlorobenzene (1-8):

ADSORBABILITY

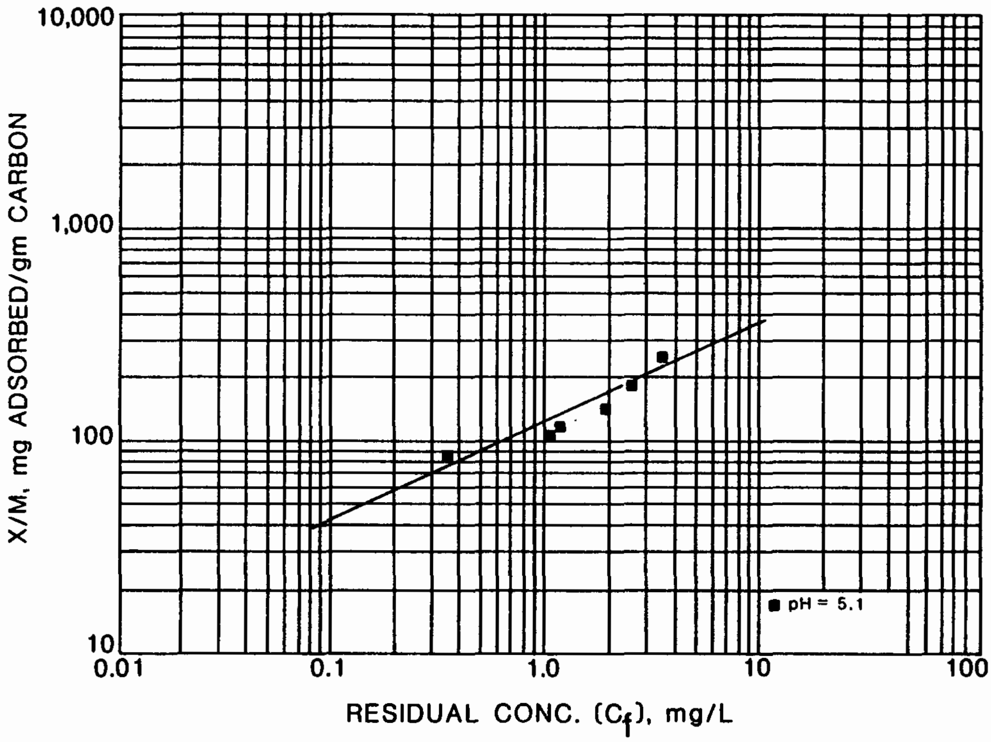
FREUNDLICH PARAMETERS	pH		
	5.1		
K	121		
1/n	0.47		
Corr. Coef. r	0.94		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	22	73	220
0.1		6.6	22
0.01			2.0

(a) Carbon doses in mg/L at pH 5.1



ANALYTICAL METHOD: Ultraviolet Spectroscopy 223 nm.

INDUSTRIAL OCCURRENCE OF 1,4-DICHLOROBENZENE

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	49	1		3.0	
Leather Tanning and Finishing	18	8	<10	54	<23
Electrical/Electronic Components (b)	28	13	1.1	15,000	<1,200
Foundries	53	1		<10	
Photographic Equipment/Supplies (c)	7	2	3.7	5.0	4.4
Nonferrous Metals Manufacturing (d) (f)	6	1	ND	26	43
Ore Mining and Dressing (a)	32	0			
Petroleum Refining (a)	21	0			
Textile Mills (a) (e)	71	8	1.0	760	190

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 1,4-DICHLOROBENZENE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	53	1		3.0	
Leather Tanning and Finishing	6	2	<10	21	<16
Foundries	53	0			
Nonferrous Metals Manufacturing	7	0			
Ore Mining and Dressing (a)	28	0			
Petroleum Refining (a)	21	0			
Textile Mills (a) (b)	66	6	1.0	16	6.0

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,4-DICHLOROBENZENE

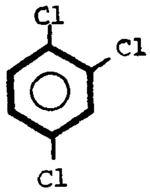
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Filtration		1	37	94	III.3.1.9
Activated Sludge		9	76* - >99	ND - 21	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	>99	ND	

ND, not detected; *approximate value.

RESERVED

Compound: 1,2,4-Trichlorobenzene

Formula:



Alternate Names: unsym-Trichlorobenzene

CAS #: 120-82-1

Physical, Chemical, and Biological Properties [1-6, 1-7, 1-15, 1-17]:

molecular weight: 181.4
melting point, °C: 17.0
boiling point (760 torr), °C: 214
vapor pressure (25°C), torr: 0.42 (calculated)
solubility in water (25°C), mg/L: 30
log octanol/water partition coefficient: 4.26 (calculated)
Henry's law constant (25°C): 1.42×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: T-significant degradation in initial culture but decreasing in subsequent subculture indicating possible toxicity
water quality criteria: See page I.9.7-5

Probable Fate [1-7]:

photolysis: Information not available

oxidation: Information not available for aqueous environment

hydrolysis: Information not available for aqueous environment

volatilization: Very rapid volatilization can be hindered by adsorption if organics are present

sorption: High potential for adsorption by suspended organic materials

biological processes: High potential for bioaccumulation; very little, if any biodegradation due to volatilization and adsorption

other reactions/interactions: Not important

Carbon Adsorption Data, 1,2,4-Trichlorobenzene (1-8):

ADSORBABILITY

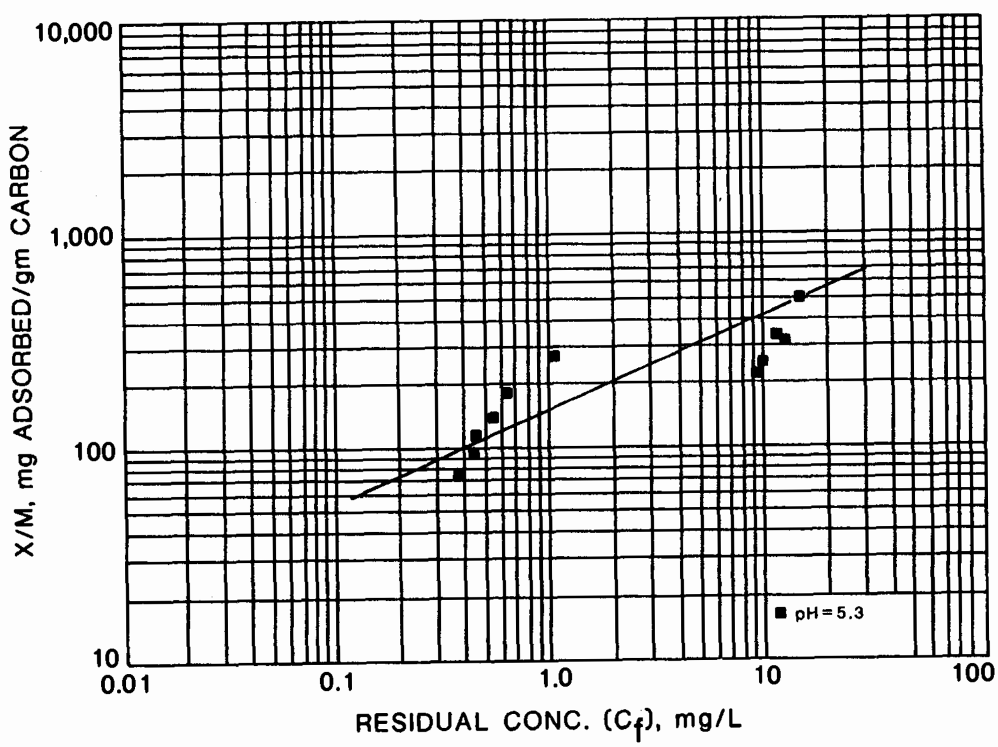
FREUNDLICH PARAMETERS	pH		
	5.3		
K	157		
1/n	0.31		
Corr. Coef. r	0.84		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	12	26	52
0.1		2.3	5.2
0.01			0.5

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Ultraviolet Spectroscopy 226.5 nm.

INDUSTRIAL OCCURRENCE OF 1,2,4-TRICHLOROBENZENE

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Leather Tanning and Finishing	18	0			
Electrical/Electronic Components (b)	28	10	<10	27,000	<4,600
Foundries	53	2	7.0	1,000	500
Photographic Equipment/Supplies (c)	6	1		0.03	
Nonferrous Metals Manufacturing (d) (f)	35	2	ND	260	22
Ore Mining and Dressing (a)	33	0			
Textile Mills (a) (e)	76	15	28	14,000	2,200

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 1,2,4-TRICHLOROBENZENE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	2	<10	≤570	<290
Nonferrous Metals Manufacturing (b) (d)	24	3	ND	47	4.4
Ore Mining and Dressing (a)	28	0			
Textile Mills (a) (c)	92	15	1.0	1,900	410

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Mean calculated using medians.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,2,4-TRICHLOROBENZENE

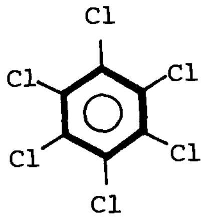
Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption					III.3.1.1
-granular	1	1	>99	ND - 94	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1		91	150	
Coagulation and Flocculation	1		91	150	III.3.1.5
Filtration		2	NM	ND - 84	III.3.1.9
Activated Sludge	1	10	49 - >99	ND - 920	III.3.2.1

ND, not detected; NM, not meaningful.

RESERVED

Compound: Hexachlorobenzene

Formula:



Alternate Names: Perchlorobenzene;
HCB

CAS #: 118-74-1

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 284.8
melting point, °C: 230
boiling point (760 torr), °C: 322
vapor pressure (20°C), torr: 1.09×10^{-5}
solubility in water (25°C), µg/L: 6
log octanol/water partition coefficient: 6.18
Henry's law constant (25°C): 1.70×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: T-significant degradation in initial culture but decreasing in subsequent subculture indicating possible toxicity
water quality criteria: See page I.9.7-5

Probable Fate [1-7]:

photolysis: Extremely slow under environmental conditions

oxidation: Resistant to oxidation

hydrolysis: Resistant to hydrolysis

volatilization: No specific information but volatilization is likely to be an important fate

sorption: Strongly sorbed by particulate matter

biological processes: Strongly bioaccumulated by many organisms; extremely slow biodegradation

other reactions/interactions: Not important

Carbon Adsorption Data, Hexachlorobenzene (1-8):

ADSORBABILITY

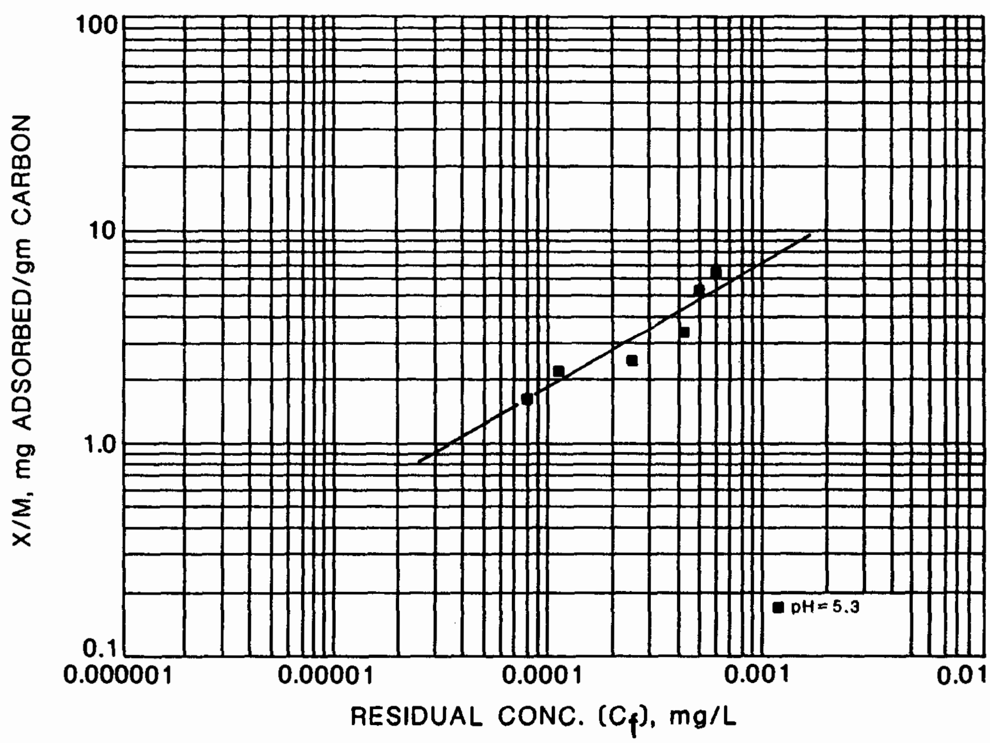
FREUNDLICH PARAMETERS	pH		
	5.3		
K	450		
1/n	0.60		
Corr. Coef. r	0.94		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	8.0	35	140
0.1		3.2	14
0.01			1.3

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent Extraction - G.C.

INDUSTRIAL OCCURRENCE OF HEXACHLOROBENZENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	49	0			
Iron and Steel Manufacturing (a)	7	1		160	
Leather Tanning and Finishing	18	0			
Foundries	53	2	<10	<10	<10
Photographic Equipment/Supplies (c)	7	1		12	
Nonferrous Metals Manufacturing (d) (f)	26	2	ND	5,000	220
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	19
Textile Mills (b) (e)	71	2	1.0	2.0	1.5

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF HEXACHLOROBENZENE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (b)	53	0			
Iron and Steel Manufacturing (a)	7	0			
Foundries	53	0			
Nonferrous Metals Manufacturing (c) (e)	26	2	ND	220	30
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	2.5
Textile Mills (b) (d)	66	3	1.0	1.0	1.0

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR HEXACHLOROBENZENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Sludge		4	>99 - >99	ND - 0.8	III.3.2.1

ND, not detected.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to chlorinated benzenes.

Freshwater Aquatic Life

The available data for chlorinated benzenes indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 250 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of the more toxic of the chlorinated benzenes to sensitive freshwater aquatic life but toxicity occurs at concentrations as low as 50 µg/L for a fish species exposed for 7.5 days.

Saltwater Aquatic Life

The available data for chlorinated benzenes indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 160 and 129 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of hexachlorobenzene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding recommended criteria are 7.2 ng/L, 0.72 ng/L, and 0.072 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 7.4 ng/L, 0.74 ng/L, and 0.074 ng/L, respectively.

For the protection of human health from the toxic properties of 1,2,4,5-tetrachlorobenzene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 38 µg/L.

For the protection of human health from the toxic properties of 1,2,4,5-tetrachlorobenzene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 48 µg/L.

For the protection of human health from the toxic properties of pentachlorobenzene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 74 µg/L.

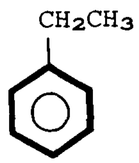
For the protection of human health from the toxic properties of pentachlorobenzene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 85 μg/L.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for trichlorobenzene.

For comparison purposes, two approaches were used to derive criterion levels for monochlorobenzene. Based on available toxicity data, for the protection of public health, the derived level is 488 μg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 20 μg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: Ethylbenzene

Formula:



Alternate Names: Phenylethane; Ethylbenzol

CAS #: 100-41-4

Physical, Chemical, and Biological Properties [1-6, 1-7, 1-15]:

molecular weight: 106.2
melting point, °C: -94.9
boiling point (760 torr), °C: 136
mvapor pressure (20°C), torr: 7
solubility in water (20°C), mg/L: 152
log octanol/water partition coefficient: 3.15
Henry's law constant (25°C): 6.44×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.9.8-5

Probable Fate [1-7]:

photolysis: Does not occur under environmental conditions

oxidation: Resistant under natural conditions

hydrolysis: Information not available

volatilization: Physical parameters indicate high rates of volatilization

sorption: No specific information, but sorption is a highly likely environmental fate

biological processes: Very little potential for bioaccumulation; specific information is not available for natural conditions but biodegradation is likely to be important

other reactions/interactions: Not important

Carbon Adsorption Data, Ethylbenzene (1-8):

ADSORBABILITY

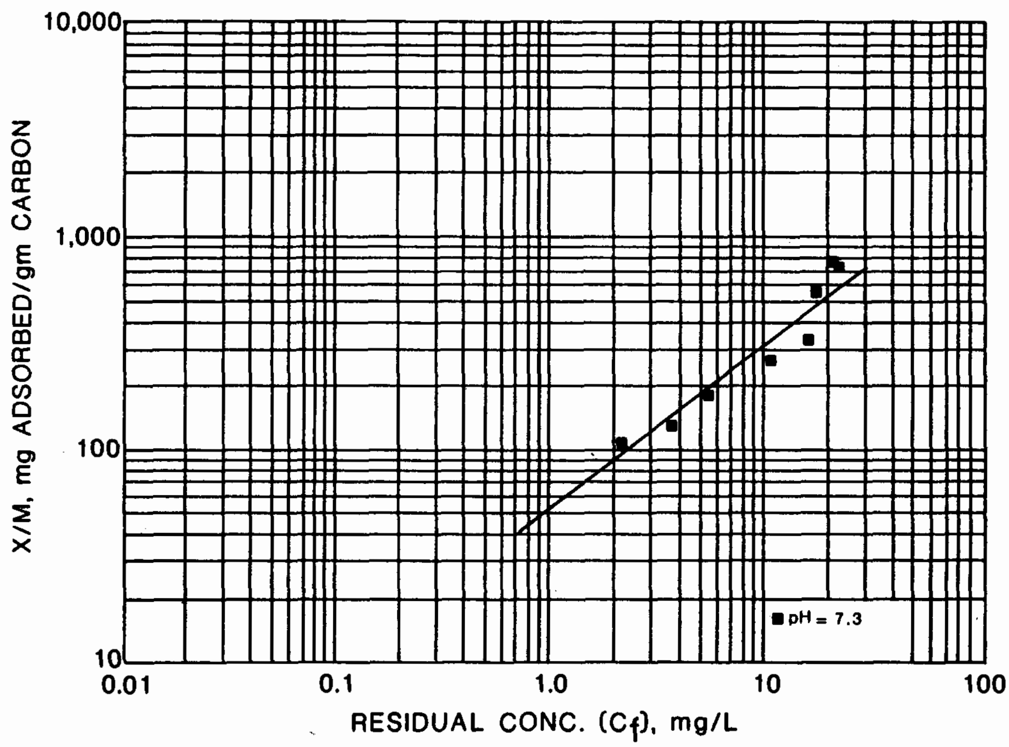
FREUNDLICH PARAMETERS	pH		
	7.3		
K	53		
1/n	0.79		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	110	710	4,400
0.1		65	440
0.01			40

(a) Carbon doses in mg/L at pH 7.3



ANALYTICAL METHOD: Ultraviolet Spectroscopy 260 nm.

Date: 10/8/82 I.9.8-2

INDUSTRIAL OCCURRENCE OF ETHYLBENZENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	17	9	1.5	18,000	<2,500
Coal Mining (b)	48	4	2.0	11	5.0
Iron and Steel Manufacturing (a)	11	8	<3	640	<210
Leather Tanning and Finishing	18	12	<10	150	<78
Aluminum Forming	4	3	15	40	32
Battery Manufacturing (h) (i)	13	2	ND	<10	<6.7
Electrical/Electronic Components (c)	28	11	0.5	110	<20
Foundries	53	8	<10	78	<18
Metal Finishing (b) (h)	87	56	ND	5,500	200
Photographic Equipment/Supplies (d)	24	7	0.74	1,100	220
Gum and Wood Chemicals	3	3	20	37,000	12,000
Pharmaceutical Manufacturing	5	5	10	42,000	8,000
Nonferrous Metals Manufacturing (f) (h)	74	3	ND	21	2.5
Ore Mining and Dressing (b)	32	4	NA	18	6.7
Organic Chemicals and Plastics and Synthetic Resins	56	NA	NA	NA	670
Paint and Ink Formulation (c)	27	19	110	7,800	2,400
Petroleum Refining (b)	16	8	28	810	>170
Pulp and Paperboard Mills (h)	102	27	ND	39,000	690
Rubber Processing	4	4	<0.1	8,600	<2,200
Steam Electric Power Plants (e)	9	0			
Textile Mills (b) (g)	78	47	1.0	19,000	920
Timber Products Processing	5	5	37	2,100	710

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF ETHYLBENZENE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	5	4	3.0	970	280
Coal Mining (b)	52	8	1.0	11	3.0
Iron and Steel Manufacturing (a)	9	6	<7.0	4,400	<750
Leather Tanning and Finishing	6	3	<10	12	<11
Aluminum Forming	22	13	2.0	36	<11
Foundries	53	4	<10	<10	<10
Photographic Equipment/Supplies (d)	10	3	1.0	5.0	3.0
Gum and Wood Chemicals	1	1		14,000	
Pharmaceutical Manufacturing	3	3	<1.0	10	<7.0
Nonferrous Metals Manufacturing (f) (h)	76	4	ND	49	1.7
Ore Mining and Dressing (b)	28	3	NA	10	6.6
Organic Chemicals and Plastics and Synthetic Resins	36	NA	NA	NA	7.8
Paint and Ink Formulation (c)	19	13	<5.0	38,000	<4,000
Petroleum Refining (b)	16	1		<10	
Pulp and Paperboard Mills (h)	90	10	ND	300	8.7
Rubber Processing	4	4	<0.1	<38	<9.6
Steam Electric Power Plants (e)	12	3	<1.0	<10	<4.0
Textile Mills (b) (g)	95	23	1.0	3,000	160
Timber Products Processing	5	5	10	20	12

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ETHYLBENZENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	7		50*	BDL - 1.3	
Chemical Oxidation					III.3.1.2
-ozone	2		NM	BDL - 0.1	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		4	70 - >99	ND - 4,600	
-combined precipitants		4	98 - >99	ND - 38,000	
-lime		1	NM	3.0	
-unspecified		1	81	130	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	BDL	
Coagulation and Flocculation	2		98*	BDL - 1.3	III.3.1.5
Filtration	8	2	33 - >99	ND - 2.0	III.3.1.9
Flotation		7	3 - >99	ND - 970	III.3.1.10
Oil Separation		2	83*	ND - BDL	III.3.1.14
Sedimentation	1	5	64 - >99	ND - 2,400	III.3.1.18
Solvent Extraction	1	1	97	4,000 - 4,400	III.3.1.20
Ultrafiltration		2	97	10 - 36	III.3.1.21
Activated Sludge		26	16 - >99	ND - 3,000	III.3.2.1
Lagoons					III.3.2.2
-aerated		4	>50 - >99	ND - <10	

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to ethylbenzene.

Freshwater Aquatic Life

The available data for ethylbenzene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 32,000 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of ethylbenzene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for ethylbenzene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 430 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of ethylbenzene to sensitive saltwater aquatic life.

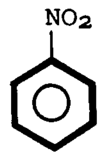
Human Health

For the protection of human health from the toxic properties of ethylbenzene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 1.4 mg/L.

For the protection of human health from the toxic properties of ethylbenzene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 3.28 mg/L.

Compound: Nitrobenzene

Formula:



Alternate Names: Nitrobenzol;
Oil of mirbane

CAS #: 98-95-3

Physical, Chemical, and Biological Properties [1-7, 1-12, 1-15]:

molecular weight: 123.1
melting point, °C: 5.6
boilng point (760 torr), °C: 211
vapor pressure (20°C), torr: 0.15
solubility in water (20°C), mg/L: 1,900
log octanol/water partition coefficient: 1.85
Henry's law constant (25°C): 2.40×10^{-5} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.9.9-5

Probable Fate [1-7]:

photolysis: Not significant under natural conditions

oxidation: Not likely to occur

hydrolysis: Not likely to occur

volatilization: Not fast enough to be important

sorption: Adsorbed by humus and probably by clay

biological processes: No bioaccumulation of any significance; slowly biodegraded under natural conditions

other reactions/interactions: Not important

Carbon Adsorption Data, Nitrobenzene (1-8):

ADSORBABILITY

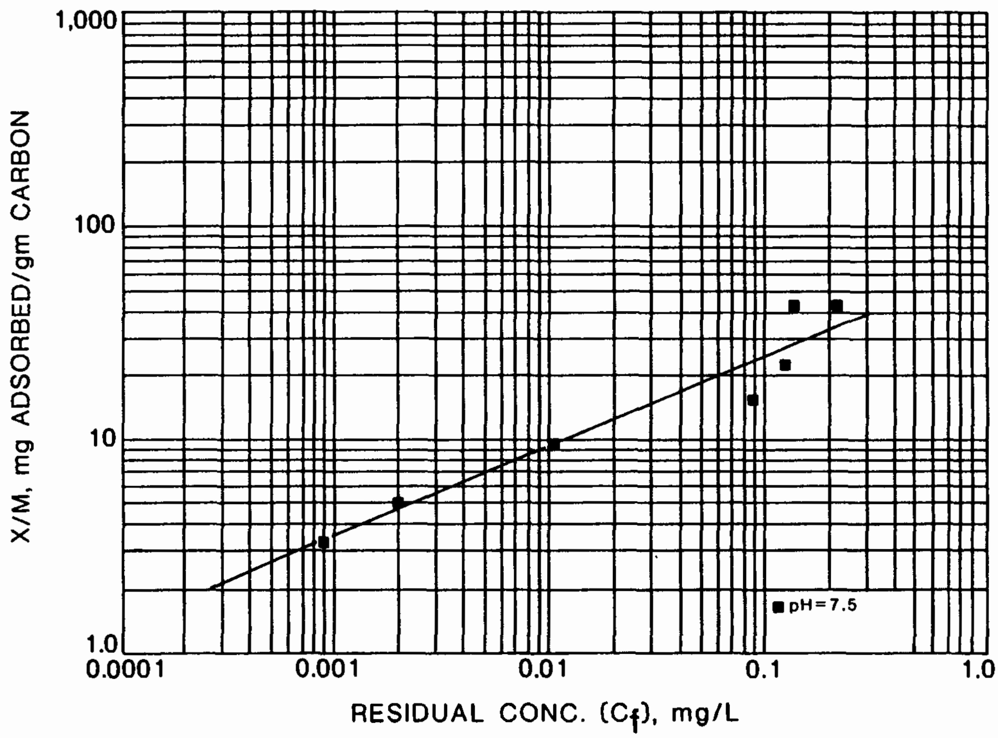
FREUNDLICH PARAMETERS	pH		
	7.5		
K	68		
1/n	0.43		
Corr. Coef. r	0.97		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	36	110	290
0.1		9.6	28
0.01			2.6

(a) Carbon doses in mg/L at pH 7.5



ANALYTICAL METHOD: Solvent Extraction - G.C.

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF NITROBENZENE

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	49	1		21	
Leather Tanning and Finishing	18	1		420	
Electrical/Electronic Components (b)	3	0			
Foundries	53	4	<3	<280	<88
Metal Finishing (a) (d)	2	2	0.4	10	5.0
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing	37	3	ND	160	11
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	5	NA	NA	NA	91,000
Paint and Ink Formulation (b)	25	4	<10	560	<220
Rubber Processing	1	1		<3.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF NITROBENZENE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	2	<10	<10	<10
Nonferrous Metals Manufacturing (c) (d) (e)	34	0	ND	5.5	1.4
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	5	NA	NA	NA	620
Paint and Ink Formulation (b)	18	1		35	
Rubber Processing	1	1		<30	

NA, not available; ND, not detected. See Section 1.1 Introduction for addtional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR NITROBENZENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	68	35	
-combined precipitants		1	>99	ND	
Filtration		1	>99	ND	III.3.1.9
Sedimentation		1	>99	ND	III.3.1.18
Activated Sludge		3	0	BDL - <30	III.3.2.1

BDL, below detection limit; ND, not detected.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to nitrobenzene.

Freshwater Aquatic Life

The available data for nitrobenzene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 27,000 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of nitrobenzene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

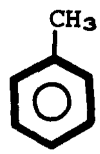
The available data for nitrobenzene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 6,680 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrobenzene to sensitive saltwater aquatic life.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for nitrobenzene. Based on available toxicity data, for the protection of public health, the derived level is 19.8 mg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 30 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: Toluene

Formula:



Alternate Names: Toluol; Phenylmethane; Methylbenzene; Methylbenzol; Methacide

CAS #: 108-88-3

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 92.13
melting point, °C: -95
boiling point (760 torr), °C: 111
vapor pressure (25°C), torr: 28.7
solubility in water (25°C), mg/L: 535
log octanol/water partition coefficient: 2.69
Henry's law constant (25°C): 5.93×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.9.10-5

Probable Fate [1-7]:

photolysis: Not likely to occur under natural conditions

oxidation: Not likely to occur

hydrolysis: Information not available

volatilization: Volatilization occurs

sorption: Specific information not available but sorption is likely on organic and clay materials

biological processes: Bioaccumulation not important; specific information not available, but degradation by sewage system is likely

other reactions/interactions: Not important

Carbon Adsorption Data, Toluene (1-8):

ADSORBABILITY

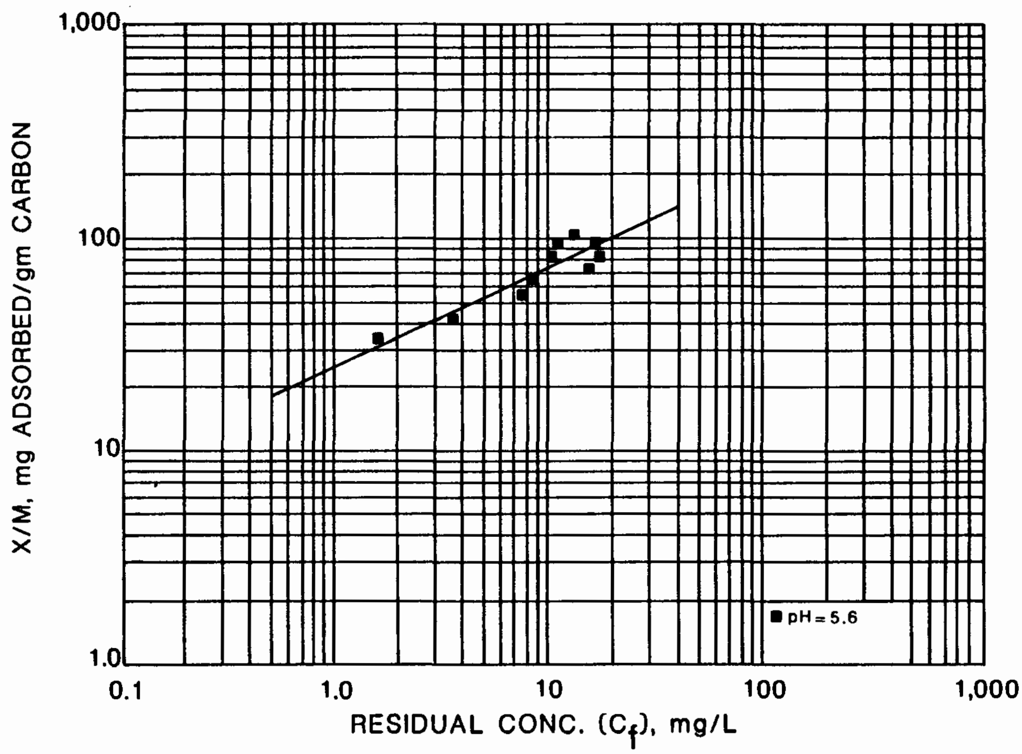
FREUNDLICH PARAMETERS	pH		
	5.6		
K	26.1		
1/n	0.44		
Corr. Coef. r	0.89		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	96	290	820
0.1		27	81
0.01			7.4

(a) Carbon doses in mg/L at pH 5.6



ANALYTICAL METHOD: Ultraviolet Spectroscopy 208.8 nm.

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF TOLUENE

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	24	21	1.0	51,000	<4,500
Coal Mining (b)	47	16	2.0	45	16
Inorganic Chemicals Manufacturing (b)	1	1		3.0	
Iron and Steel Manufacturing (a)	11	10	<10	8,900	<2,300
Leather Tanning and Finishing	18	17	9.0	400	<69
Aluminum Forming	5	5	<10	320	<140
Battery Manufacturing (h) (i)	18	7	ND	<10	<8.0
Coil Coating	25	0			
Electrical/Electronic Components (c)	28	16	2.0	140	<20
Foundries	53	16	1.0	540	<47
Metal Finishing (b) (h)	94	68	ND	37,000	780
Photographic Equipment/Supplies (d)	48	18	0.01	8,600	420
Porcelain Enameling	6	0			
Gum and Wood Chemicals	4	4	20	15,000	>4,500
Pharmaceutical Manufacturing	8	8	10	2.3 x 10E5	39,000
Nonferrous Metals Manufacturing (f) (h)	85	7	ND	55	6.9
Ore Mining and Dressing (b)	33	9	NA	3,600	400
Organic Chemicals and Plastics and Synthetic Resins	74	NA	NA	NA	11,000
Paint and Ink Formulation (c)	30	27	10	2.6 x 10E5	13,000
Petroleum Refining (b)	16	12	<10	12,000	>1,100
Pulp and Paperboard Mills (h)	172	101	ND	660	16
Rubber Processing	6	6	<0.1	2,700	<500
Steam Electric Power Plants (e)	11	2	2.0	9.1	5.6
Textile Mills (b) (g)	78	54	1.0	3,200	200
Timber Products Processing	5	5	27	3,200	1,300

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF TOLUENE

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	7	7	4.5	2,100	600
Coal Mining (b)	51	22	ND	40	7.0
Iron and Steel Manufacturing (a)	9	8	<7.0	10,000	<1,500
Leather Tanning and Finishing	6	5	<10	<10	<10
Aluminum Forming	17	13	<0.3	30	<8.2
Coil Coating (i)	3	1		0.0	
Foundries	53	15	<10	180	<24
Photographic Equipment/Supplies (d)	13	9	0.1	230	71
Gum and Wood Chemicals	5	5	10	>8,800	>2,100
Pharmaceutical Manufacturing	6	6	<1.0	49	<11
Nonferrous Metals Manufacturing (f) (h)	70	6	ND	69	4.0
Ore Mining and Dressing (b)	28	6	NA	10	2.6
Organic Chemicals and Plastics and Synthetic Resins	47	NA	NA	NA	24
Paint and Ink Formulation (c)	20	16	<10	4,200	<1,300
Petroleum Refining (b)	16	5	<1.0	35	<11
Pulp and Paperboard Mills (h)	160	49	ND	150	3.6
Rubber Processing	5	5	<0.1	<26	<7.3
Steam Electric Power Plants (e)	12	2	3.5	3.5	3.5
Textile Mills (b) (g)	96	51	1.0	140	13
Timber Products Processing	5	5	10	140	43

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR TOLUENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	8	3	23 - 99	BDL - 630	
Chemical Oxidation					III.3.1.2
-ozone	2		31	0.9 - 1.2	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1	5	0 - 73	3 - 2,900	
-combined precipitants		4	84 - 96	73 - 4,200	
-lime		2	0 - >99	ND - 5.0	
-sodium carbonate		1	NM	BDL	
-sodium hydroxide		1	NM	ND	
-unspecified		1	39	1,900	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	0	1.0	
Chemical Reduction		1		BDL	III.3.1.4
Coagulation and Flocculation	2	1	55 - 93	BDL - 14	III.3.1.5
Filtration	10	9	0 - >99	ND - 200	III.3.1.9
Flotation		7	10 - >99	ND - 2,100	III.3.1.10
Oil Separation		2	83*	ND - BDL	III.3.1.14
Reverse Osmosis	5		12	0.7 - 29	III.3.1.16
Sedimentation	1	7	17 - 83	BDL - 1,100	III.3.1.18
Solvent Extraction	2	1	94 - 96	1,600 - 10,000	III.3.1.20
Ultrafiltration		2	71*	BDL - 60	III.3.1.21
Activated Sludge	1	33	17 - >99	ND - 1,400	III.3.2.1
Lagoons					III.3.2.2
-aerated		7	0 - >99	ND - <63	

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to toluene.

Freshwater Aquatic Life

The available data for toluene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 17,500 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of toluene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for toluene indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 6,300 and 5,000 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

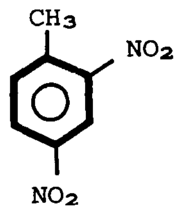
Human Health

For the protection of human health from the toxic properties of toluene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 14.3 mg/L.

For the potection of human health from the toxic properties of toluene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 424 mg/L.

Compound: 2,4-Dinitrotoluene

Formula:



Alternate Names: Dinitrotoluol; DNT;
1-Methyl-2,4-dinitrotoluene

CAS #: 121-14-2

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 182.1
melting point, °C: 70
boiling point (760 torr), °C: 300
vapor pressure (59°C), torr: 0.0013
solubility in water (22°C), mg/L: 270
log octanol/water partition coefficient: 2.01 (calculated)
Henry's law constant (25°C): 4.68×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: T-significant degradation in initial culture but decreasing in subsequent subculture indicating possible toxicity.
water quality criteria: See page I.9.11-5

Probable Fate [1-7]:

photolysis: Intramolecular photolysis could be an important fate

oxidation: Oxidation could follow adsorption onto clay particles

hydrolysis: Not likely to occur under natural conditions

volatilization: Too slow to be important

sorption: 2,4-Dinitrotoluene should be strongly sorbed by humus and clay

biological processes: Some bioaccumulation possible; biodegradation very slow

other reactions/interactions: Not important

Carbon Adsorption Data, 2,4-Dinitrotoluene (1-8):

ADSORBABILITY

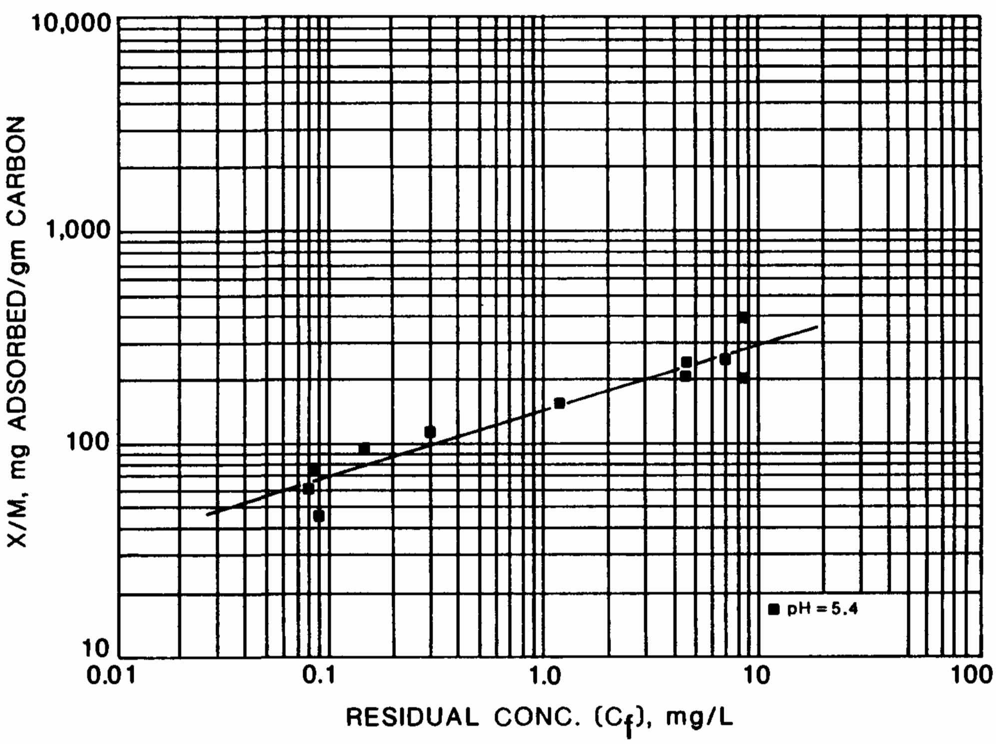
FREUNDLICH PARAMETERS	pH		
	5.4		
K	146		
1/n	0.31		
Corr. Coef. r	0.94		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	13	29	59
0.1		2.6	5.9
0.01			0.5

(a) Carbon doses in mg/L at pH 5.4



ANALYTICAL METHOD: Ultraviolet Spectroscopy 252 nm.

INDUSTRIAL OCCURRENCE OF 2,4-DINITROTOLUENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	49	1		18	
Iron and Steel Manufacturing (a)	5	1		530	
Aluminum Forming	2	1		77	
Foundries	53	4	<7.0	<50	<26
Photographic Equipment/Supplies (d)	7	0			
Nonferrous Metals Manufacturing (e) (f)	22	1	ND	16	1.7
Ore Mining and Dressing (b)	32	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	14,000
Paint and Ink Formulation (c)	1	0			

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 2,4-DINITROTOLUENE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	53	0			
Iron and Steel Manufacturing (a)	5	1		510	
Aluminum Forming	2	0			
Foundries	53	3	<10	<300	<110
Nonferrous Metals Manufacturing (d) (e)	13	0	ND	7.0	0.9
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	870
Paint and Ink Formulation (c)	1	1		<10	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Detections >10 µg/L.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 2,4-DINITROTOLUENE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., μg/L	Volume III section number
	Pilot scale	Full scale			
Sedimentation		1	80	10	III.3.1.18
Activated Sludge	1		NM	100	III.3.2.1

NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to 2,4-dinitrotoluene.

Freshwater Aquatic Life

The available data for 2,4-dinitrotoluene indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 330 and 230 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

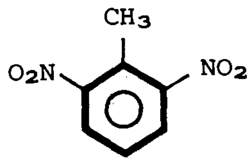
The available data for 2,4-dinitrotoluene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 590 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of 2,4-dinitrotoluene to sensitive saltwater aquatic life but a decrease in algal cell numbers occurs at concentrations as low as 370 µg/L.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 2,4-dinitrotoluene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 1.1 µg/L, 0.11 µg/L, and 0.011 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 91 µg/L, 9.1 µg/L, and 0.91 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: 2,6-Dinitrotoluene

Formula:



Alternate Names: Dinitrotoluol

CAS #: 606-20-2

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 182.1
melting point, °C: 65
boiling point (760 torr), °C: 285
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: Not available
log octanol/water partition coefficient: 2.05 (calculated)
Henry's law constant: Not available
biodegradability: T-significant degradation in initial culture but decreasing in subsequent subculture indicating possible toxicity
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Intramolecular photolysis could be very important

oxidation: Photooxidation can occur

hydrolysis: Not likely to occur under natural conditions

volatilization: Probably not an important transport process

sorption: 2,6-Dinitrotoluene should be strongly sorbed by humus and clay

biological processes: No data on bioaccumulation; biodegradation very slow

other reactions/interactions: Not important

Carbon Adsorption Data, 2,6-Dinitrotoluene (1-8):

ADSORBABILITY

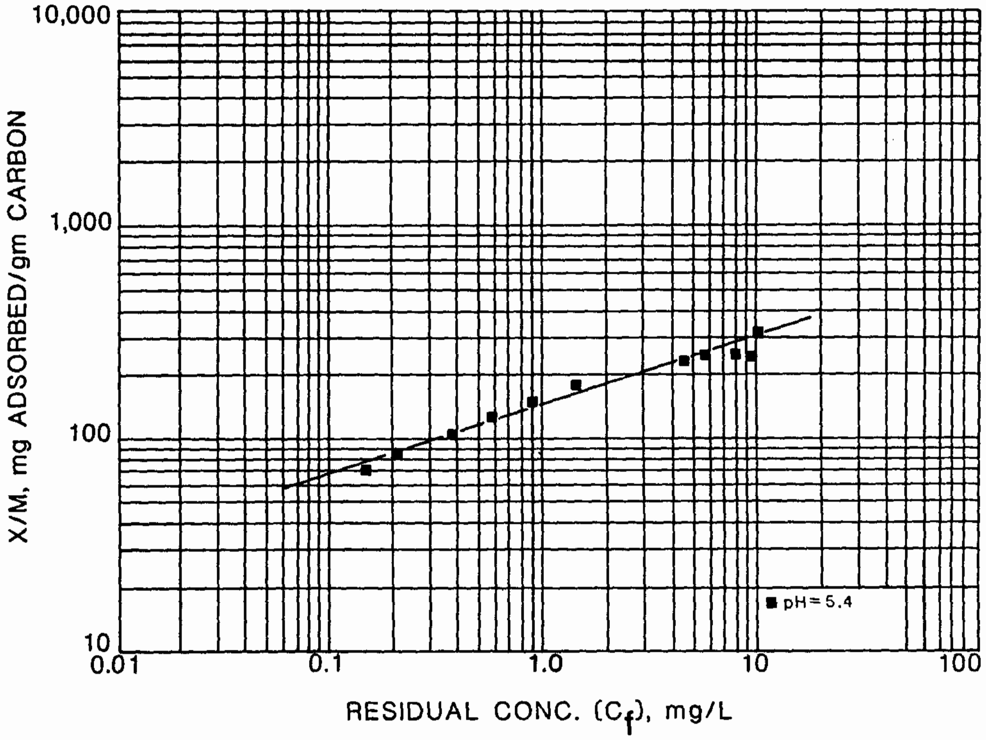
FREUNDLICH PARAMETERS	pH		
	5.4		
K	145		
1/n	0.32		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	13	30	62
0.1		2.7	6.2
0.01			0.6

(a) Carbon doses in mg/L at pH 5.4



ANALYTICAL METHOD: Ultraviolet Spectroscopy 242 nm.

INDUSTRIAL OCCURRENCE OF 2,6-DINITROTOLUENE

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (b)	49	1		30	
Inorganic Chemicals Manufacturing (b)	1	1		0.03	
Iron and Steel Manufacturing (a)	8	2	47	140	94
Foundries	53	5	4.0	<50	<22
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (f)	22	1	ND	16	NA
Ore Mining and Dressing (b)	32	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	3,800
Textile Mills (b) (e)	68	1		54	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 2,6-DINITROTOLUENE

			Treated Raw wastewater		
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (b)	52	0			
Iron and Steel Manufacturing (a)	8	1		140	
Foundries	53	3	<10	<300	<110
Nonferrous Metals Manufacturing (c) (d)	13	0	ND	1.0	0.1
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	580

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 2,6-DINITROTOLUENE

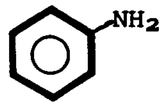
Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Sedimentation		1	80	10	III.3.1.18
Activated Sludge	1		NM	200	III.3.2.1

NM, not meaningful.

RESERVED

Compound: Aniline

Formula:



Alternate Names: Aminobenzene;
Phenylamine;
Aminophen

CAS #: 62-53-3

Physical, Chemical, and Biological Properties [1-6, 1-12]:

molecular weight: 93.1
melting point, °C: -6
boiling point (760 torr), °C: 184
vapor pressure (20°C), torr: 0.3
solubility in water (temp. unknown), mg/L: 34,000
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 95% aniline removal (measured as COD removal) obtained at 20°C in activated sludge at a rate of 19 mg COD/g dry inoculum/hr
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Aniline (1-8, 1-16):

ADSORBABILITY

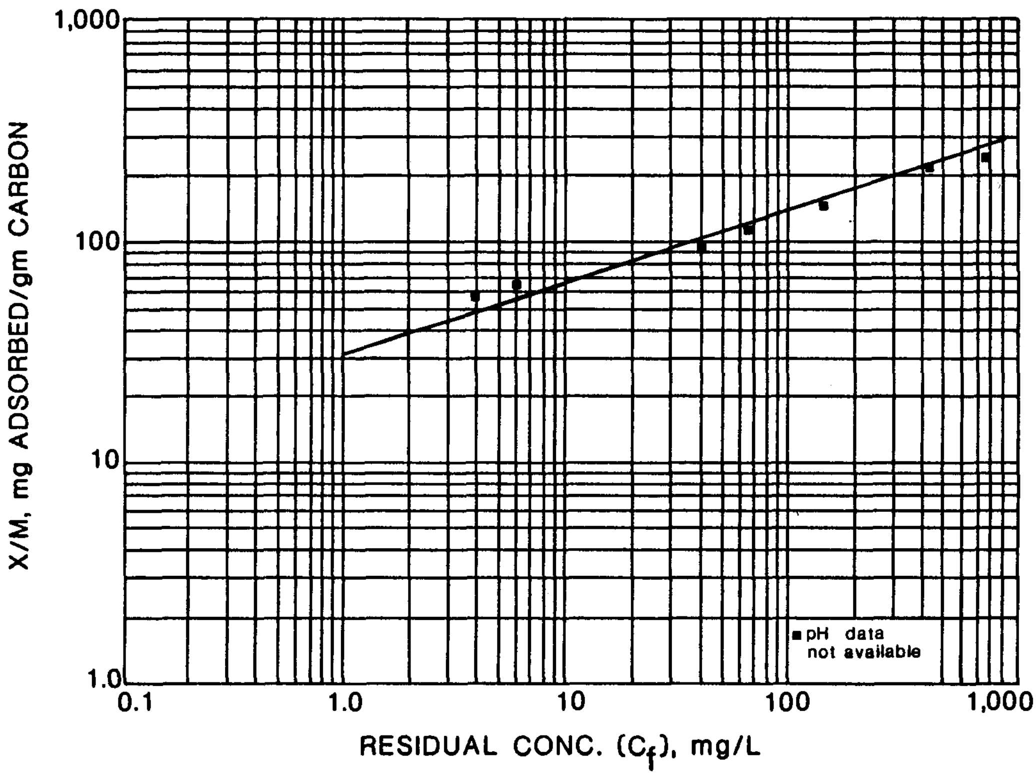
FREUNDLICH PARAMETERS	pH		
	7.1		
K	33.8		
1/n	0.31		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

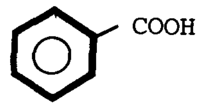
C_o, mg/L	0.1	0.01	0.001
1.0	54		
0.1			
0.01			

(a) Carbon doses in mg/L at pH 7.1



Compound: Benzoic acid

Formula:



Alternate Names: Benzenecarboxylic acid

CAS #: 65-85-0

Physical, Chemical, and Biological Properties [1-6, 1-12, 1-28]:

molecular weight: 122.1
melting point, °C: 122
boiling point (760 torr), °C: 249
vapor pressure (25°C), torr: Not available
solubility in water (20°C), mg/L: 2,900
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 7.02×10^{-8} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: 99% benzoic acid removal (measured as COD removal) obtained at 20°C in activated sludge at a rate of 88 mg COD/g dry inoculum/hr
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Benzoic acid (1-8);

ADSORBABILITY

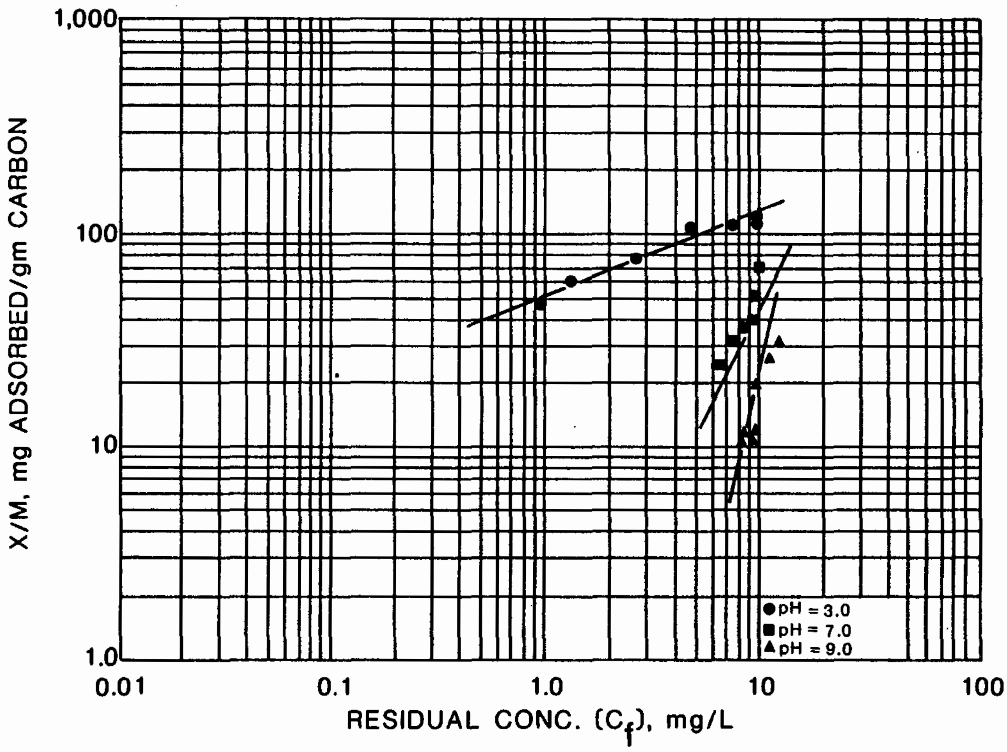
FREUNDLICH PARAMETERS	pH		
	3.0	7.0	9.0
K	51	0.76	0.0008
1/n	0.42	1.8	4.3
Corr. Coef. r	0.99	0.91	0.86

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	85,000	>100,000	>100,000
0.1		>100,000	>100,000
0.01			>100,000

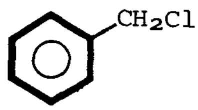
(a) Carbon doses in mg/L at neutral pH



ANALYTICAL METHOD: Ultraviolet Spectroscopy 223 nm.

Compound: Benzyl chloride

Formula:



Alternate Names: α-Chlorotoluene

CAS #: 100-44-7

Physical, Chemical, and Biological Properties [1-6, 1-28]:

molecular weight: 126.6
melting point, °C: -43 to -48
boiling point (760 torr), °C: 179
vapor pressure (22°C), torr: 1
solubility in water (25°C), mg/L: Not available
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 5.22×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

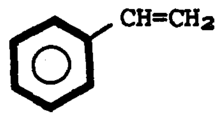
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Styrene

Formula:



Alternate Names: Vinylbenzene; Cinnamene;
Phenylethylene; Ethylbenzene

CAS #: 100-42-5

Physical, Chemical, and Biological Properties [1-6, 1-28]:

molecular weight: 104.1
melting point, °C: -30.6
boiling point (760 torr), °C: 145
vapor pressure (20°C), torr: 5
solubility in water (20°C), mg/L: 300
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 2.61×10^{-3} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Styrene (1-8):

ADSORBABILITY

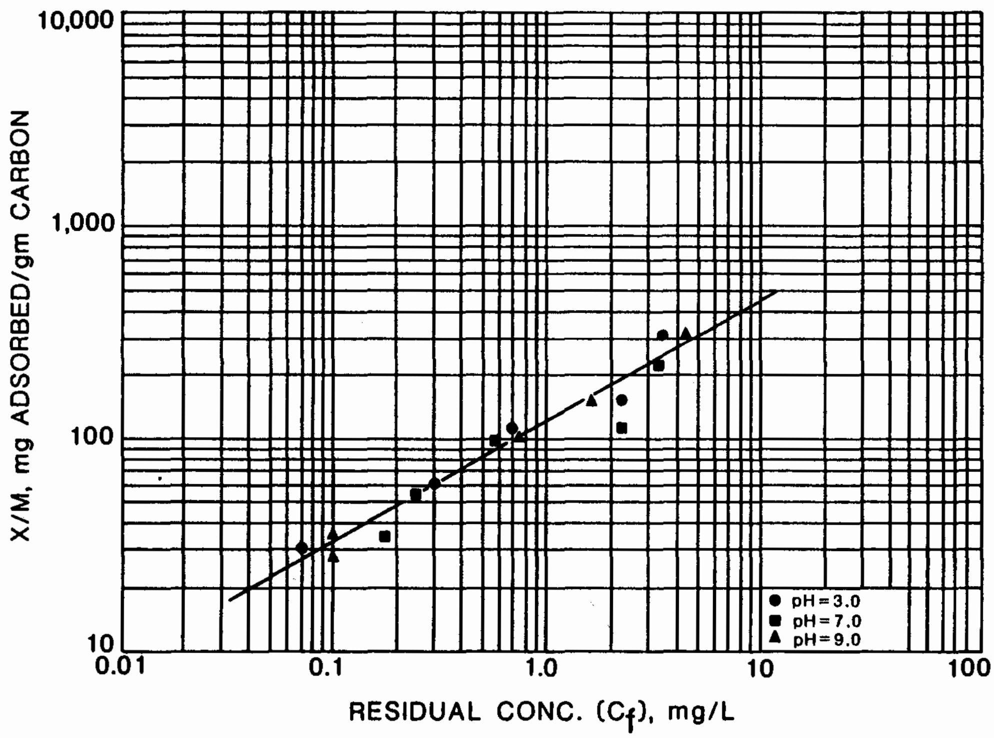
FREUNDLICH PARAMETERS	pH		
	All data pooled		
K	120		
1/n	0.56		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_0. mg/L	0.1	0.01	0.001
1.0	27	110	400
0.1		9.8	39
0.01			3.6

(a) Carbon doses in mg/L at neutral pH



ANALYTICAL METHOD: Ultraviolet Spectroscopy 245 nm.

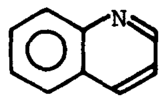
Date: 10/8/82

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR STYRENE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Solvent Extraction	1		>93	<1,000	III.3.1.20

RESERVED

Compound: Quinoline

Formula: 

Alternate Names: Benzo(b)pyridine;
1-Benzazine;
Chinoline

CAS #: 91-22-5

Physical, Chemical, and Biological Properties [1-6, 1-28]:

molecular weight: 129.2
melting point, °C: -15
boiling point (760 torr), °C: 238
vapor pressure (60°C), torr: 1
solubility in water (temp. unknown), mg/L: 60,000
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 2.7×10^{-7} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Xylenes

Formula: $CH_3(C_6H_4)CH_3$ and various derivatives

Alternate Names: Dimethylbenzenes; Methyltoluenes

CAS #: Different for each compound; o-Xylene has CAS # 95-47-6

Physical, Chemical, and Biological Properties [1-18, 1-28]:

molecular weight: 106.2
melting point, °C: -25.2
boiling point (760 torr), °C: 144
vapor pressure (32°C), torr: 10 (o-Xylene)
solubility in water (25°C), mg/L: Insoluble
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 6.12×10^{-3} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Xylenes, (p-Xylene) (1-8):

ADSORBABILITY

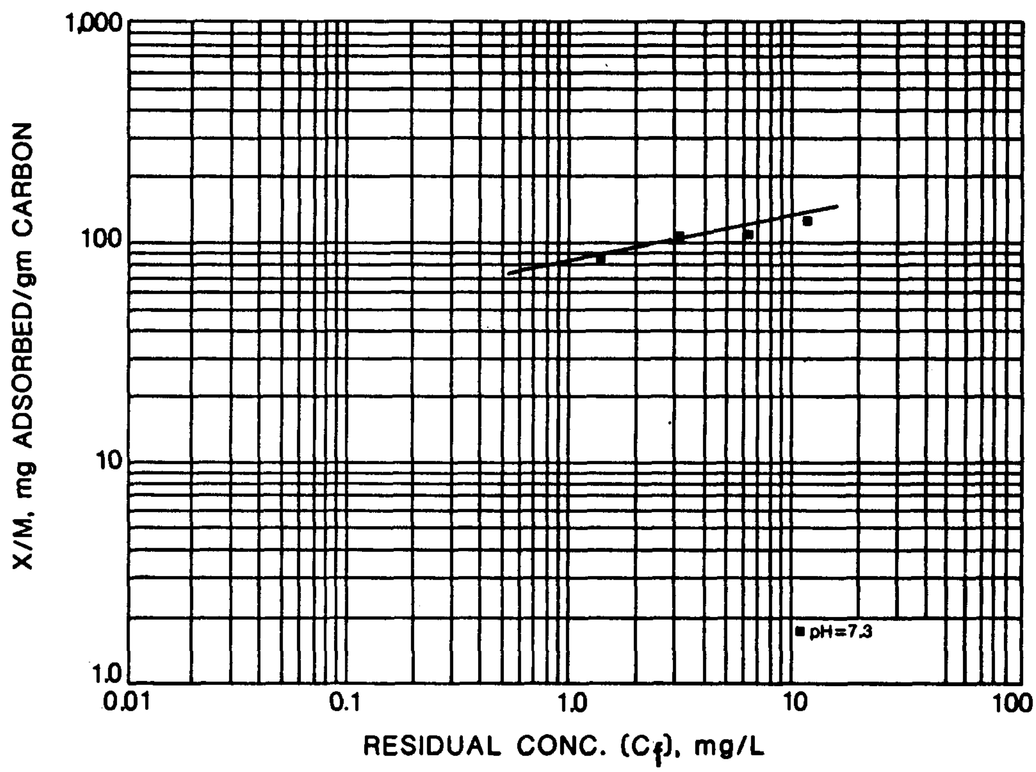
FREUNDLICH PARAMETERS	pH		
	7.3		
K	85		
1/n	0.19		
Corr. Coef. r	0.93		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_0, mg/L	0.1	0.01	0.001
1.0		15	24
0.1			2.2
0.01			

(a) Carbon doses in mg/L at pH 7.3



ANALYTICAL METHOD: Ultraviolet spectroscopy 267 nm

INDUSTRIAL OCCURRENCE OF XYLENES

Industry	Number of samples	Number of detections	Raw wastewater Detected concentrations, µg/L Minimum	Maximum	Mean
Iron and Steel Manufacturing (a)	8	5	<10	1.0 x 10E5	<21,000
Electrical/Electronic Components (b)	3	0			
Foundries	53	7	<5.0	47,000	<6,700
Pulp and Paperboard Mills	129	63	ND	37,000	650

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Analytic method not specified.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF XYLENES

	Treated wastewater				
	Number of	Number of	Detected concentrations, μg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Iron and Steel Manufacturing (a)	7	3	<5.0	25,000	<8,300
Foundries	53	8	<5.0	12,000	<1,500
Pulp and Paperboard Mills	123	14	ND	1,600	46

ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR XYLENE

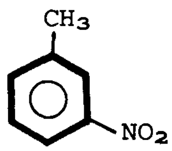
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Chemical Precipitation with Sedimentation -alum		1	93*	BDL	III.3.1.3
Filtration		1	75	12,000	III.3.1.9
Flotation		1	>99	ND	III.3.1.10
Oil Separation		1	>17	<10	III.3.1.14
Solvent Extraction	3	1	96 - >97	<1,000 - 25,000	III.3.1.20
Ultrafiltration		1	>99	<5.0	III.3.1.21
Activated Sludge		1	>99	ND	III.3.2.1
Trickling Filters	1		NM	2.0	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Nitrotoluene

Formula:



Alternate Names: Methyl nitrobenzene

CAS #: o, 88-72-2; m, 99-081; ρ, 99-99-0

Physical, Chemical, and Biological Properties [1-6, 1-12, 1-28]:

molecular weight: 137.1
melting point, °C: o, -10.6 to -4.1; m, 15.5; ρ, 51.3
boiling point (760 torr), °C: o, 222; m, 231; ρ, 238
vapor pressure (20°C), torr: 0.1
solubility in water (30°C), mg/L: o, 652; m, 498, ρ, 442
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): o, 1.28×10^{-4}; m, 7.2×10^{-5}; ρ, 6.3×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: o and ρ, 32.5 mg COD g^{-1} dry inoculum h^{-1}; 98% removal by activated sludge at 20°C; m, 21.0 mg COD g^{-1} dry inoculum h^{-1}; 99% removal by activated sludge at 20°C
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Naphthenic acid

Formula [1-18]: Exact composition unknown, complex mixture of normal and branched carboxylic acids, alkyl derivatives of cyclopentane and cyclohexane carboxylic acids, and cyclopentyl and cyclohexyl derivatives of carboxylic acid

Alternate Names: None

Cas #: 1338-24-5

Physical, Chemical, and Biological Properties:

molecular weight: 180-350
melting point, °C: Not available
boiling point (760 torr), °C: 200-300 range
vapor pressure (25°C), torr:
solubility in water (25°C), mg/L: Not available
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

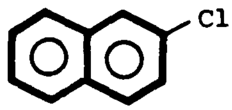
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: 2-Chloronaphthalene

Formula:



Alternate Names: Halowax; β-Chloronaphthalene

CAS #: 91-58-7

Physical, Chemical, and Biological Properties [1-2, 1-28]:

molecular weight: 162.6
melting point, °C: 61
boiling point (760 torr), °C: 256
vapor pressure (20°C), torr: 0.017 (calculated)
solubility in water (25°C), mg/L: 6.74 (calculated)
log octanol/water partition coefficient: 4.12
Henry's law constant (25°C): 6.12×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.10.1-5 (also page I.10.2-5)

Probable Fate [1-2]:

photolysis: Some of the dissolved compound may be photolyzed slowly

oxidation: Probably too slow to be important

hydrolysis: Not important

volatilization: No volatilization rate has been determined, but slow volatilization has been recorded

sorption: 2-Chloronaphthalene should be adsorbed onto particulates, especially organic matter

biological processes: Bioaccumulation accompanied by metabolization; biodegradation and metabolization are both fairly rapid

other reactions/interactions: Not important

Carbon Adsorption Data, 2-Chloronaphthalene (1-8):

ADSORBABILITY

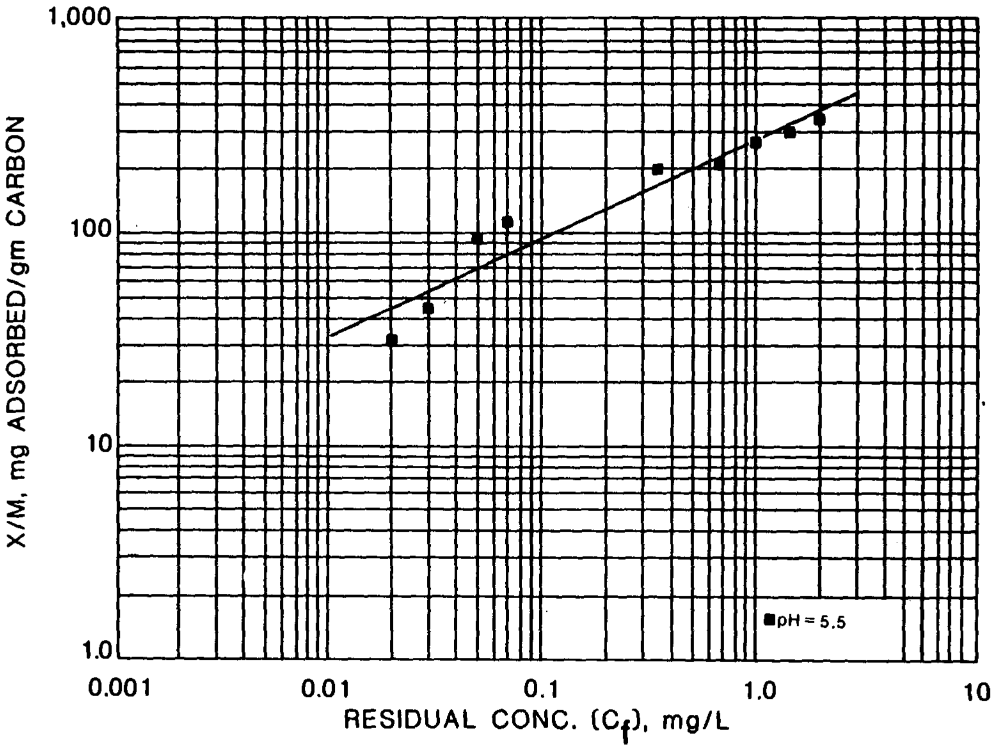
FREUNDLICH PARAMETERS	pH		
	5.5		
K	280		
1/n	0.46		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	9.3	29	86
0.1		2.7	8.5
0.01			0.8

(a) Carbon doses in mg/L at pH 5.5



ANALYTICAL METHOD: Ultraviolet Spectroscopy 224.5 nm.

INDUSTRIAL OCCURRENCE OF 2-CHLORONAPHTHALENE

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	1		17	
Coal Mining (b)	49	1		3.0	
Leather Tanning and Finishing	18	1		<10	
Aluminum Forming	1	1		19	
Foundries	53	0			
Metal Finishing (b) (e)	1	1		130	
Photographic Equipment/Supplies (c)	15	3	0.69	1.0	0.91
Nonferrous Metals Manufacturing (d) (e)	24	0	ND	3.0	0.3
Ore Mining and Dressing (b)	32	0			
Timber Products Processing	12	12	10	7,700	1,600

ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 2-CHLORONAPHTHALENE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	1		16	
Coal Mining (b)	53	0			
Foundries	53	3	<10	<140	<53
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing	15	0			
Ore Mining and Dressing (b)	28	0			

See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 2-CHLORONAPHTHALENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Filtration		1	0	17	III.3.1.9
Flotation		1	0	17	III.3.1.10

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to chlorinated naphthalenes.

Freshwater Aquatic Life

The available data for chlorinated naphthalenes indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 1,600 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of chlorinated naphthalenes to sensitive freshwater aquatic life.

Saltwater Aquatic Life

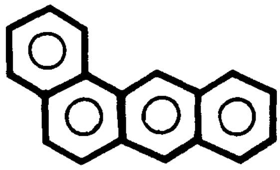
The available data for chlorinated naphthalenes indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 7.5 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of chlorinated naphthalenes to sensitive saltwater aquatic life.

Human Health

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for chlorinated naphthalenes.

Compound: Benzo(a)anthracene

Formula:



Alternate Names: 1,2-Benzanthracene; Tetraphene; Naphthanthracene; 2,3-Benzophenanthrene

CAS #: 56-55-3

Physical, Chemical, and Biological Properties [1-7, 1-9]:

molecular weight: 228.3
melting point, °C: 155-157
boiling point (760 torr), °C: Sublimes
vapor pressure (20°C), torr: 5×10^{-9}
solubility in water (25°C), mg/L: 0.014
log octanol/water partition coefficient: 5.61
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.10.2-5

Probable Fate [1-7]:

photolysis: Photolysis to quinones is rapid, but is greatly hindered by adsorption

oxidation: Oxidation of polycyclic aromatic hydrocarbons is slow; not a significant process

hydrolysis: Polycyclic aromatic hydrocarbons do not contain groups amenable to hydrolysis

volatilization: Too slow to compete with sorption as a transport process

sorption: Very strong adsorption by suspended solids is the principal transport process

biological processes: Bioaccumulation is accompanied by metabolization; polycyclic aromatic hydrocarbons (PAH's) are degraded in the environment; PAH's with four or more aromatic rings degrade slowly with long half-lives.

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF BENZO(A)ANTHRACENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	46	0			
Iron and Steel Manufacturing (a)	5	4	2.0	620	<160
Aluminum Forming	1	1		19	
Coil Coating (g)	78	7	0.0	30	9
Foundries	53	10	<10	<13,000	<2,600
Metal Finishing (b) (f)	8	6	ND	170	31
Photographic Equipment/Supplies (d)	15	3	1.0	350	88
Nonferrous Metals Manufacturing (e) (f)	33	3	ND	180	13
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	11	NA	NA	NA	880
Paint and Ink Formulation (c)	1	0			
Timber Products Processing	12	12	10	7,700	1,600

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Reference reports 0.0 µg/L for detections less then detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BENZO(A)ANTHRACENE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	5	3	<2.0	27	<11
Aluminum Forming	3	0			
Coil Coating (h)	16	8	0.0	3.0	0.38
Foundries	53	10	<10	7,300	<740
Photographic Equipment/Supplies (d)	10	4	0.50	1.0	0.75
Nonferrous Metals Manufacturing (e) (g)	29	0	ND	6.0	0.7
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	7	NA	NA	NA	42
Paint and Ink Formulation (c)	1	1		<10	
Textile Mills (b) (f)	61	1		2.0	
Timber Products Processing	9	9	10	3,400	440

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BENZO(A)ANTHRACENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	1		95*	BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	NM	BDL	
-lime		1	NM	ND	
-sodium hydroxide		1	80*	BDL	
Filtration		1	NM	7,300	III.3.1.9
Oil Separation		1	>9	<10	III.3.1.14
Sedimentation		2	NM	10* - 13	III.3.1.18
Solvent Extraction		1	NM	ND	III.3.1.20

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to polynuclear aromatic hydrocarbons (PAHs).

Freshwater Aquatic Life

The limited freshwater data base available for polynuclear aromatic hydrocarbons, mostly from short-term bioconcentration studies with two compounds, does not permit a statement concerning acute or chronic toxicity.

Saltwater Aquatic Life

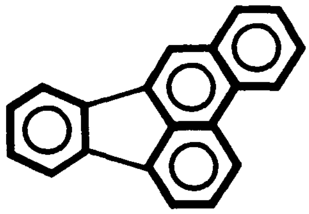
The available data for polynuclear aromatic hydrocarbons indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 300 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of polynuclear aromatic hydrocarbons to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of PAHs through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 28 ng/L, 2.8 ng/L, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311 ng/L, 31.1 ng/L, and 3.11 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Benzo(b)fluoranthene

Formula:



Alternate Names: 2,3-Benzofluoranthene; Benz(e)acephenanthrylene; 3,4-Benzofluoranthene; B(b)F

CAS #: 205-99-2

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 252.3
melting point, °C: 167-168
boiling point (760 torr), °C: Not available
vapor pressure (20°C), torr: 10^{-11} - 10^{-6}*
solubility in water (25°C), mg/L: 0.0012
log octanol/water partition coefficient: 6.57
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: See page I.10.2-5

*Estimated based on data for structurally similar compounds.

Probable Fate [1-7]:

photolysis: Dissolved portion may undergo direct photolysis to quinones

oxidation: Rapid oxidation by chlorine and ozone could occur when chlorine and ozone are available in sufficient quantity

hydrolysis: Not important

volatilization: Probably too slow to compete with adsorption as a transport process

sorption: Very strong adsorption onto suspended solids is the principal transport process

biological processes: Short-term bioaccumulation accompanied by metabolization; polycyclic aromatic hydrocarbons (PAH's) are degraded in the environment; PAH's with four or more aromatic rings degrade slowly with long half-lives.

other reactions/interactions: Not important

Carbon Adsorption Data, Benzo(b)fluoranthene (1-8):

ADSORBABILITY

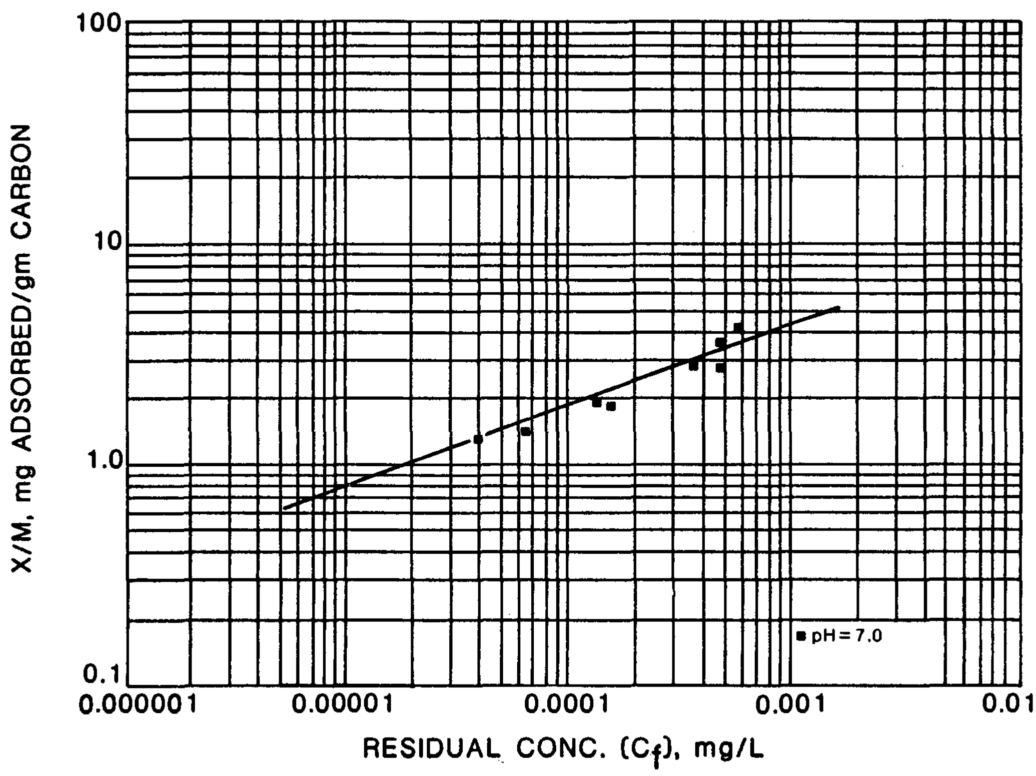
FREUNDLICH PARAMETERS	pH		
	7.0		
K	57		
1/n	0.37		
Corr. Coef. r	0.94		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	37	95	230
0.1		8.7	22
0.01			2.0

(a) Carbon doses in mg/L at neutral pH



ANALYTICAL METHOD: Fluorescence: excitation 298 nm; emission 440 nm

REMARKS: Modified protocol used for isotherm due to unlimited solubility.

Date: 1/24/83 1.10.3-2

INDUSTRIAL OCCURRENCE OF BENZO(B)FLUORANTHENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Coil Coating (d)	78	1		0.0	
Foundries	53	4	6.0	<36	<15
Photographic Equipment/Supplies (c)	7	0			
Pharmaceutical Manufacturing	56	1	ND	260	19
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	27
Paint and Ink Formulation (b)	1	0			
Timber Products Processing	12	12	10	1,700	190

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BENZO(B)FLUORANTHENE

Industry	Treated wastewater Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Coil Coating (e)	16	1		0.0	
Foundries	53	1		<6.0	
Nonferrous Metals Manufacturing (b) (d) (f)	42	1	ND	12	0.5
Ore Mining and Dressing (a)	28	0			
Textile Mills (a) (c)	63	1		1.0	
Timber Products Processing	9	9	10	2,500	310

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Mean calculated using medians.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(f) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

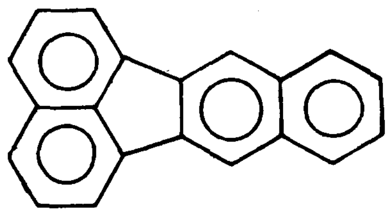
POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BENZO(B)FLUORANTHENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Oil Separation		1	>9	<10	III.3.1.14
Sedimentation		1	86*	BDL	III.3.1.18

BDL, below detection limit; *approximate value.

RESERVED

Compound: Benzo(k)fluoranthene

Formula: 

Alternate Names: 11, 12-Benzofluoranthene;
B(k)F

CAS #: 207-08-9

Physical, Chemical, and Biological Properties [1-4, 1-7, 1-28]:

molecular weight: 252.3
melting point, °C: 217
boiling point (760 torr), °C: 480
vapor pressure (20°C), torr: 9.59×10^{-11}
solubility in water (25°C), mg/L: 0.00055
log octanol/water partition coefficient: 6.84 (calculated)
Henry's law constant (25°C): 1.04×10^{-3} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: See page I.10.2-5

Probable Fate [1-7]:

photolysis: Dissolved portion may undergo photolysis to quinones

oxidation: If chlorine and/or ozone is present in sufficient quantity, rapid oxidation should occur

hydrolysis: Not important

volatilization: Probably too slow to compete with adsorption as a transport process; rate uncertain

sorption: Very strongly sorbed onto suspended solids; dominant transport process

biological processes: Bioaccumulation accompanied by metabolization; polycyclic aromatic hydrocarbons, (PAH's) are degraded in the environment; PAH's with four or more aromatic rings degrade slowly with long half-lives

other reactions/interactions: Not important

Carbon Adsorption Data, Benzo(k)fluoranthene (1-8):

ADSORBABILITY

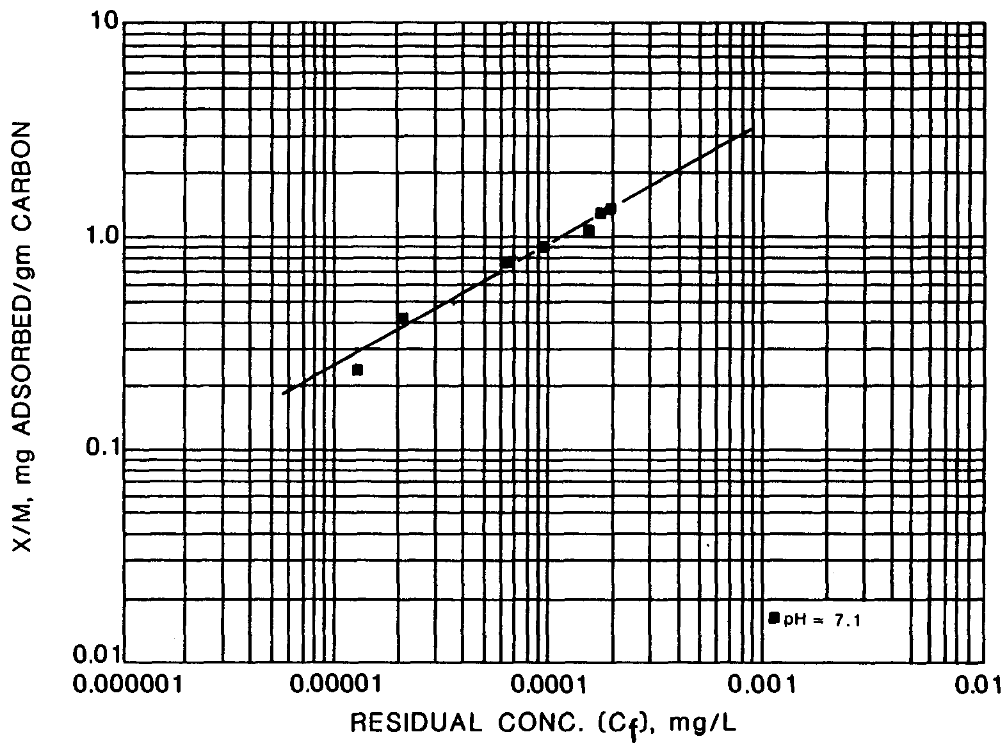
FREUNDLICH PARAMETERS	pH		
	7.1		
K	181		
1/n	0.57		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	18	76	280
0.1		6.7	28
0.01			2.6

(a) Carbon doses in mg/L at pH 7.1



ANALYTICAL METHOD: Fluorescence: excitation 302 nm; emission 415 nm.
REMARKS: Modified protocol used for isotherm due to limited solubility.

INDUSTRIAL OCCURRENCE OF BENZO(K)FLUORANTHENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	49	3	1.0	11	6.0
Coil Coating (e)	78	1		0.0	
Foundries	53	3	6.0	10	<8.0
Photographic Equipment/Supplies (b)	7	1		5.0	
Nonferrous Metals Manufacturing (c) (d)	56	2	ND	210	20
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	27
Timber Products Processing	12	12	10	3,900	500

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BENZO(K)FLUORANTHENE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	53	2	13	13	13
Coil Coating	16	0			
Foundries	53	0			
Nonferrous Metals Manufacturing (b) (c) (d)	42	1	ND	12	0.47
Ore Mining and Dressing (a)	28	0			
Timber Products Processing	9	9	10	210	40

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BENZO(K)FLUORANTHENE

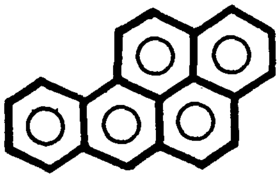
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	1		90*	BDL	
Chemical Oxidation					III.3.1.2
-ozone	1		90*	BDL	
Filtration	1		NM	0.1	III.3.1.9
Sedimentation	1	1	99* - >99	ND - BDL	III.3.1.18

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Benzo(a)pyrene

Formula:



Alternate Names: 3,4-Benzopyrene; BaP

CAS #: 50-32-8

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 252.3
melting point, °C: 179
boiling point (10 torr), °C: 310-312
vapor pressure (25°C), torr: 5×10^{-9}
solubility in water (25°C), mg/L: 0.0038
log octanol/water partition coefficient: 6.04
Henry's law constant (25°C): 1.26×10^{-2} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: See page I.10.2-5

Probable Fate [1-7]:

photolysis: Dissolved portion should undergo rapid photolysis to quinones

oxidation: Free chlorine or ozone oxidizes polycyclic aromatic hydrocarbons to form quinones

hydrolysis: Not likely to occur

volatilization: Probably too slow to compete with adsorption as a transport process

sorption: Very strong adsorption onto suspended solids is the dominant transport process

biological processes: Bioaccumulation is short-term; polycyclic aromatic hydrocarbons (PAH's) are degraded in the environment; PAH's with four or more aromatic rings degrade slowly with long half-lives

other reactions/interactions: Not important

Carbon Adsorption Data, Benzo(a)pyrene (1-8):

ADSORBABILITY

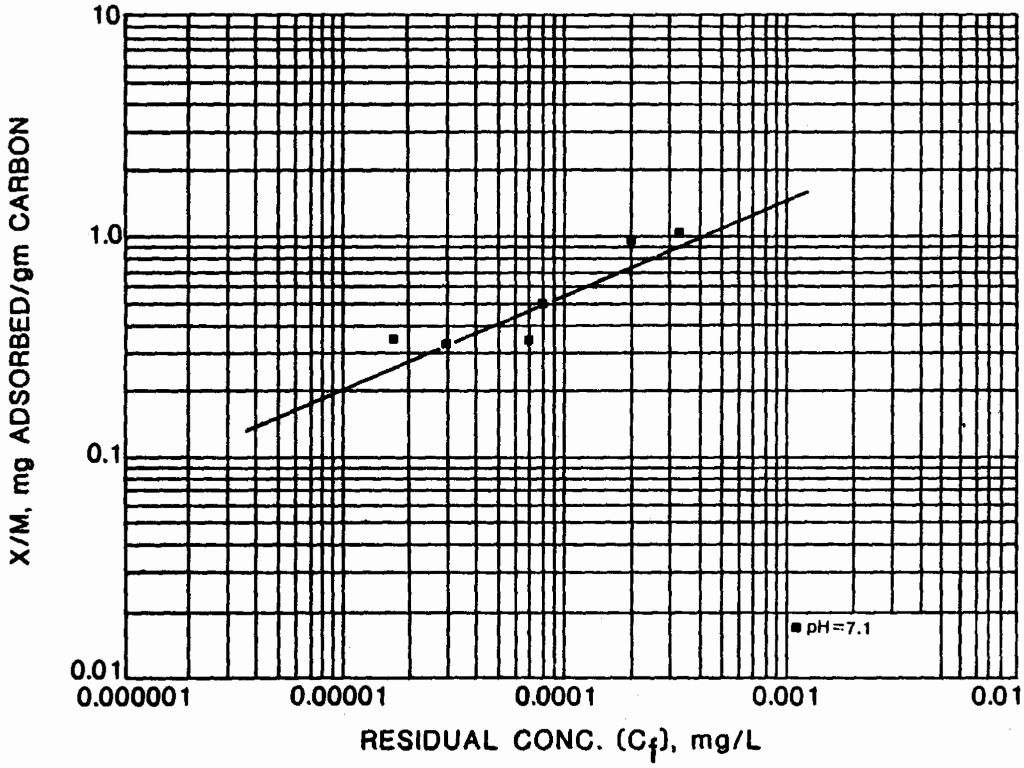
FREUNDLICH PARAMETERS	pH		
	7.1		
K	33.6		
1/n	0.44		
Corr. Coef. r	0.90		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	74	220	621
0.1		20	62
0.01			5.6

(a) Carbon doses in mg/L at pH 7.1



ANALYTICAL METHOD: Fluorescence: excitation 298 nm; emission 405 nm

REMARKS: Modified protocol used for isotherm due to unlimited solubility.

Date: 1/24/83

INDUSTRIAL OCCURRENCE OF BENZO(A)PYRENE

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (b)	49	7	1.0	140	24
Iron and Steel Manufacturing (a)	12	10	1.0	14,000	<1,500
Coil Coating (f)	78	6	0.0	0.0	0.0
Foundries	53	9	6.0	53	<20
Metal Finishing (b) (e)	11	6	ND	10	2.0
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (e)	50	5	ND	570	99
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	5.0
Petroleum Refining (b)	21	0			
Timber Products Processing	12	12	7.0	2,700	390

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BENZO(A)PYRENE

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (b)	53	2	3.0	6.0	5.0
Iron and Steel Manufacturing (a)	12	7	<2.0	13	<8.4
Coil Coating (f)	15	1		0.0	
Foundries	53	9	6.0	<10	<9.6
Nonferrous Metals Manufacturing (c) (e)	55	0	ND	9.0	1.0
Ore Mining and Dressing (b)	28	0			
Petroleum Refining (b)	21	2	1.3	3.0	2.2
Textile Mills (b) (d)	61	1		1.0	
Timber Products Processing	9	9	10	290	48

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BENZO(A)PYRENE

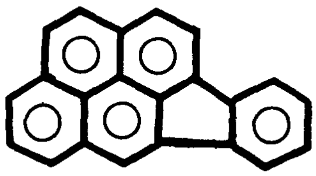
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	1		NM	0.8	
Chemical Oxidation					III.3.1.2
-ozone	1		95*	BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	91*	BDL	
-lime		1	NM	ND	
Filtration	2		NM	0.2 - 0.8	III.3.1.9
Oil Separation		1	>23	<10	III.3.1.14
Sedimentation	1	3	83* - >99	ND - 10*	III.3.1.18
Solvent Extraction		1	98	13	III.3.1.20
Activated Sludge		1	NM	BDL	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Indeno(1,2,3-cd)pyrene

Formula:



Alternate Names: 2,3-o-Phenylenepyrene;
IP

CAS #: 193-39-5

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 276.3
melting point, °C: 162-164
boiling point (760 torr), °C: Not available
vapor pressure (20°C), torr: $\sim 10^{-10}$ (calculated)
solubility in water (25°C), mg/L: 0.62
log octanol/water partition coefficient: 7.66 (calculated)
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: See page I.10.2-5

Probable Fate [1-7]:

photolysis: Insufficient data, but at best only a small portion of the compound would be available in dissolved form for photolysis

oxidation: Rapid oxidation by chlorine and/or ozone may compete for dissolved compound

hydrolysis: Not important

volatilization: Probably too slow to be important; rate uncertain

sorption: Very strong adsorption onto suspended solids should be the dominant transport process

biological processes: Bioaccumulation accompanied by metabolization; polycyclic aromatic hydrocarbons (PAH's) are degraded in the environment; PAH's with four or more aromatic rings degrade slowly with long half-lives

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF INDENO(1,2,3-CD)PYRENE

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	49	4	3.0	10	6.0
Coil Coating	78	0			
Foundries	53	0			
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (e)	39	2	ND	350	18
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	3.3
Textile Mills (a) (d)	66	1		2.0	
Timber Products Processing	12	12	6.0	5,500	520

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF INDENO(1,2,3-CD)PYRENE

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	53	3	10	11	11
Coil Coating	15	0			
Foundries	53	0			
Nonferrous Metals Manufacturing (b) (c)	30	0	ND	8.0	0.35
Ore Mining and Dressing (a)	28	0			
Timber Products Processing	9	9	10	110	29

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR INDENO(1,2,3-CD)PYRENE

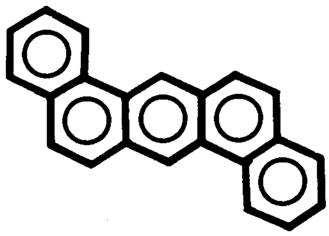
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Sludge		1	>99	ND	III.3.2.1

ND, not detected.

RESERVED

Compound: Dibenzo(a,h)anthracene

Formula:



Alternate Names: DB(a,h)A;
1,2,5,6-Dibenz-anthracene;
DBA

CAS #: 53-70-3

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 278.4
melting point, °C: 270
boiling point (760 torr), °C: Sublimes
vapor pressure (20°C), torr: ~10^{-10} (calculated)
solubility in water (25°C), mg/L: 0.0005
log octanol/water partition coefficient: 5.97 (calculated)
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: See page I.10.2-5

Probable Fate [1-7]:

photolysis: The dissolved portion of the compound may undergo rapid photolysis to quinones

oxidation: Rapid oxidation by chlorine and/or ozone may compete for dissolved DBA

hydrolysis: Not important

volatilization: Probably too slow to be important; rate uncertain

sorption: Strong adsorption by suspended solids, especially organic particulates, should be the principal transport process

biological processes: Bioaccumulation accompanied by metabolization; polycyclic aromatic hydrocarbons (PAH's) are degraded in the environment; PAH's with four or more aromatic rings degrade slowly with long half-lives

other reactions/interactions: Not important

Carbon Adsorption Data, Dibenzo(a,h)anthracene (1-8):

ADSORBABILITY

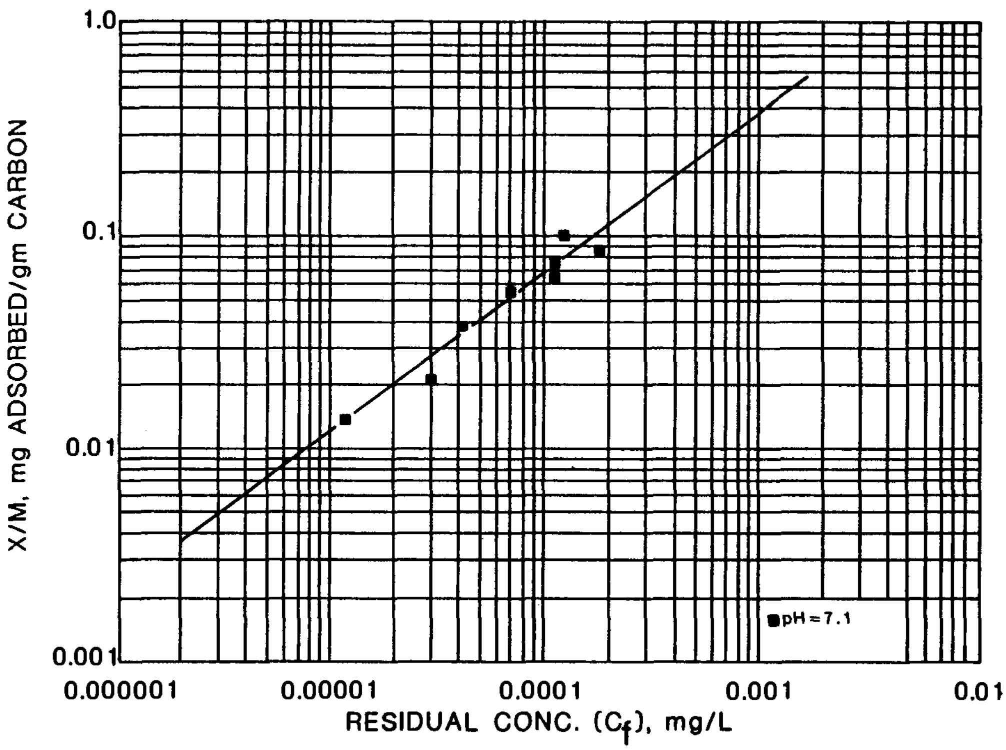
FREUNDLICH PARAMETERS	pH		
	7.1		
K	69.3		
1/n	0.75		
Corr. Coef. r	0.97		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	73	450	2,600
0.1		41	250
0.01			23

(a) Carbon doses in mg/L at pH 7.1



ANALYTICAL METHOD: Fluorescence: excitation 298 nm; 395 nm.

REMARKS: Modified protocol used for isotherm due to limited solubility.

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF DIBENZO(AH)ANTHRACENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	49	5	3.0	10	5.0
Coil Coating	78	0			
Foundries	53	0			
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d)	34	1	ND	110	8.2
Ore Mining and Dressing (a)	33	0			
Timber Products Processing	12	12	10	430	45

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF DIBENZO(AH)ANTHRACENE

	Treated wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Coal Mining (a)	53	3	10	12	11
Coil Coating	15	0			
Foundries	53	0			
Nonferrous Metals Manufacturing (b) (c)	26	0	ND	8.0	0.6
Ore Mining and Dressing (a)	28	0			
Timber Products Processing	5	5	10	10	10

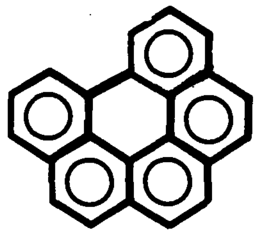
ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

Compound: Benzo(ghi)perylene

Formula:



Alternate Names: 1,12-Benzoperylene

CAS #: 191-24-2

Physical, Chemical, and Biological Properties [1-7]:

molecular weight: 276
melting point, °C: 222
boiling point (760 torr), °C: Not available
vapor pressure (20°C), torr: $\sim 10^{-10}$ (calculated)
solubility in water (25°C), mg/L: 0.00026
log octanol/water partition coefficient: 7.23 (calculated)
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: See page I.10.2-5

Probable Fate [1-7]:

photolysis: The dissolved portion could undergo rapid photolysis, but very little of the compound is present in dissolved form

oxidation: Oxidation by chlorine and/or ozone could occur if enough chlorine or ozone is present; relatively unimportant

hydrolysis: Not important

volatilization: Probably too slow to compete with adsorption as a transport process; rate uncertain

sorption: Very strong adsorption onto suspended solids, especially organic matter, should be the dominant transport process

biological processes: Bioaccumulation accompanied by metabolization; polycyclic aromatic hydrocarbons (PAH's) are degraded in the environment; PAH's with four or more aromatic rings degrade slowly with long half-lives

other reactions/interactions: Not important

Carbon Adsorption Data, Benzo(ghi)perylene (1-8):

ADSORBABILITY

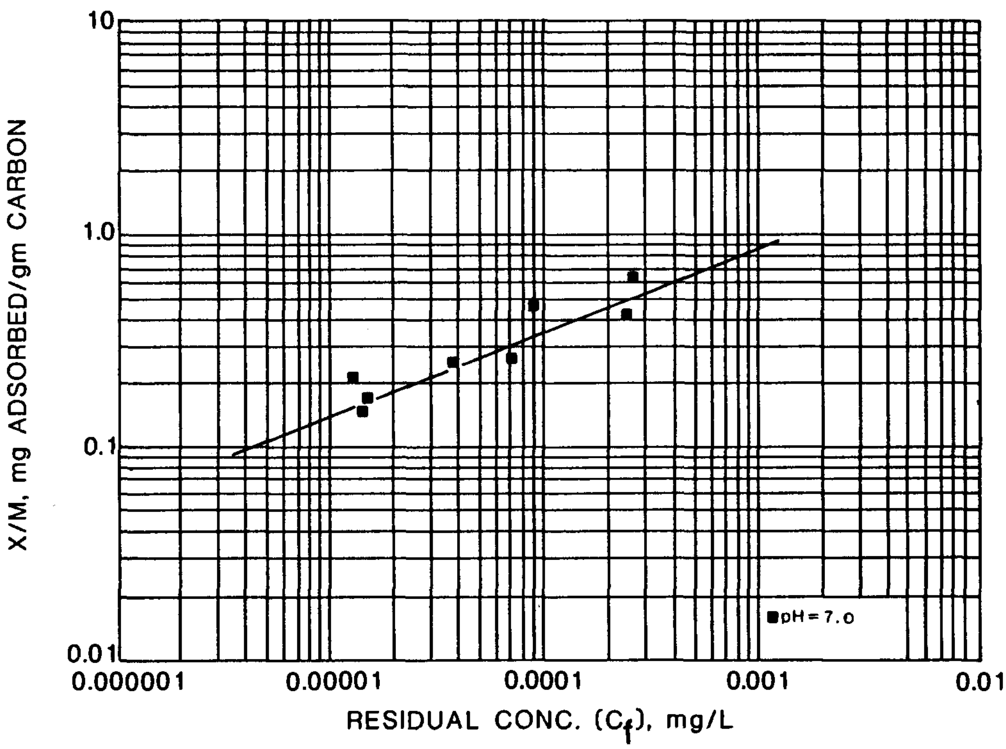
FREUNDLICH PARAMETERS	pH		
	7.0		
K	10.7		
1/n	0.37		
Corr. Coef. r	0.92		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	200	510	1,200
0.1		46	120
0.01			11

(a) Carbon doses in mg/L at neutral pH



ANALYTICAL METHOD: Fluorescence: excitation 293 nm; emission 418 nm.

REMARKS: Modified protocol used for isotherm due to limited solubility.

INDUSTRIAL OCCURRENCE OF BENZO(GHI)PERYLENE

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	49	7	1.0	10	5.0
Coil Coating (e)	78	1		0.0	
Foundries	53	0			
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d)	38	1	ND	150	12
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	3.3
Timber Products Processing	12	12	6.0	320	35

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BENZO(GHI)PERYLENE

Industry	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	53	4	3.0	13	8.0
Coil Coating	14	0			
Foundries	53	0			
Nonferrous Metals Manufacturing (b) (c)	26	1	ND	11	0.22
Ore Mining and Dressing (a)	28	0			
Timber Products Processing	9	9	2.0	63	15

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BENZO(GHI)PERYLENE

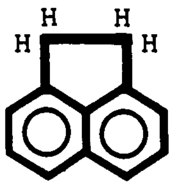
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Sedimentation		1	>99	ND	III.3.1.18

ND, not detected.

RESERVED

Compound: Acenaphthene

Formula:



Alternate Names: 1,8-Ethylenenaphthalene

CAS #: 83-32-9

Physical, Chemical, and Biological Properties [1-4, 1-7, 1-15]:

molecular weight: 154.2
melting point, °C: 96
boiling point (760 torr), °C: 279
vapor pressure (20°C), torr: 10^{-3} - 10^{-2}*
solubility in water (25°C), mg/L: 3.42
log octanol/water partition coefficient: 4.33
Henry's law constant (25°C): 2.34×10^{-4} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.10.9-5 (also page I.10.2-5)

*Estimated, based on data for structurally similar compounds

Probable Fate [1-7]:

photolysis: Photolysis should be an important fate in view of the relatively high solubility and the strong absorption above 300 nm

oxidation: Rapid oxidation by chlorine and ozone requires high concentrations of Cl or O_3

hydrolysis: Not important

volatilization: Cannot compete with adsorption as a transport process

sorption: Adsorption onto suspended solids, especially organic matter, should be dominant transport process

biological processes: Bioaccumulation accompanied by metabolization and biodegradation are principal fates

other reactions/interactions: Not important

Carbon Adsorption Data, Acenaphthene (1-8):

ADSORBABILITY

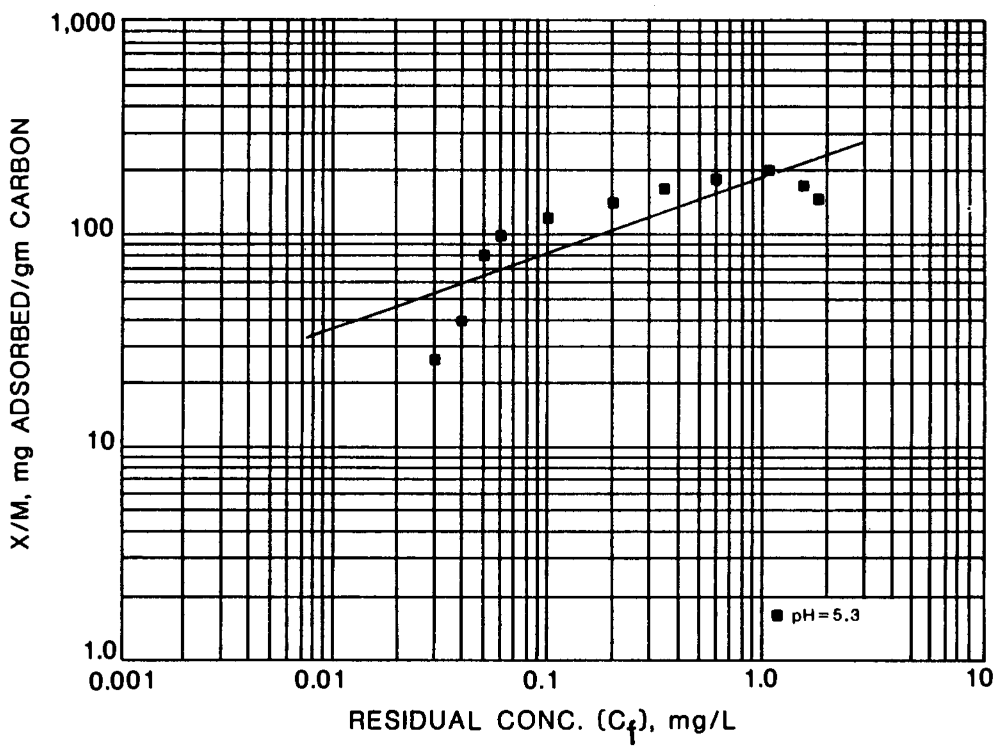
FREUNDLICH PARAMETERS	pH		
	5.3		
K	190		
1/n	0.36		
Corr. Coef. r	0.82		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	10	30	60
0.1		2.4	6.1
0.01			0.6

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Ultraviolet Spectroscopy 226 nm.

INDUSTRIAL OCCURRENCE OF ACENAPHTHENE

Industry	Raw wastewater: Number of samples	Raw wastewater: Number of detections	Detected concentrations, µg/L: Minimum	Detected concentrations, µg/L: Maximum	Detected concentrations, µg/L: Mean
Coal Mining (a)	49	3	3.0	3.0	3.0
Leather Tanning and Finishing	18	2	<10	32	<21
Aluminum Forming	23	6	2.0	95	<24
Foundries	53	14	5.0	200	<30
Metal Finishing (a) (f)	6	4	ND	5,700	1,400
Photographic Equipment/Supplies (c)	7	1		2.9	
Nonferrous Metals Manufacturing (d) (f)	59	7	ND	100	6.3
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	12	NA	NA	NA	890
Paint and Ink Formulation (b)	1	0			
Petroleum Refining (a)	21	5	37	520	280
Textile Mills (a) (e)	69	8	2.0	270	52
Timber Products Processing	12	12	10	55,000	7,800

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ACENAPHTHENE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	17	<10	67	<19
Nonferrous Metals Manufacturing (c) (e)	44	6	ND	36	5.1
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	11	NA	NA	NA	19
Paint and Ink Formulation (b)	1	1		<10	
Petroleum Refining (a)	21	1		6.0	
Textile Mills (a) (d)	64	3	1.0	2.0	2.0
Timber Products Processing	9	9	4.0	18,000	2,100

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ACENAPHTHENE

Treatment process	Number of data points Pilot scale	Number of data points Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption -granular	1		97*	BDL	III.3.1.1
Coagulation and Flocculation		1	NM	ND	III.3.1.5
Filtration	1	2	73 - >99	ND - <10	III.3.1.9
Oil Separation		1	>99	6.0	III.3.1.14
Reverse Osmosis	6		57 - >99*	BDL - 3.0	III.3.1.16
Sedimentation		3	>99	ND - 53	III.3.1.18
Ultrafiltration	1		NM	3.0	III.3.1.21
Activated Sludge	1	9	>99 - >99	ND - 2.0	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a)(1) of the Clean Water Act. These summaries apply to acenaphthene.

Freshwater Aquatic Life

The available data for acenaphthene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 1,700 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of acenaphthene to sensitive freshwater aquatic animals but toxicity to freshwater algae occur at concentrations as low as 520 µg/L.

Saltwater Aquatic Life

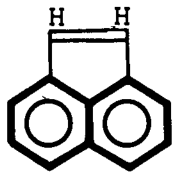
The available data for acenaphthene indicate that acute and chronic toxicity to salt water aquatic life occur at concentrations as low as 970 and 710 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Toxicity to algae occurs at concentrations as low as 500 µg/L.

Human Health

Sufficient data is not available for acenaphthene to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 20 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: Acenaphthylene

Formula:



Alternate Names: None

CAS #: 208-96-8

Physical, Chemical, and Biological Properties [1-4, 1-7, 1-15]:

molecular weight: 152.2
melting point, °C: 92
boiling point (760 torr), °C: 265-275 (partial decomposition)
vapor pressure (20°C), torr: 10^{-3} - 10^{-2}*
solubility in water (25°C), mg/L: 3.93
log octanol/water partition coefficient: 4.07 (calculated)
Henry's law constant (25°C): 0.114×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: Not included

*Estimated, based on data for structurally similar compounds

Probable Fate [1-7]:

photolysis: Rapid photolysis of dissolved acenaphthylene could be an important fate; data inconclusive

oxidation: No data on acenaphthylene, but in the presence of ozone and/or chlorine in large amounts, oxidation may occur

hydrolysis: Not important

volatilization: Probably too slow to compete with adsorption as a transport process; rate uncertain

sorption: Acenaphthylene should be adsorbed onto suspended solids, especially organic particulates

biological processes: Bioaccumulation accompanied by metabolization and biodegradation are the most important fates

other reactions/interactions: Not important

Carbon Adsorption Data, Acenaphthylene (1-8):

ADSORBABILITY

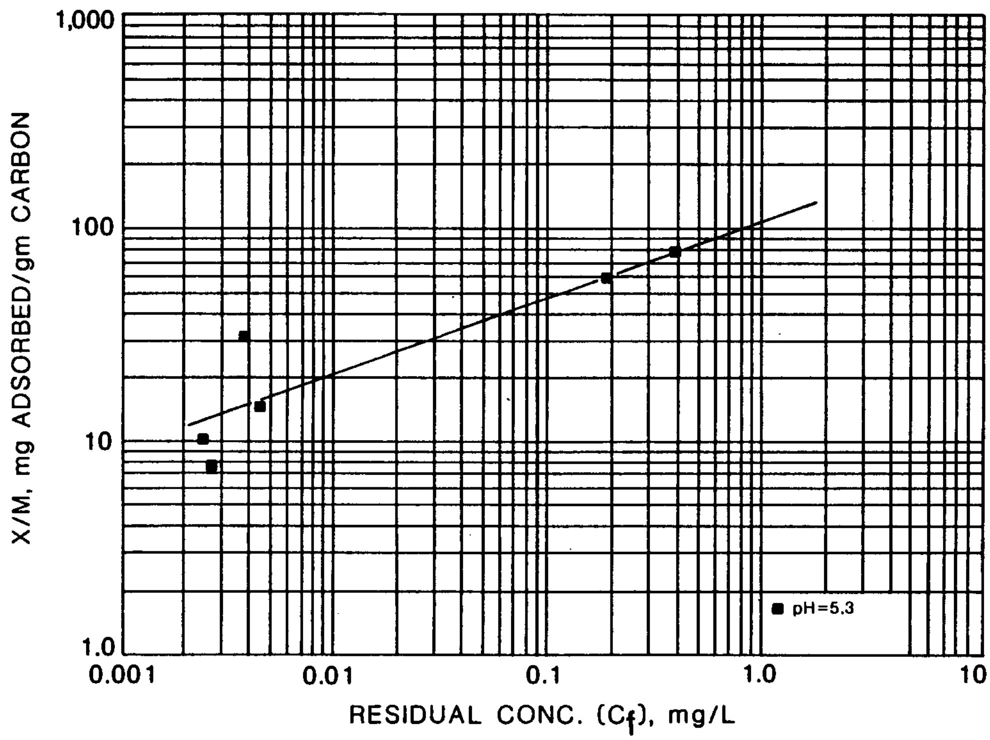
FREUNDLICH PARAMETERS	pH		
	5.3		
K	115		
1/n	0.37		
Corr. Coef. r	0.90		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	18	47	110
0.1		4.3	11
0.01			1.0

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent Extraction - G.C.

INDUSTRIAL OCCURRENCE OF ACENAPHTHYLENE

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (b)	49	1		9.0	
Iron and Steel Manufacturing (a)	5	5	17	6,400	3,000
Leather Tanning and Finishing	18	2	<10	16	<13
Coil Coating (g)	78	3	0.0	0.0	0.0
Foundries	53	14	2	62	<22
Metal Finishing (b) (f)	11	7	ND	1,000	170
Photographic Equipment/Supplies (c)	7	1		5.0	
Nonferrous Metals Manufacturing (d) (f)	70	8	ND	120	8.2
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	23	NA	NA	NA	1,600
Petroleum Refining (b)	21	4	4.0	660	320
Rubber Processing	1	1		<33	
Textile Mills (b) (e)	68	1		4,400	
Timber Products Processing	12	12	6.0	2,100	730

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ACENAPHTHYLENE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (b)	53	0			
Iron and Steel Manufacturing (a)	5	5	<3.0	1,600	<330
Aluminum Forming	20	8	1.0	5,700	750
Coil Coating (e)	16	1		0.0	
Foundries	53	19	<10	500	<41
Nonferrous Metals Manufacturing (c) (d)	55	0	ND	8.0	1.3
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	23	NA	NA	NA	14
Petroleum Refining (b)	21	0			
Rubber Processing	1	1		<8.0	
Timber Products Processing	9	9	4.0	190	56

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ACENAPHTHYLENE

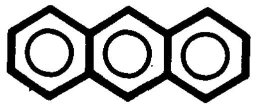
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	75*	BDL	
-lime		1	NM	BDL	
Filtration		1	NM	500	III.3.1.9
Sedimentation		5	>99	ND - 19	III.3.1.18
Solvent Extraction		1	50	1,600	III.3.1.20

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Anthracene

Formula:



Alternate Names: Paranaphthalene;
Green oil;
Tetra Olive NZG

CAS #: 120-12-7

Physical, Chemical, and Biological Properties [1-4, 1-7, 1-28]:

molecular weight: 178.2
melting point, °C: 216
boiling point (760 torr), °C: 342
vapor pressure (20°C), torr: 1.95×10^{-4}
solubility in water (25°C), mg/L: 0.073
log octanol/water partition coefficient: 4.45
Henry's law constant (25°C): 2.88×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Rapid photolysis occurs only for dissolved portion; thus, increased adsorption greatly decreases photolysis

oxidation: Ozone and chlorine in sufficient quantities can oxidize dissolved anthracene

hydrolysis: Not important

volatilization: Volatilization is hindered by adsorption and is significant only in shallow, clear, well-mixed streams

sorption: Adsorption by suspended solids and sediments is the primary transport process

biological processes: Bioaccumulation accompanied by metabolization and biodegradation are the ultimate fates

other reactions/interactions: Not important

Carbon Adsorption Data, Anthracene (1-8):

ADSORBABILITY

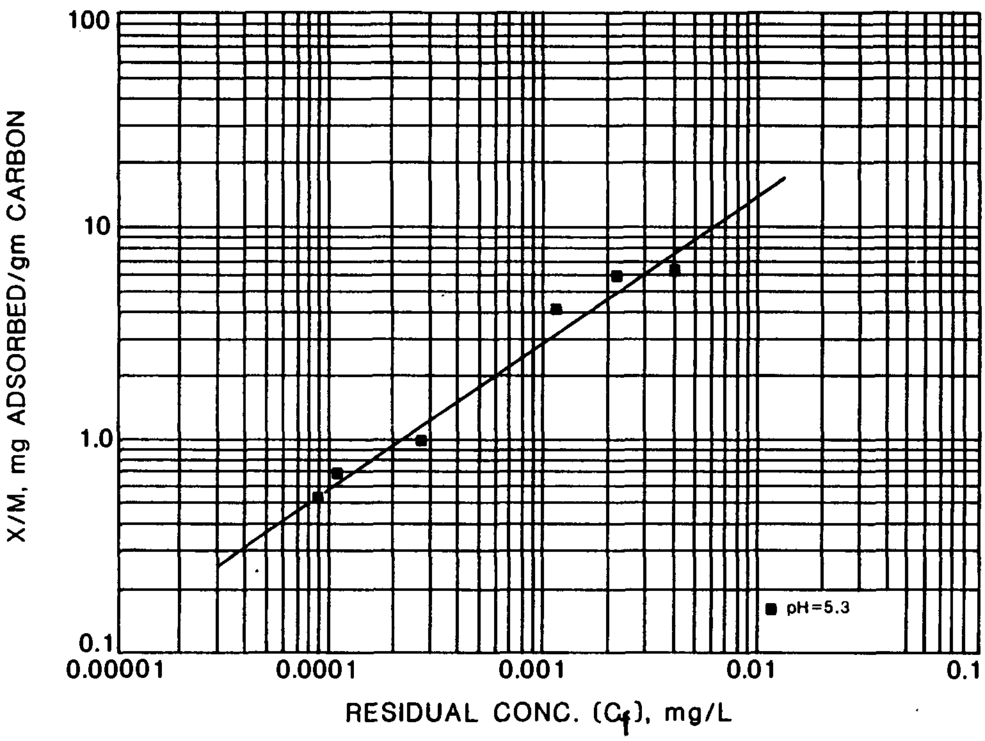
FREUNDLICH PARAMETERS	pH		
	5.3		
K	376		
1/n	0.70		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	12	67	340
0.1		6.1	34
0.01			3.1

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent Extraction - G.C.

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF ANTHRACENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a) (h)	22	9	0.9	470	<100
Coal Mining (b)	46	0			
Iron and Steel Manufacturing (a)	9	3	<10	16,000	<5,400
Leather Tanning and Finishing (h)	18	9	8.0	130	<63
Aluminum Forming	5	4	28	<1,100	<350
Battery Manufacturing (g) (i)	13	7	ND	30	<10
Coil Coating (j)	78	24	0.0	290	36
Electrical/Electronic Components (c)	3	1		<10	
Foundries	53	16	<3.0	<470	<87
Metal Finishing (b) (g)	124	94	ND	2,000	120
Photographic Equipment/Supplies (d) (j)	15	5	0.0	5.0	2.8
Nonferrous Metals Manufacturing (e) (g)	75	14	ND	3,000	38
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	23	NA	NA	NA	340
Paint and Ink Formulation (c)	3	2	<10	16	<13
Petroleum Refining (b)	21	2	660	1,800	1,200
Pulp and Paperboard Mills (g)	16	2	ND	5.0	1.0
Textile Mills (b) (f)	71	4	1.0	12	4.0
Timber Products Processing (h)	12	10	10	39,000	8,800

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Data presented are for anthracene/phenanthrene.
(i) Detections may include values less than 5 µg/L.
(j) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF ANTHRACENE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a) (h)	5	5	2.0	66	<20
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	6	3	<10	10	<10
Leather Tanning and Finishing (h)	6	4	1.4	<10	<6.2
Aluminum Forming	21	8	<1.0	41,000	<5,200
Coil Coating (i)	16	13	0.0	15	2.0
Foundries	53	12	<4.0	<3,200	<280
Photographic Equipment/Supplies (d)	11	2	0.5	5.0	2.8
Nonferrous Metals Manufacturing (e) (g)	60	10	ND	140	5.7
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	23	NA	NA	NA	6.0
Paint and Ink Formulation (c)	1	1		<10	
Petroleum Refining (b)	21	0			
Pulp and Paperboard Mills (g)	16	1	ND	1.0	0.33
Textile Mills (b) (f)	66	9	1.0	4.0	1.0
Timber Products Processing (h)	9	9	10	37,000	4,400

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Data presented are for anthracene/phenanthrene.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ANTHRACENE

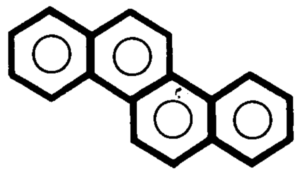
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	5		50 - 98*	BDL - 0.4	
Chemical Oxidation					III.3.1.2
-ozone	2		98*	BDL - 0.4	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum (a)		1	NM	BDL	
-lime		9	92* - >99	ND - BDL	
-sodium hydroxide		3	NM	ND - BDL	
-unspecified (a)		1	NM	BDL	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1	1	50	ND - 0.1	
Chemical Reduction		1	NM	ND	III.3.1.4
Coagulation and Flocculation	1		NM	0.01	III.3.1.5
Filtration	5	4	0 - 70	ND - 3,200	III.3.1.9
Flotation (a)		5	45 - >98	0.2 - 600	III.3.1.10
Oil Separation		1	>99	ND	III.3.1.14
Reverse Osmosis	4		77 - 99*	BDL - 0.7	III.3.1.16
Sedimentation	1	3	0 - 73	BDL - 40	III.3.1.18
Activated Sludge	1		NM	500	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value;
(a) Data presented are for anthracene/phenanthrene.

RESERVED

Compound: Chrysene

Formula:



Alternate Names: 1,2-Benzophenanthrene; Benzo(a)phenanthrene; 1,2,5,6-Dibenzonaphthalene

CAS #: 218-01-9

Physical, Chemical, and Biological Properties [1-4, 1-7]:

molecular weight: 228.3
melting point, °C: 256
boiling point (760 torr), °C: 448
vapor pressure (20°C), torr: 10^{-11} - 10^{-6}*
solubility in water (25°C), mg/L: 0.002
log octanol/water partition coefficient: 5.61
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: Not included

*Estimated, based on data for structurally similar compounds.

Probable Fate [1-7]:

photolysis: Very little specific data, but photolysis may claim some dissolved chrysene

oxidation: Chlorine and/or ozone in sufficient quantities may oxidize dissolved chrysene

hydrolysis: Not important

volatilization: Probably too slow to compete with adsorption as a transport process

sorption: Adsorption onto suspended solids and sediment is the dominant transport process

biological processes: Bioaccumulation accompanied by metabolization; polycyclic aromatic hydrocarbons (PAH's) are degraded in the environment; PAH's with four or more aromatic rings degrade slowly with long half-lives

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF CHRYSENE

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	46	0			
Iron and Steel Manufacturing (a)	15	13	1	810	<160
Leather Tanning and Finishing	18	0			
Aluminum Forming	5	3	<10	360	<130
Coil Coating (g)	78	7	0.0	30	9.0
Foundries	53	11	<10	<13,000	<2,500
Metal Finishing (b) (f)	9	6	ND	73	13
Photographic Equipment/Supplies (d)	15	2	1.0	350	170
Nonferrous Metals Manufacturing (e) (f)	70	11	ND	10,000	160
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	8	NA	NA	NA	390
Paint and Ink Formulation (c)	1	1	<10		
Petroleum Refining (b)	21	4	0.1	20	6.6
Timber Products Processing	12	12	10	4,700	630

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF CHRYSENE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	15	13	3.0	410	<52
Aluminum Forming	25	2	<3.0	10	<6.5
Coil Coating (g)	16	8	0.0	3.0	0.38
Foundries	53	10	<10	19	<12
Photographic Equipment/Supplies (d)	7	4	0.5	1.0	0.75
Nonferrous Metals Manufacturing (e) (f) (h)	55	1	ND	140	3.7
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	10
Paint and Ink Formulation (c)	1	0			
Petroleum Refining (b)	21	4	<0.1	1.4	<0.65
Timber Products Processing	9	9	10	1,900	250

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(h) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CHRYSENE

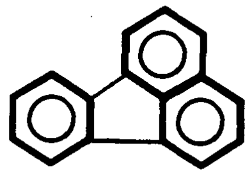
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	99	10	
-lime		2	NM	ND - ND	
-sodium hydroxide		1	80*	BDL	
-unspecified		1	>99	ND	
Oil Separation		1	>9	<10	III.3.1.14
Sedimentation		5	0 - >99	ND - 19	III.3.1.18
Solvent Extraction		1	67	95	III.3.1.20
Ultrafiltration		1	NM	ND	III.3.1.21
Activated Sludge	1		NM	100	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Fluoranthene

Formula:



Alternate Names: 1,2-Benzacenaphthlene;
Benzo(j,k)fluorene;
Idryl

CAS #: 206-44-0

Physical, Chemical, and Biological Properties [1-4, 1-7]:

molecular weight: 202.3
melting point, °C: 111
boiling point (760 torr), °C: 375
vapor pressure (20°C), torr: 10^{-6} - 10^{-4}*
solubility in water (25°C), mg/L: 0.26
log octanol/water partition coefficient: 5.33 (calculated)
Henry's law constant: Not available
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.10.13-5 (also page I.10.2-5)

*Estimated, based on data for structurally similar compounds.

Probable Fate [1-7]:

photolysis: Insufficient data, but photolysis may be very important

oxidation: Chlorine and/or ozone in sufficient quantities may oxidize fluoranthene

hydrolysis: Not important

volatilization: Not an important transport process

sorption: Adsorption onto suspended solids and sediments is probably the dominant transport process

biological processes: Bioaccumulation accompanied by metabolization; biodegradation is an important fate

other reactions/interactions: Not important

Carbon Adsorption Data, Fluoranthene (1-8):

ADSORBABILITY

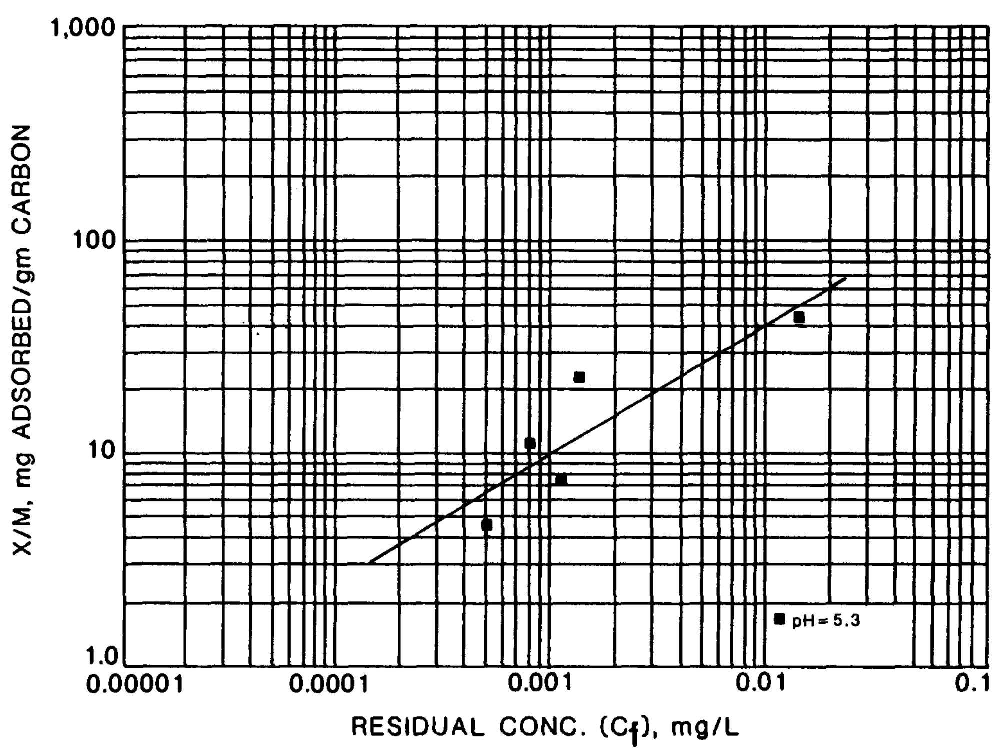
FREUNDLICH PARAMETERS	pH		
	5.3		
K	664		
1/n	0.61		
Corr. Coef. r	0.88		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	6.0	24	100
0.1		2.2	9.9
0.01			0.9

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent Extraction - G.C.

Date: 10/8/82 I.10.13-2

INDUSTRIAL OCCURRENCE OF FLUORANTHENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	1		0.3	
Coal Mining (b)	49	5	3.0	11	6.0
Iron and Steel Manufacturing (a)	20	17	3	16,000	<1,300
Leather Tanning and Finishing	18	1		2.0	
Aluminum Forming	1	1		18	
Coil Coating (g)	78	7	0.0	68	18
Electrical/Electronic Components (c)	28	1		<10	
Foundries	53	21	2.0	<390	<60
Metal Finishing (b) (f)	17	13	ND	55,000	3,700
Photographic Equipment/Supplies (d)	7	2	3.7	5.0	4.4
Nonferrous Metals Manufacturing (e) (f)	75	12	ND	3,000	390
Ore Mining and Dressing (b)	32	0			
Organic Chemicals and Plastics and Synthetic Resins	12	NA	NA	NA	1,300
Paint and Ink Formulation (c)	1	1		<10	
Petroleum Refining (b)	21	2	3.0	8.0	5.5
Pulp and Paperboard Mills (f)	7	2	ND	7.0	1.5
Timber Products Processing	12	12	10	35,000	5,700

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF FLUORANTHENE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	0.4	<10	<5.2
Coal Mining (b)	53	1		3.0	
Iron and Steel Manufacturing (a)	26	24	<3.0	860	<84
Aluminum Forming	6	1		10	
Coil Coating (f)	16	4	0.0	0.0	0.0
Foundries	53	22	6.0	480	<45
Nonferrous Metals Manufacturing (c) (e)	60	6	ND	200	13
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	11	NA	NA	NA	16
Petroleum Refining (b)	21	1		<0.1	
Pulp and Paperboard Mills (e)	7	1	ND	1.0	0.5
Textile Mills (b) (d)	61	2	1.0	1.0	1.0
Timber Products Processing	9	9	10	17,000	2,100

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR FLUORANTHENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	2		88* - 95*	BDL - BDL	
Chemical Oxidation					III.3.1.2
-ozone	1		50	0.1	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	99*	BDL	
-lime		2	NM	ND - BDL	
-unspecified		1	>99	ND	
Coagulation and Flocculation		1	>99	ND	III.3.1.5
Filtration	2	2	20 - 50	0.05 - 93	III.3.1.9
Flotation		2	NM	0.5 - <10	III.3.1.10
Reverse Osmosis	2		75* - 97*	BDL - BDL	III.3.1.16
Sedimentation	1	5	64 - >99	ND - 33	III.3.1.18
Solvent Extraction		1	49	500	III.3.1.20
Activated Sludge		1	NM	BDL	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to fluoranthene.

Freshwater Aquatic Life

The available data for fluoranthene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 3,980 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of fluoranthene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for fluoranthene indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 40 and 16 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

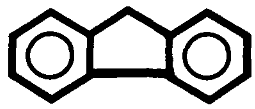
Human Health

For the protection of human health from the toxic properties of fluoranthene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 42 µg/L.

For the protection of human health from the toxic properties of fluoranthene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 54 µg/L.

Compound: Fluorene

Formula:



Alternate Names: 2,3-Benzidene;
Diphenylenemethane

CAS #: 86-73-7

Physical, Chemical, and Biological Properties [1-4, 1-7, 1-15]:

molecular weight: 166.2
melting point, °C: 116-117
boiling point (760 torr), °C: 293-295 (slight decomposition)
vapor pressure (20°C), torr: 10^{-3} - 10^{-2}*
solubility in water (25°C), mg/L: 1.98
log octanol/water partition coefficient: 4.18 (calculated)
Henry's law constant (25°C): 0.117×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: Not included

*Estimated, based on data for structurally similar compounds

Probable Fate [1-7]:

photolysis: Inconclusive data; photolysis may be important, but is probably impeded by adsorption

oxidation: Chlorine and/or ozone in sufficient quantities may oxidize fluorene

hydrolysis: Not important

volatilization: Probably not an important transport process

sorption: Adsorption onto particles, biota, and sediments is probably the dominant transport process

biological processes: Bioaccumulation accompanied by metabolization and biodegradation are important fates

other reactions/interactions: Not important

Carbon Adsorption Data, Fluorene (1-8):

ADSORBABILITY

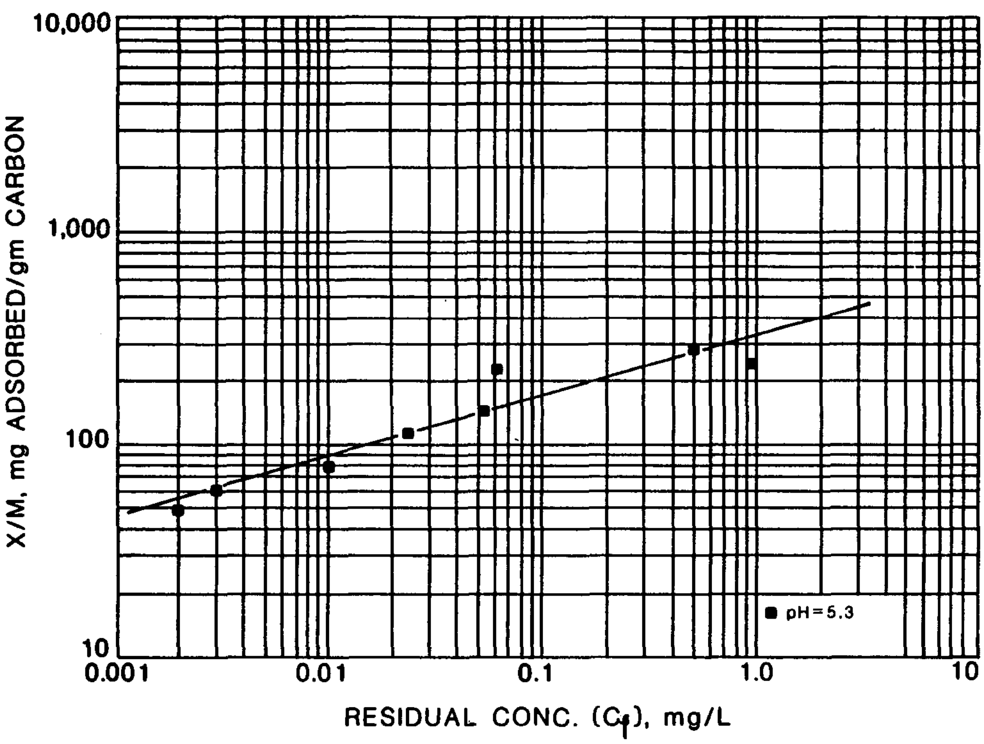
FREUNDLICH PARAMETERS	pH		
	5.3		
K	330		
1/n	0.28		
Corr. Coef. r	0.94		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	5.3	11	22
0.1		1.0	2.1
0.01			0.2

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent Extraction - G.C.

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF FLUORENE

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	49	5	1.0	44	14
Iron and Steel Manufacturing (a)	11	8	<10	2,500	<530
Leather Tanning and Finishing	18	1		<10	
Aluminum Forming	4	3	40	450	190
Coil Coating (h)	78	9	0.0	85	5.5
Foundries	53	17	3.0	800	<100
Metal Finishing (b) (g)	15	12	ND	760	95
Photographic Equipment/Supplies (d)	7	0			
Nonferrous Metals Manufacturing (e) (g)	64	8	ND	94	7.2
Ore Mining and Dressing (b)	33	1		10	
Organic Chemicals and Plastics and Synthetic Resins	19	NA	NA	NA	120
Paint and Ink Formulation (c)	1	1		<10	
Petroleum Refining (b)	21	3	110	500	290
Rubber Processing (i)	1	1		<2,000	
Textile Mills (b) (f)	68	3	1.0	15	7

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(i) Interference during analysis may cause value to be high.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF FLUORENE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	1		14	
Coal Mining (b)	53	1		1.0	
Iron and Steel Manufacturing (a)	9	8	<3.0	190	<36
Aluminum Forming	20	8	<3.0	330	<49
Coil Coating (f)	16	8	0.0	3.3	0.58
Foundries	53	13	5.0	10,000	<780
Nonferrous Metals Manufacturing (d) (e)	48	3	ND	100	8.7
Ore Mining and Dressing (b)	28	1		10	
Organic Chemicals and Plastics and Synthetic Resins	17	NA	NA	NA	4.7
Paint and Ink Formulation (c)	1	0			
Petroleum Refining (b)	21	0			
Rubber Processing (g)	1	1		<12	
Timber Products Processing	9	9	10	16,000	1,800

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Detections >10 µg/L.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(g) Interference during analysis may cause value to be high.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR FLUORENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	1		NM	BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	99*	BDL	
-lime		3	>99	ND - 1.0	
-sodium hydroxide		1	94*	BDL	
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration	1	1	NM	0.05 - 10,000	III.3.1.9
Flotation		1	NM	14	III.3.1.10
Oil Separation		1	>99	ND	III.3.1.14
Sedimentation		6	40 - >99	ND - 12	III.3.1.18
Solvent Extraction		1	75	190	III.3.1.20
Activated Sludge		2	>99 - >99	ND - ND	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Naphthalene

Formula:

Alternate Names: Moth balls;
Naphthene;
Tar camphor

CAS #: 9-120-3

Physical, Chemical, and Biological Properties [1-4, 1-7, 1-10, 1-28]:

molecular weight: 128.2
melting point, °C: 80.6
boiling point (760 torr), °C: 218 (starts to sublime above melting point)
vapor pressure (20°C), torr: 0.0492
solubility in water (25°C), mg/L: 34.4
log octanol/water partition coefficient: 3.37
Henry's law constant (25°C): 3.6×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.10.15-5 (also page I.10.2-5)

Probable Fate [1-7]:

photolysis: Relatively high solubility could make photooxidation an important fate; data inconclusive

oxidation: Chlorine and/or ozone in sufficient quantities may oxidize naphthalene

hydrolysis: Not important

volatilization: Volatilization can occur but it is too slow to compete with adsorption

sorption: Relatively low partition coefficient makes adsorption less dominant but sorption is still a competitive transport process

biological processes: Bioaccumulation accompanied by metabolization and biodegradation are the ultimate fates

other reactions/interactions: Not important

Carbon Adsorption Data, Naphthalene (1-8):

ADSORBABILITY

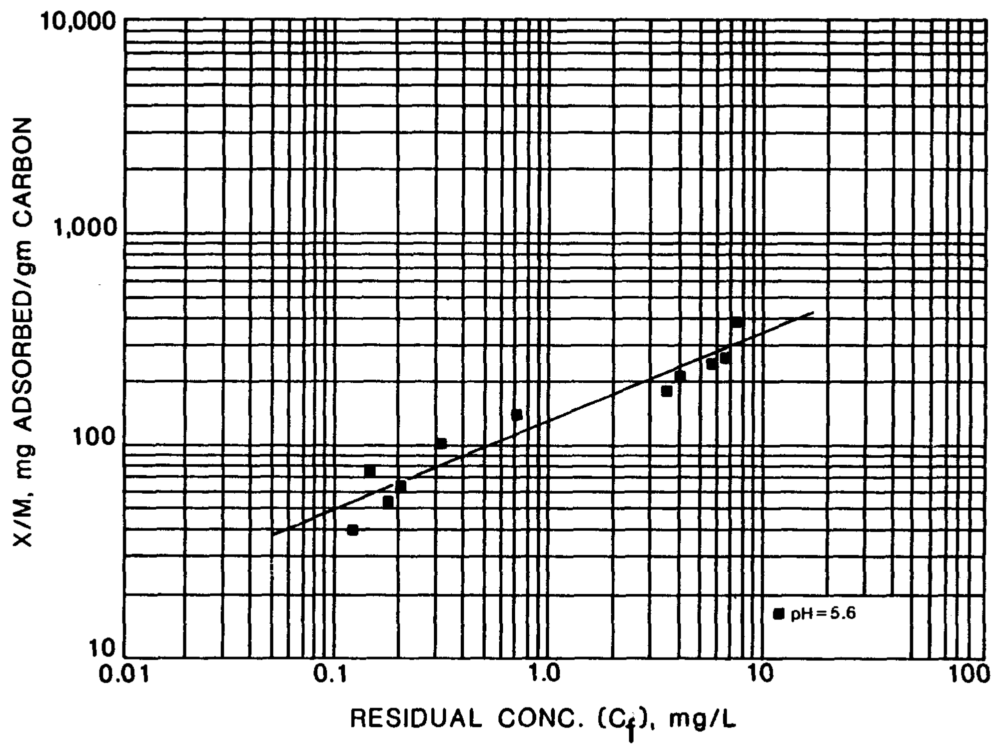
FREUNDLICH PARAMETERS	pH		
	5.6		
K	132		
1/n	0.42		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	18	52	140
0.1		4.7	13
0.01			1.2

(a) Carbon doses in mg/L at pH 5.6



ANALYTICAL METHOD: Ultraviolet Spectroscopy 275.5 nm.

INDUSTRIAL OCCURRENCE OF NAPHTHALENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	24	15	<0.007	4,800	<1,100
Coal Mining (b)	49	10	2.0	410	75
Iron and Steel Manufacturing (a)	11	6	540	29,000	16,000
Leather Tanning and Finishing	18	12	5.0	67	<28
Aluminum Forming	4	3	10	380	180
Battery Manufacturing (g) (h)	30	19	ND	20	8.0
Coil Coating (i)	78	22	0.0	38	4.6
Electrical/Electronic Components (c)	28	12	6.0	1,500	<180
Foundries	53	15	4.0	3,300	<250
Metal Finishing (b) (g)	131	101	ND	2.6 x 10E5	15,000
Photographic Equipment/Supplies (d)	25	20	0.12	10	3.9
Nonferrous Metals Manufacturing (e) (g)	64	8	ND	5,000	110
Ore Mining and Dressing (b)	33	1		12	
Organic Chemicals and Plastics and Synthetic Resins	24	NA	NA	NA	1,100
Paint and Ink Formulation (c)	28	12	<5.0	9,000	<1,100
Petroleum Refining (b)	21	10	68	3,800	1,100
Pulp and Paperboard Mills (g)	52	17	ND	230	36
Rubber Processing (j)	1	1		1.0 x 10E5	
Textile Mills (b) (f)	76	44	1.0	2,100	220
Timber Products Processing	12	12	10	45,000	<12,000

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(j) Interference during analysis may cause value to be high.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF NAPHTHALENE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	7	7	0.9	840	390
Coal Mining (b)	53	4	3.0	14	10
Iron and Steel Manufacturing (a)	9	7	<3.0	5,900	<1,100
Leather Tanning and Finishing	6	3	2.3	15	8.6
Aluminum Forming	20	9	<3.0	210	<59
Coil Coating (h)	16	7	0.0	1.7	0.31
Foundries	53	16	2.0	270	<28
Photographic Equipment/Supplies (d)	6	4	1.0	1.0	1.0
Nonferrous Metals Manufacturing (e) (g)	55	3	ND	930	17
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	18	NA	NA	NA	19
Paint and Ink Formulation (c)	19	7	<5.0	1,300	<200
Petroleum Refining (b)	21	1		0.1	
Pulp and Paperboard Mills (g)	52	5	ND	88	6.0
Rubber Processing (i)	1	1		<44	
Textile Mills (b) (f)	94	15	1.0	260	25
Timber Products Processing	9	9	10	36,000	4,200

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(i) Interference during analysis may cause value to be high.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR NAPHTHALENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular		1	51	78	
-powdered		1	98*	5.0	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	97*	BDL	
-combined precipitants		3	>33 - 86	8 - 1,300	
-lime		7	NM	ND - BDL	
-sodium hydroxide		3	86*	BDL - 1.0	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	BDL	
Chemical Reduction		1	NM	ND	III.3.1.4
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		6	83 - >99	ND - 160	III.3.1.9
Flotation		9	33 - >99	ND - 840	III.3.1.10
Reverse Osmosis	1		99*	BDL	III.3.1.16
Sedimentation		4	>99	ND - <55	III.3.1.18
Solvent Extraction		1	NM	5,900	III.3.1.20
Ultrafiltration		2	NM	<34 - 66	III.3.1.21
Activated Sludge		26	2 - >99	ND - 260	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	>99	ND	
-non-aerated		1	>99	ND	
Trickling Filters	1		NM	55	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to naphthalene.

Freshwater Aquatic Life

The available data for naphthalene indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 2,300 and 620 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

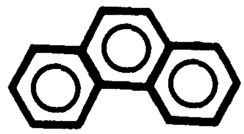
The available data for naphthalene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 2,350 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of naphthalene to sensitive saltwater aquatic life.

Human Health

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for naphthalene.

Compound: Phenanthrene

Formula:



Alternate Names: Phenanthrin

CAS #: 85-01-8

Physical, Chemical, and Biological Properties [1-4, 1-7, 1-28]:

molecular weight: 178.2
melting point °C: 101
boiling point (760 torr), °C: 340
vapor pressure (20°C), torr: 6.8×10^{-4}
solubility in water (25°C), mg/L: 1.29
log octanol/water partition coefficient: 4.46
Henry's law constant (25°C): 1.08×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, gradual adaptation
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Data inconclusive; photolysis is probably greatly hindered by strong adsorption

oxidation: Chlorine and/or ozone in sufficient quantities may oxidize phenanthrene

hydrolysis: Not important

volatilization: Volatilization can occur but it is too slow to compete with adsorption

sorption: Probably the dominant transport process; organic particulates preferred

biological processes: Bioaccumulation accompanied by metabolization and biodegradation are the principal fates

other reactions/interactions: Not important

Carbon Adsorption Data, Phenanthrene (1-8):

ADSORBABILITY

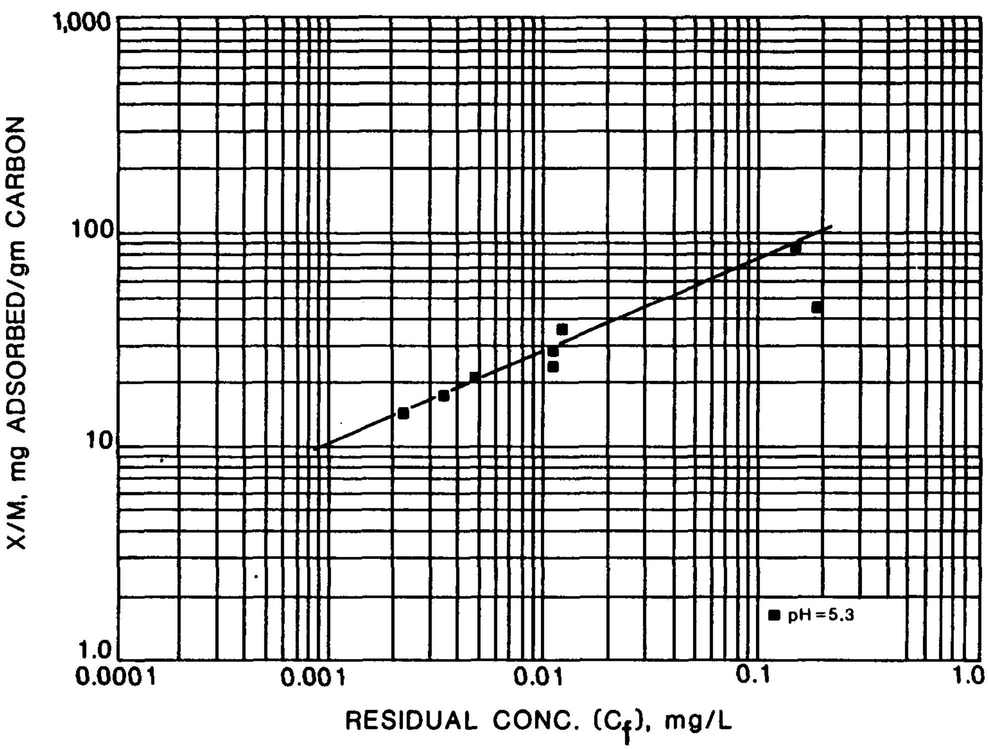
FREUNDLICH PARAMETERS	pH		
	5.3		
K	215		
1/n	0.44		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	11	34	95
0.1		3.1	9.4
0.01			0.9

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent Extraction - G.C.

INDUSTRIAL OCCURRENCE OF PHENANTHRENE

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a) (h)	22	9	0.9	470	<100
Coal Mining (b)	46	1		12	
Leather Tanning and Finishing (h)	18	9	8.0	130	<63
Aluminum Forming	5	4	28	<1,100	<350
Battery Manufacturing (g) (j)	13	7	ND	30	<10
Coil Coating (k)	78	24	0.0	290	26
Electrical/Electronic Components (c)	3	1		<10	
Foundries	53	16	<3.0	<470	<87
Metal Finishing (b) (g)	122	93	ND	2,000	150
Photographic Equipment/Supplies (d) (k)	15	5	0.0	5.0	2.8
Nonferrous Metals Manufacturing (e) (g)	75	14	ND	3,000	46
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	24	NA	NA	NA	1,500
Paint and Ink Formulation (c)	3	2	<5.0	<10	<7.5
Petroleum Refining (b)	21	2	660	1,800	1,200
Soap and Detergent Manufacturing (a) (i)	3	3	0.4	27	9.7
Textile Mills (b) (f)	68	2	1.0	12	7.0
Timber Products Processing (h)	12	10	10	39,000	8,800

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Data presented are for anthracene/phenanthrene.
(i) Data presented are for phenanthrene/trichloroethylene.
(j) Detections may include values less than 5 µg/L.
(k) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF PHENANTHRENE

	Treated wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Auto and Other Laundries (a) (h)	5	5	2.0	66	<20
Coal Mining (b)	51	1		3.0	
Leather Tanning and Finishing (h)	6	4	1.4	<10	<6.2
Aluminum Forming	25	10	<1.0	1.1 x 10E5	<15,000
Coil Coating (i)	16	13	0.0	15	2.0
Foundries	53	12	<4.0	<3,200	<280
Photographic Equipment/Supplies (d)	11	2	0.5	5.0	2.8
Nonferrous Metals Manufacturing (e) (g)	60	5	ND	140	11
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	26	NA	NA	NA	7.2
Paint and Ink Formulation (c)	1	1		12	
Petroleum Refining (b)	21	0			
Textile Mills (b) (f)	63	1		1.0	
Timber Products Processing (h)	9	9	10	37,000	4,400

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Data presented are for anthracene/phenanthrene.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/l.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR PHENANTHRENE

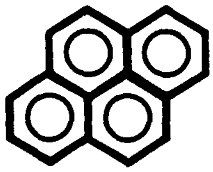
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	2		98* - 99*	BDL - BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum (a)		1	NM	BDL	
-lime		7	92* - >99	ND - BDL	
-sodium hydroxide		3	NM	ND - BDL	
-unspecified (a)		1	NM	BDL	
Chemical Precipitation with Filtration					III.3.1.3
-lime		1	NM	ND	
Chemical Reduction		1	>99	ND	III.3.1.4
Filtration	1	4	67	ND - 3,200	III.3.1.9
Flotation (a)		5	45 - >98	0.2 - 600	III.3.1.10
Oil Separation		1	>99	ND	III.3.1.14
Reverse Osmosis	1		99*	BDL	III.3.1.16
Sedimentation		5	0	BDL - 40	III.3.1.18
Solvent Extraction		1	66	280	III.3.1.20
Activated Sludge	1		NM	BDL	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value;
(a) Data presented are for anthracene/phenanthrene.

RESERVED

Compound: Pyrene

Formula:



Alternate Names: Benzo(d,e,f)phenanthrene

CAS #: 129-00-0

Physical, Chemical, and Biological Properties [1-4, 1-7]:

molecular weight: 202
melting point, °C: 150
boiling point (760 torr), °C: 393
vapor pressure (20°C), torr: 6.85×10^{-7}
solubility in water (25°C), mg/L: 0.14
log octanol/water partition coefficient: 5.32 (calculated)
Henry's law constant: Not available
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Low solubility probably hinders photolysis; relatively unimportant fate

oxidation: Chlorine and/or ozone in sufficient quantities can oxidize dissolved pyrene

hydrolysis: Not important

volatilization: Probably not as important as adsorption as a transport process; rate uncertain

sorption: Adsorption onto suspended particles, biota, and sediment is probably the dominant transport process

biological processes: Bioaccumulation accompanied by metabolization; polycyclic aromatic hydrocarbons (PAH's) are degraded in tne environment; PAH's with four or more aromatic rings degrade slowly with long half-lives

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF PYRENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	1		0.3	
Coal Mining (b)	49	6	1.0	25	9.0
Iron and Steel Manufacturing (a)	20	18	3.0	15,000	<1,100
Leather Tanning and Finishing	18	1		1.0	
Aluminum Forming	5	3	20	98	40
Battery Manufacturing (g) (h)	13	5	ND	<10	<10
Coil Coating (i)	78	1	0.0	11	5.5
Electrical/Electronic Components (c)	2	0			
Foundries	53	22	6.0	<1,100	<83
Metal Finishing (b) (g)	7	6	ND	190	57
Photographic Equipment/Supplies (d)	7	3	5.0	5.5	5.2
Nonferrous Metals Manufacturing (e) (g)	78	11	ND	7,000	130
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	18	NA	NA	NA	540
Petroleum Refining (b)	21	3	5.0	16	11
Pulp and Paperboard Mills (g)	3	1	ND	6.0	2.0
Rubber Processing (j)	1	1		6,700	
Textile Mills (b) (f)	71	1		1.0	
Timber Products Processing	12	12	10	22,000	3,900

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(j) Interference during analysis may cause value to be high.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF PYRENE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	1		0.3	
Coal Mining (b)	53	1		2.0	
Iron and Steel Manufacturing (a)	21	18	3.0	1,100	<110
Aluminum Forming	25	10	<0.3	41	<9.6
Coil Coating (f)	16	5	0.0	0.0	0.0
Foundries	53	21	<10	3,200	<190
Nonferrous Metals Manufacturing (c) (e)	59	7	ND	180	11
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	17	NA	NA	NA	30
Petroleum Refining (b)	21	3	<0.1	7.0	<2.5
Pulp and Paperboard Mills	3	0			
Rubber Processing (g)	1	1		<14	
Textile Mills (b) (d)	65	7	1.0	1.0	1.0
Timber Products Processing	9	9	10	9,400	1,200

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(g) Interference during analysis may cause value to be high.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR PYRENE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption					III.3.1.1
-granular	2		95* - 98*	BDL - BDL	
Chemical Oxidation					III.3.1.2
-ozone	1		67	0.1	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	94*	BDL	
-lime		1	90	1.0	
-unspecified		1	>99	ND	
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration	2	2	0 - 10	0.09 - 3,200	III.3.1.9
Flotation		2	0	0.3 - 18	III.3.1.10
Oil Separation		1	>99	ND	III.3.1.14
Reverse Osmosis	2		99* - >99*	BDL - BDL	III.3.1.16
Sedimentation	1	7	75 - >99	ND - 21	III.3.1.18
Ultrafiltration		1	NM	ND	III.3.1.21
Activated Sludge		5	78	BDL - 0.3	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Aroclor 1016

Formula: A mixture of mono, di, and trichloro isomers of the polychlorinated biphenyls (PCB's). Approximately 41% chlorine by weight

Alternate Names: None

CAS #: Not assigned

Physical, Chemical, and Biological Properties [1-2, 1-19, 1-28]:

molecular weight: 257.9*
melting point, °C: Not available
boiling point (760 torr), °C: 325-356
vapor pressure (25°C), torr: 4×10^{-4} (estimated)
solubility in water (temp. unknown), mg/L: 0.42
log octanol/water partition coefficient: 4.38
Henry's law constant (25°C): 1.8×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: N-not significantly degraded
water quality criteria: See page I.11.1-5

*Average.

Probable Fate [1-2]:

photolysis: Too slow to be important

oxidation: Not important

hydrolysis: Not important

volatilization: Slow volatilization is the cause of global distribution of PCB's, but is inhibited by adsorption

sorption: PCB's are rapidly adsorbed onto solids, especially organic matter, and are often immobilized in sediments, but may reenter solution

biological processes: Strong bioaccumulation; mono-, di- and tri-chlorinated biphenyls are gradually biodegraded. Increasing resistance to biodegradation with increasing chlorine content

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF AROCLOR 1016

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Aluminum Forming	25	11	0.06	20	2.4
Foundries (c)	53	17	<5	830	<160
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	9	0			
Petroleum Refining (a)	17	6	1.8	<10	<7.3

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Includes data for Aroclor 1016, 1232, 1248, and 1260.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF AROCLOR 1016

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Aluminum Forming	6	4	1.0	5.3	2.2
Foundries (b)	53	13	<5.0	480	<58
Ore Mining and Dressing (a)	6	0			
Petroleum Refining (a)	17	4	<10	<10	<10

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Includes data for Aroclor 1016, 1232, 1248, and 1260.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR AROCLOR 1016

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	16	480	III.3.1.9
Flotation		1	NM	7.9	III.3.1.10
Oil Separation		2	98	BDL - 8.0	III.3.1.14
Ultrafiltration		1	99*	BDL	III.3.1.21

BDL, below detection limit; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to polychlorinated biphenyls.

Freshwater Aquatic Life

For polychlorinated biphenyls the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.014 µg/L as a 24-hour average. The available data indicate that acute toxicity to freshwater aquatic life probably will only occur at concentrations above 2.0 µg/L and that the 24-hour average should provide adequate protection against acute toxicity.

Saltwater Aquatic Life

For polychlorinated biphenyls the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.030 µg/L as a 24-hour average. The available data indicate that acute toxicity to saltwater aquatic life probably will only occur at concentrations above 10 µg/L and that the 24-hour average should provide adequate protection against acute toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of PCBs through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 0.79 ng/l, 0.079 ng/l, and 0.0079 ng/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 0.79 ng/l, 0.079 ng/l, and 0.0079 ng/l, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Aroclor 1221

Formula: A mixture of polychlorinated biphenyls which is approximately 21% chlorine by weight

Alternate Names: None

Cas #: 111-042-82

Physical, Chemical, and Biological Properties [1-2, 1-19, 1-28]:

molecular weight: 200.7*
melting point, °C: Not available
boiling point (760 torr), °C: 275-320
vapor pressure (25°C), torr: 6.7×10^{-3} (estimated)
solubility in water (25°C), mg/L: 15 (estimated)
log octanol/water partition coefficient: 2.8 (estimated)
Henry's law constant (25°C): 3.24×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.11.1-5

*Average.

Probable Fate [1-2]:

photolysis: Too slow to be important

oxidation: Not important

hydrolysis: Not important

volatilization: Slow volatilization distributes PCB's globally, but is inhibited by adsorption

sorption: PCB's are rapidly adsorbed onto solids, especially organic matter, and are often immobilized in sediment, but may reenter solution

biological processes: Strong bioaccumulation; mono-, di-, and tri-chlorinated biphenyls are gradually biodegraded. Increasing resistance to biodegradation with increasing chlorine content

other reactions/interactions: Not important

Carbon Adsorption Data, Aroclor 1221 (1-8):

ADSORBABILITY

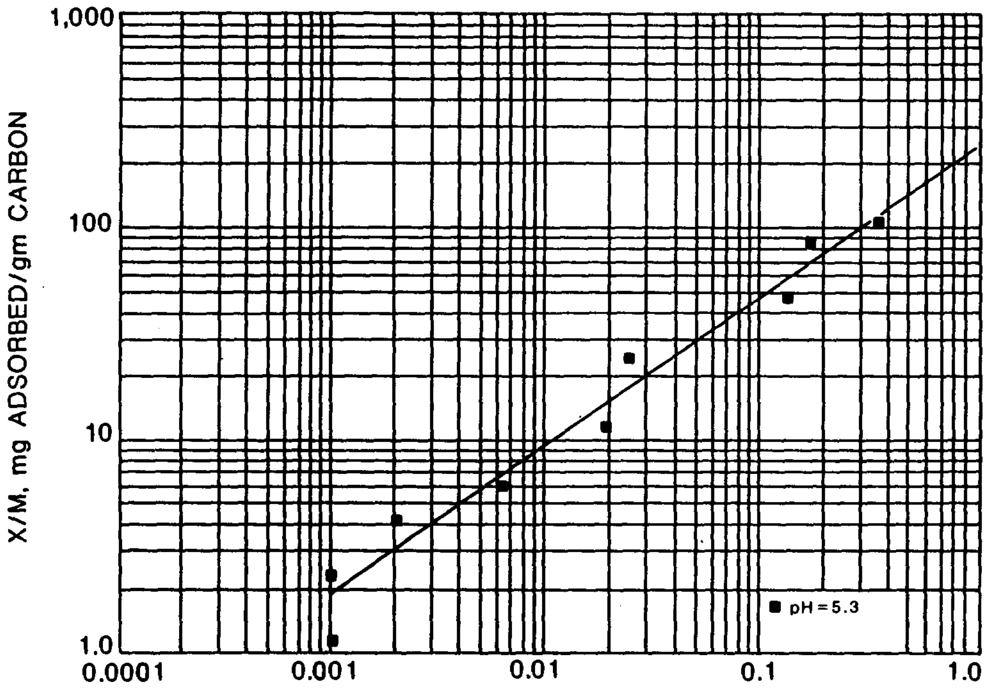
FREUNDLICH PARAMETERS	pH		
	5.3		
K	242		
1/n	0.70		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

Co. mg/L	0.1	0.01	0.001
1.0	19	100	520
0.1		9.3	52
0.01			5.7

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF AROCLOR 1221

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Aluminum Forming	19	11	0.09	16	2.1
Foundries (c)	53	16	3.0	1,400	<260
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	9	0			
Petroleum Refining (a)	17	5	0.1	<10	<8.0

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Includes data for Aroclor 1221, 1242, and 1254.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF AROCLOR 1221

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Aluminum Forming	8	7	0.5	6.1	1.8
Foundries (b)	53	21	<5.0	650	<49
Ore Mining and Dressing (a)	6	0			
Petroleum Refining (a)	17	5	<5.0	<10	<9.0

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Includes data for Aroclor 1221, 1242, and 1254.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR AROCLOR 1221

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	20	650	III.3.1.9
Oil Separation		2	97	BDL - 6.0	III.3.1.14

BDL, below detection limit; NM, not meaningful.

RESERVED

Compound: Aroclor 1232

Formula: A mixture of polychlorinated biphenyls which is approximately 32% chlorine by weight

Alternate Names: None

CAS #: 111-411-65

Physical, Chemical, and Biological Properties [1-2, 1-28]:

molrcular weight: 232.2*
melting point, °C: Not available
boiling point (760 torr), °C: 290-325
vapor pressure (25°C), torr: 4.06 x 10^{-3} (estimated)
solubility in water (25°C), mg/L: 1.45 (estimated)
log octanol/water partition coefficient: 3.2 (estimated)
Henry's law constant (25°C): 8.64 x 10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.11.1-5

*Average.

Probable Fate [1-2]:

photolysis: Too slow to be important

oxidation: Not important

hydrolysis: Not important

volatilization: Slow volatilization distributes PCB's globally, but is inhibited by adsorption

sorption: PCB's are rapidly adsorbed onto solids, especially organic matter, and are often immobilized in sediment, but may reenter solution

biological processes: Strong bioaccumulation, mono-, di-, and tri-chlorinated biphenyls are gradually biodegraded. Increasing resistance to biodegradation with increasing chlorine content

other reactions/interactions: Not important

Carbon Adsorption Data, Aroclor 1232 (1-8):

ADSORBABILITY

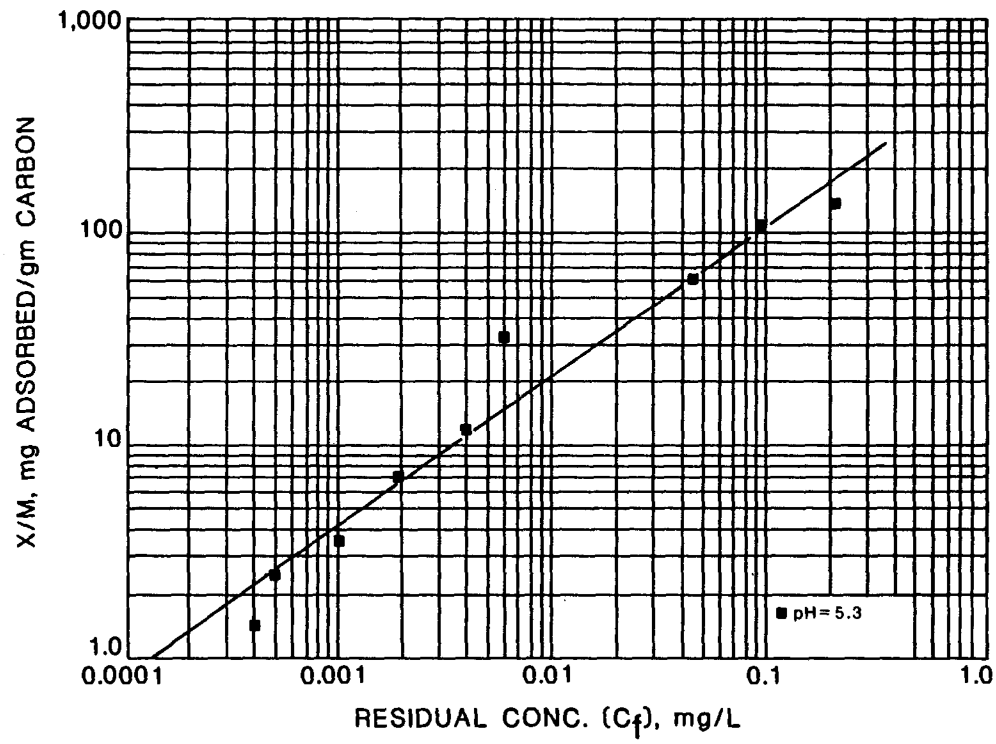
FREUNDLICH PARAMETERS	pH		
	5.3		
K	630		
1/n	0.73		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	7.7	45	240
0.1		4.1	24
0.01			2.2

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF AROCLOR 1232

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Aluminum Forming	4	2	1.4	3.2	2.3
Foundries (c)	53	17	<5.0	830	<160
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	9	0			
Petroleum Refining (a)	17	6	0.5	<10	<6.9

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Includes data for Aroclor 1016, 1232, 1248, and 1260.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF AROCLOR 1232

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Aluminum Forming	6	3	1.2	360	120
Foundries (b)	53	13	<5.0	480	<58
Ore Mining and Dressing (a)	6	0			
Petroleum Refining (a)	17	4	<10	<10	<10

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Includes data for Aroclor 1016, 1232, 1248, and 1260.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR AROCLAR 1232

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	16	480	III.3.1.9
Oil Separation		2	98	BDL - 8.0	III.3.1.14
Ultrafiltration		1	99*	BDL	III.3.1.21

BDL, below detection limit; NM, not meaningful; *approximate value.

RESERVED

Compound: Aroclor 1242

Formula: A mixture of polychlorinated biphenyls which is approximately 42% chlorine by weight

Alternate Names: None

CAS #: 534-692-19

Physical, Chemical, and Biological Properties [1-2, 1-19]:

molecular weight: 266.5*
melting point, °C: Not available
boiling point (760 torr), °C: 325-366
vapor pressure (25°C), torr: 4.06×10^{-4}
solubility in water (25°C), mg/L: 0.24
log octanol/water partition coefficient: 4.11
Henry's law constant (25°C): 5.7×10^{-4} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.11.1-5

*Average.

Probable Fate [1-2]:

photolysis: Inhibited by presence of oxygen, but possibly the only degradative pathway for highly chlorinated PCB's

oxidation: Not important

hydrolysis: Not important

volatilization: Slow volatilization causes global dispersion of PCB's, but is inhibited by adsorption

sorption: PCB's are rapidly adsorbed onto solids, especially organic matter, and are often immobilized in sediment, but may reenter solution

biological processes: Strong bioaccumulation; mono-, di-, and tri-chlorinated biphenyls are gradually biodegraded. Increasing resistence to biodegradation with increasing chlorine content

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF AROCLOR 1242

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Aluminum Forming	3	1		4.5	
Foundries (e)	53	16	3.0	1,400	<260
Photographic Equipment/Supplies (b)	15	6	0.01	1.2	0.58
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	10
Petroleum Refining (a)	17	8	0.2	<10	<5.9
Pulp and Paperboard Mills (d)	3	1	ND	9.9	3.0
Textile Mills (a) (c)	50	1		1.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Mean calculated using medians.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Includes data for Aroclor 1221, 1242, and 1254.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF AROCLOR 1242

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Aluminum Forming	7	3	1.3	110	38
Foundries (c)	53	21	<5.0	650	<49
Photographic Equipment/Supplies (b)	8	4	0.28	0.5	0.39
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	6.7
Petroleum Refining (a)	17	4	<10	<10	<10
Pulp and Paperboard Mills	3	0			

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Includes data for Aroclor 1221, 1242, and 1254.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR AROCLOR 1242

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	20	650	III.3.1.9
Flotation		1	0	0.5	III.3.1.10
Oil Separation		2	97	BDL - 6.0	III.3.1.14

BDL, below detection limit; NM, not meaningful.

RESERVED

Compound: Aroclor 1248

Formula: A mixture of polychlorinated biphenyls which is approximately 48% chlorine by weight

Alternate Names: None

CAS #: 126-722-96

Physical, Chemical, and Biological Properties [1-2]:

molecular weight: 299.5*
melting point, °C: Not available
boiling point (760 torr), °C: 340-375
vapor pressure (25°C), torr: 4.94×10^{-4}
solubility in water (25°C), mg/L: 0.054
log octanol/water partition coefficient: 5.75 (estimated)
Henry's law constant (25°C): 3.5×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.11.1-5

*Average.

Probable Fate [1-2]:

photolysis: Inhibited by presence of oxygen, but possibly the only degradative pathway for highly chlorinated PCB's

oxidation: Stable to oxidation

hydrolysis: Stable to hydrolysis

volatilization: Slow volatilization may be the cause of global dispersion of PCB's, but volatility is inhibited by adsorption

sorption: PCB's are rapidly adsorbed onto solids, especially with high organic content, and are often immobilized in sediment, but may reenter solution

biological processes: Strong bioaccumulation: PCB's with high chlorine content are resistant to biodegradation

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF AROCLOR 1248

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Aluminum Forming	5	4	0.16	65	25
Foundries (e)	53	17	<5.0	830	<160
Metal Finishing (a) (d)	4	3	ND	1,800	650
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d)	73	1	ND	32	0.74
Ore Mining and Dressing (a)	9	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	4.0
Petroleum Refining (a)	17	4	<10	<10	<10
Pulp and Paperboard Mills (d)	30	6	ND	10	2.2

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Includes data for Aroclor 1016, 1232, 1248, and 1260.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF AROCLOR 1248

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Aluminum Forming	12	4	1.0	160	43
Foundries (d)	53	13	<5.0	480	<58
Nonferrous Metals Manufacturing (b) (c) (e)	53	0	ND	7.0	0.62
Ore Mining and Dressing (a)	6	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Petroleum Refining (a)	17	4	<10	<10	<10
Pulp and Paperboard Mills (c)	21	2	ND	<1.0	0.33

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Includes data for Aroclor 1016, 1232, 1248, and 1260.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR AROCLOR 1248

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	16	480	III.3.1.9
Oil Separation		2	98	BDL - 8.0	III.3.1.14
Ultrafiltration		1	99*	BDL	III.3.1.21

BDL, below detection limit; NM, not meaningful; *approximate value.

RESERVED

Compound: Aroclor 1254

Formula: A mixture of polychlorinated biphenyls which is approximately 54% chlorine by weight

Alternate Names: None

CAS #: 110-976-91

Physical, Chemical, and Biological Properties [1-2, 1-15, 1-19]:

molecular weight: 328.4*
melting point, °C: Not available
boiling point (760 torr), °C: 365-390
vapor pressure (25°C), torr: 7.71×10^{-5}
solubility in water (25°C), mg/L: 0.012
log octanol/water partition coefficient: 6.03 (estimated)
Henry's law constant (25°C): 8.37×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.11.1-5

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*Average.

Probable Fate [1-2]:

photolysis: Suppressed by presence of oxygen, but possibly the only degradative mechanism for highly chlorinated PCB's

oxidation: Not important

hydrolysis: Not important

volatilization: Slow volatilization distributes PCB's globally, but is inhibited by adsorption

sorption: PCB's are rapidly adsorbed onto solids, especially organic matter, and are often immobilized in sediment, but may reenter solution

biological processes: Strong bioaccumulation: essentially non-biodegradable because of highly chlorinated isomer content

other reactions/interactions: Not important

Carbon Adsorption Data, Aroclor 1254 (1-8, 1-16):

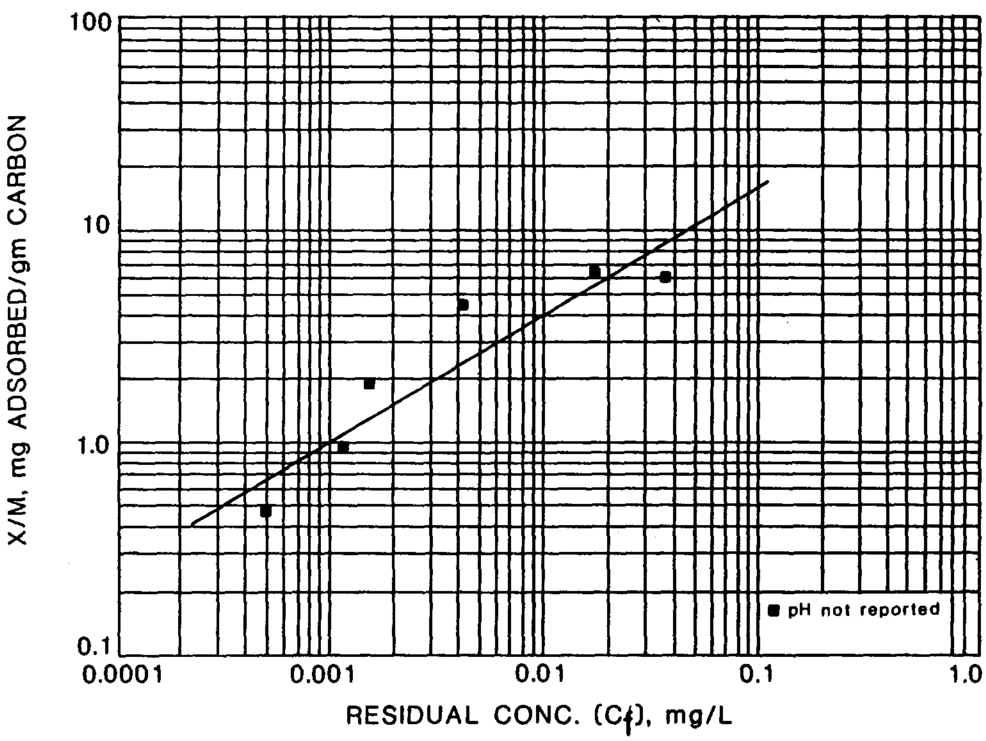
ADSORBABILITY

FREUNDLICH PARAMETERS	pH		
	Not reported		
K	65.4		
1/n	0.60		
Corr. Coef. r	0.92		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	55	240	964
0.1		22	96
0.01			8.6



ANALYTICAL METHOD: Not Specified

INDUSTRIAL OCCURRENCE OF AROCLOR 1254

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Aluminum Forming	4	3	0.29	63	22
Foundries (e)	53	16	3.0	1,400	<260
Metal Finishing (a) (d)	4	3	ND	1,100	390
Photographic Equipment/Supplies (b)	7	1		5.0	
Nonferrous Metals Manufacturing (c) (d)	75	1	ND	52	1.1
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	2	NA	NA	NA	0.01
Petroleum Refining (a)	17	4	<10	<10	<10
Pulp and Paperboard Mills (d)	87	20	ND	28	1.2

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Includes data for Aroclor 1221, 1242, and 1254.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF AROCLOR 1254

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Aluminum Forming	7	3	1.0	76	26
Foundries (d)	53	21	<5.0	650	<49
Nonferrous Metals Manufacturing (b) (c) (e)	55	0	ND	9.8	0.7
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Petroleum Refining (a)	17	4	<10	<10	<10
Pulp and Paperboard Mills (c)	78	12	ND	2.0	0.33

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Includes data for Aroclor 1221, 1242, and 1254.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR AROCLOR 1254

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	20	650	III.3.1.9
Oil Separation		2	97	BDL - 6.0	III.3.1.14

BDL, below detection limit; NM, not meaningful.

RESERVED

Compound: Aroclor 1260

Formula: A mixture of polychlorinated biphenyls which is approximately 60% chlorine by weight

Alternate Names: None

CAS #: 110-968-25

Physical, Chemical, and Biological Properties [1-2]:

molecular weight: 375.7*
melting point, °C: Not available
boiling point (760 torr), °C: 385-420
vapor pressure (25°C), torr: 4.05×10^{-5}
solubility in water (25°C), mg/L: 0.0027
log octanol/water partition coefficient: 7.14 (estimated)
Henry's law constant (25°C): 7.1×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.11.1-5

*Average.

Probable Fate [1-2]:

photolysis: Inhibited by presence of oxygen, but possibly the only degradative mechanism for highly chlorinated PCB's

oxidation: Not important

hydrolysis: Not important

volatilization: Slow volatilization distributes PCB's globally, but is inhibited by adsorption

sorption: PCB's are rapidly adsorbed onto solids, especially organic matter and are often immobilized in sediment, but may reenter solution

biological processes: Strong bioaccumulation: essentially non-biodegradable because of highly chlorinated isomer content

other reactions/interactions: Not important

Carbon Adsorption Data, Aroclor 1260 (1-8, 1-16):

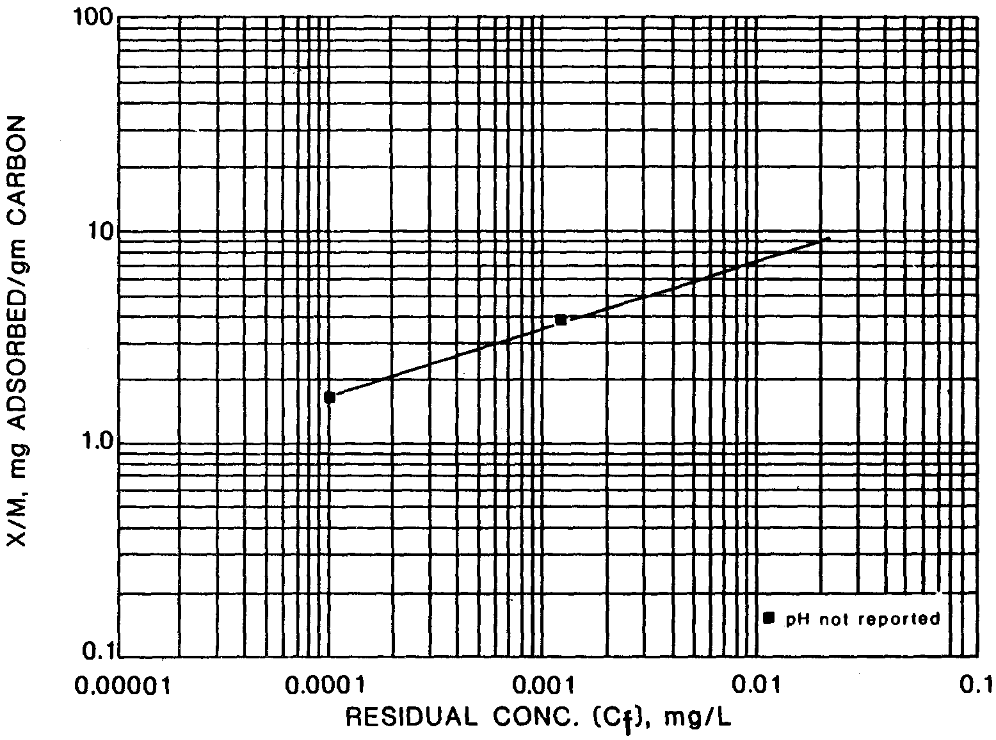
ADSORBABILITY

FREUNDLICH PARAMETERS	pH		
	Not reported		
K	29.4		
1/n	0.30		
Corr. Coef. r	1.0		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	61	134	270
0.1		12	27
0.01			2.4



ANALYTICAL METHOD: Not specified.

INDUSTRIAL OCCURRENCE OF AROCLOR 1260

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Aluminum Forming	3	2	0.16	27	14
Foundries (c)	53	17	<5.0	830	<160
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	9	0			
Petroleum Refining (a)	17	4	<10	<10	<10

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Includes data for Aroclor 1016, 1232, 1248, and 1260.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF AROCLOR 1260

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Aluminum Forming	4	3	0.41	1.6	1.0
Foundries (b)	53	13	<5.0	480	<58
Ore Mining and Dressing (a)	6	0			
Petroleum Refining (a)	17	4	<10	<10	<10

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Includes data for Aroclor 1016, 1232, 1248, and 1260.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR AROCLOR 1260

Treatment process	Number of data points Pilot scale	Number of data points Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	16	480	III.3.1.9
Oil Separation		2	98	BDL - 8.0	III.3.1.14
Ultrafiltration		1	99*	BDL	III.3.1.21

BDL, below detection limit; NM, not meaningful; *approximate value.

RESERVED

Compound: Methyl chloride

Formula:

```
     H
     |
  Cl-C-H
     |
     H
```

Alternate Names: Chloromethane;
Monochloromethane

CAS #: 74-87-3

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 50.59
melting point, °C: -97.7
boiling point (760 torr), °C: -24.2
vapor pressure (20°C), torr: 3,765
solubility in water (20°C), mg/L: 6,450-7,250
log octanol/water partition coefficient: 0.91
Henry's law constant (25°C): 3.68×10^{-2} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Information lacking, probably unimportant

oxidation: Information lacking, probably unimportant

hydrolysis: Slow hydrolysis, unimportant in comparison to volatilization

volatilization: Volatilization to the atmosphere is rapid and is a major transport process for removal of methyl chloride

sorption: No data available, sorption onto sediments and suspended particulates probably unimportant

biological processes: Data lacking, biodegradation and bioaccumulation are not expected to be important fates

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF METHYL CHLORIDE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Electrical/Electronic Components (b)	3	0			
Foundries	53	0			
Metal Finishing (a) (d)	149	78	ND	4,700	600
Photographic Equipment/Supplies (c)	7	0			
Porcelain Enameling (e)	1	0			
Nonferrous Metals Manufacturing (d)	8	0			
Ore Mining and Dressing (a)	33	1		45	
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Methyl chloride was not detected during the screening program and was not detected in the verification program.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF METHYL CHLORIDE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Photographic Equipment/Supplies (b)	20	6	1.0	960	480
Nonferrous Metals Manufacturing	14	0			
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Textile Mills (a) (c)	64	1		20	

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR METHYL CHLORIDE

Treatment process	Number of data points Pilot scale	Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	NM	38	
Flotation		1	NM	30	III.3.1.10
Reverse Osmosis	1		NM	45	III.3.1.16
Sedimentation		3	84	BDL - 39	III.3.1.18

BDL, below detection limit; NM, not meaningful.

RESERVED

Compound: Methylene chloride

Formula:

```
   Cl
   |
Cl-C-H
   |
   H
```

Alternate Names: Dichloromethane; Methylene dichloride; Methane dichloride; Methylene bichloride

CAS #: 74-09-2

Physical, Chemical, and Biological Properties [1-7, 1-5]:

molecular weight: 84.94
melting point, °C: -95
boiling point (760 torr), °C: 39.8
vapor pressure (20°C), torr: 362
solubility in water (25°C), mg/L: 16,700
log octanol/water partition coefficient: 1.25
Henry's law constant (25°C): 3.19×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation.
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Photochemical reactions in aqueous media are probably unimportant

oxidation: Information lacking, probably unimportant

hydrolysis: Not important fate process

volatilization: Due to high vapor pressure, volatilization to the atmosphere is rapid and is a major transport process

sorption: Data lacking, sorption by inorganic and organic materials not expected to be important fate mechanism

biological processes: Data lacking, bioaccumulation not expected, biodegradation may be possible in acclimated systems

other reactions/interactions: Not important

Carbon Adsorption Data, Methylene chloride (1-8):

ADSORBABILITY

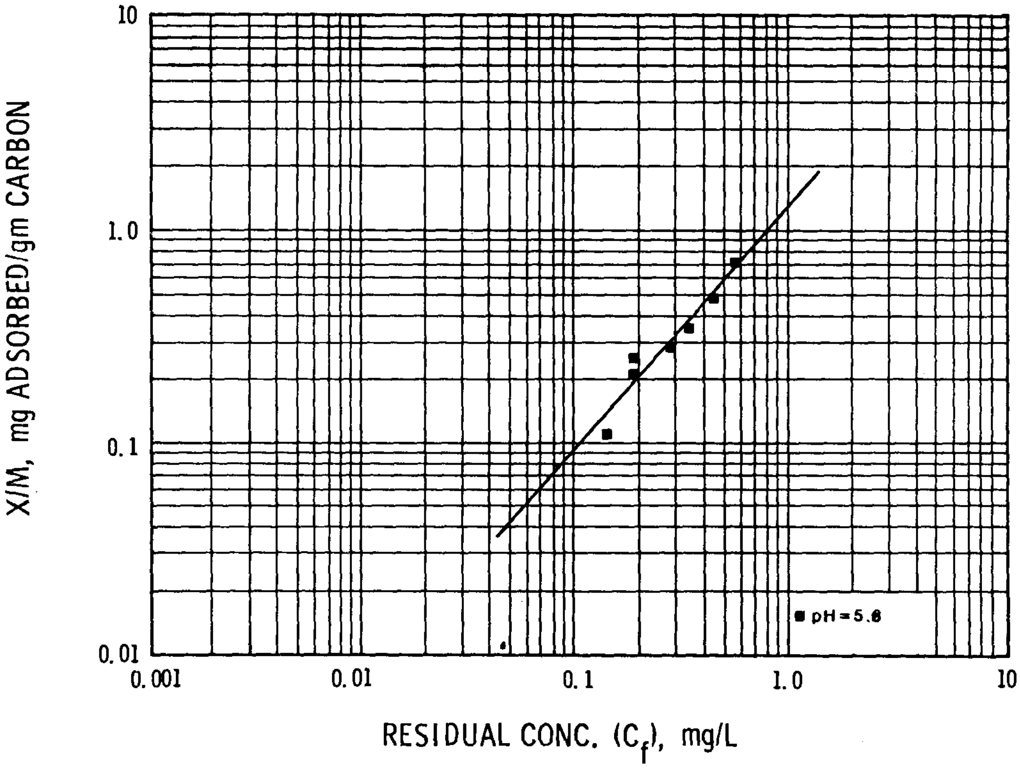
FREUNDLICH PARAMETERS	pH		
	5.8		
K	1.30		
1/n	1.16		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	10,000	>100,000	>100,000
0.1		14,000	>100,000
0.01			21,000

(a) Carbon doses in mg/L at pH 5.8



ANALYTICAL METHOD: G.C. - Purge and Trap

INDUSTRIAL OCCURRENCE OF METHYLENE CHLORIDE

	Raw wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	26	13	<0.4	540	<80
Coal Mining (b)	47	43	3.0	11,000	1,200
Inorganic Chemicals Manufacturing (b)	1	1		0.56	
Aluminum Forming	47	46	<2.0	2.1 x 10E5	<5,500
Battery Manufacturing (h) (i)	66	22	ND	30	<8.8
Electrical/Electronic Components (c)	28	18	7.5	2,400	<220
Foundries	53	13	1.0	2,400	260
Metal Finishing (b) (h)	162	109	ND	7,600	310
Photographic Equipment/Supplies (d)	44	14	0.01	53,000	5,400
Porcelain Enameling (j)	1	0			
Explosives Manufacturing	1	1		3.4 x 10E6	
Gum and Wood Chemicals	5	5	190	6,600	1,900
Pharmaceutical Manufacturing	6	6	110	80,000	19,000
Nonferrous Metals Manufacturing (f) (h)	80	11	ND	88,000	680
Organic Chemicals and Plastics and Synthetic Resins	49	NA	NA	NA	1,100
Paint and Ink Formulation (c)	31	22	1.0	1.3 x 10E5	7,800
Petroleum Refining (b)	16	11	3.0	1,600	>320
Pulp and Paperboard Mills (h)	154	73	ND	2,500	23
Rubber Processing	4	4	<0.1	<67	<19
Soap and Detergent Manufacturing (a)	3	3	1.1	59	26
Steam Electric Power Plants (e)	10	1		<10	
Textile Mills (b) (g)	75	22	3.0	2,600	140
Timber Products Processing	5	5	6.0	700	210

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.
(j) Methylene chloride was detected during the screening program, however, there is no verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating.

INDUSTRIAL OCCURRENCE OF METHYLENE CHLORIDE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	7	6	2.0	6,000	1,200
Coal Mining (b)	51	47	3.0	71,000	5,700
Iron and Steel Manufacturing (a)	6	6	<10	230	<48
Aluminum Forming	28	28	3.0	1,000	<220
Foundries	53	25	5.0	9,600	<540
Gum and Wood Chemicals	5	5	340	5,600	2,000
Pharmaceutical Manufacturing	5	5	10	8,100	1,600
Nonferrous Metals Manufacturing (e) (g)	71	10	ND	4,200	110
Organic Chemicals and Plastics and Synthetic Resins	41	NA	NA	NA	32
Paint and Ink Formulation (c)	19	15	29	31,000	5,000
Petroleum Refining (b)	16	13	3.0	>100	<43
Pulp and Paperboard Mills (g)	139	58	ND	3,100	14
Rubber Processing	4	4	<1.0	<340	<110
Steam Electric Power Plants (d)	12	2	10	32	21
Textile Mills (b) (f)	67	16	1.0	58	17
Timber Products Processing	5	5	13	1,900	560

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Verification data plus surveillance and analysis program data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR METHYLENE CHLORIDE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	9	2	0 - 92	1.8 - 940	
Chemical Oxidation					III.3.1.2
-ozone	2		NM	15 - 61	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		6	90 - >99	ND - 13,000	
-combined precipitants		4	13 - 94	330 - 9,800	
-lime		2	33	BDL - 2.0	
-sodium carbonate		1	NM	31	
-sodium hydroxide		2	90	1.0 - 90	
-unspecified		3	94	BDL - 130	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1		42	14	
Chemical Reduction		3	NM	ND - 60	III.3.1.4
Coagulation and Flocculation	1	2	56 - 90	70 - <630	III.3.1.5
Filtration	9	10	5 - >99	ND - 31,000	III.3.1.9
Flotation		5	0 - 84	2.0 - 6,000	III.3.1.10
Oil Separation		2	>17	330 - 630	III.3.1.14
Reverse Osmosis	5		0 - 64	4.0 - 6.0	III.3.1.16
Sedimentation	1	11	17 - >99	BDL -1,100	III.3.1.18
Stripping	5		54 - 87	90,000 - 3.0 x 10E5	III.3.1.19
Ultrafiltration		2	>57	<270 - 320	III.3.1.21
Activated Sludge		8	38 - 99	0.9 - 250	III.3.2.1
Lagoons					III.3.2.2
-aerated		7	0 - 97	<5.0 - 2,000	
Trickling Filters	1		NM	1.0	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: Chloroform

Formula:

```
      Cl
      |
   Cl-C-Cl
      |
      H
```

Alternate Names: Trichloromethane

CAS #: 67-66-3

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 119.4
melting point, °C: -63.5
boiling point (760 torr), °C: 61.7
vapor pressure (20°C), torr: 150
solubility in water (20°C), mg/L: 8,200
log octanol/water partition coefficient: 1.97
Henry's law constant (25°C): 3.39×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.12.3-5

Probable Fate [1-7, 1-20]:

photolysis: Not significant in aqueous systems

oxidation: Could be important in sunlight

hydrolysis: Not likely to occur

volatilization: Volatilization is a major transport process for removal of chloroform from aqueous mediums

sorption: Data lacking, sorption by inorganic and organic particulate materials not expected to be important fate mechanism

biological processes: Weak to moderate bioaccumulation, no biomagnification; may be biodegraded in acclimated sewage systems

other reactions/interactions: Not important

Carbon Adsorption Data, Chloroform (1-8):

ADSORBABILITY

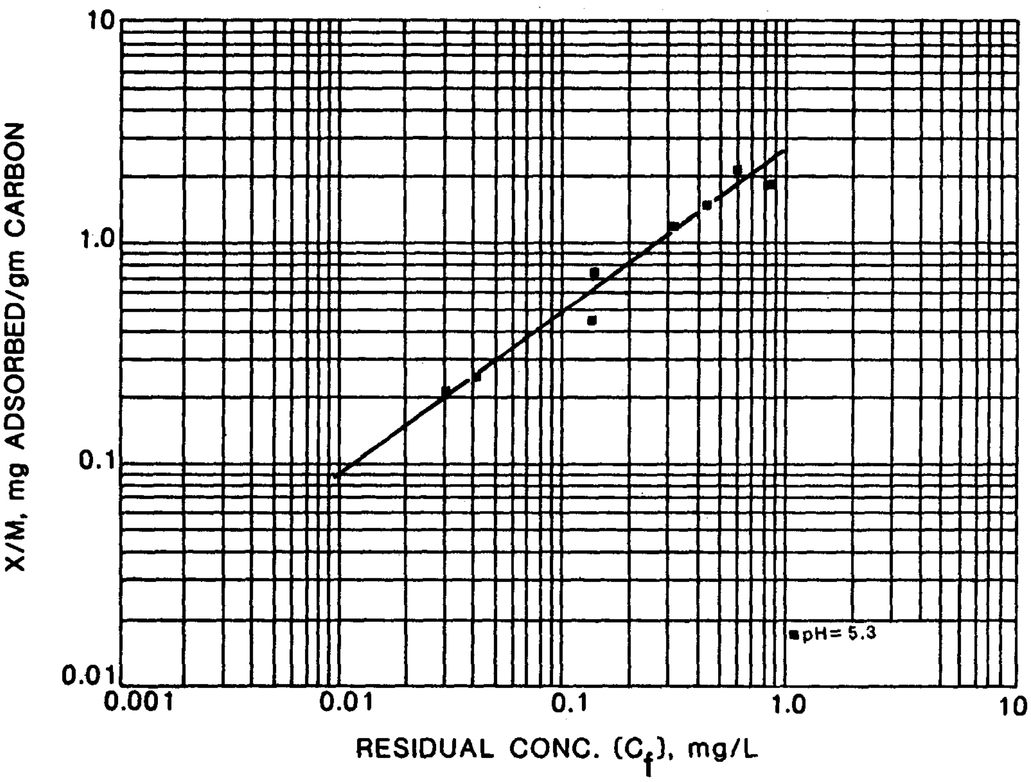
FREUNDLICH PARAMETERS	pH		
	5.3		
K	2.6		
1/n	0.73		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	1,900	11,000	50,000
0.1		1,000	6,000
0.01			540

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. Purge and Trap

INDUSTRIAL OCCURRENCE OF CHLOROFORM

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L — Minimum	Maximum	Mean
Auto and Other Laundries (a)	28	23	0.7	35,000	<2,700
Coal Mining (b)	47	25	3.0	480	95
Inorganic Chemicals Manufacturing (b)	1	1		85	
Iron and Steel Manufacturing (a)	34	29	<3	1,400	<110
Leather Tanning and Finishing	18	12	2.0	41	<17
Aluminum Forming	34	32	2.0	12,000	<400
Battery Manufacturing (h) (i)	13	6	ND	<10	<10
Electrical/Electronic Components (c)	28	15	5.5	50	<15
Foundries	53	11	1.0	470	<79
Metal Finishing (b) (h)	101	84	ND	690	31
Photographic Equipment/Supplies (d)	22	11	1.0	26	10
Porcelain Enameling	4	4	<10	<10	<10
Explosives Manufacturing	1	1		540	
Gum and Wood Chemicals	3	3	10	1,100	530
Pharmaceutical Manufacturing	6	6	10	2.8 × 10E5	35,000
Nonferrous Metals Manufacturing (f) (h)	95	32	ND	1,800	48
Ore Mining and Dressing (b)	32	9	NA	35	7.6
Organic Chemicals and Plastics and Synthetic Resins	58	NA	NA	NA	240
Paint and Ink Formulation (c)	29	17	<5.0	900	<150
Petroleum Refining (b)	16	9	<5.0	100	<41
Pulp and Paperboard Mills (h)	154	103	ND	9,700	510
Rubber Processing	5	5	1.9	27	8.5
Soap and Detergent Manufacturing (a)	2	2	1.1	4.8	3.0
Steam Electric Power Plants (e)	11	3	0.17	<10	<3.9
Textile Mills (b) (g)	78	34	1.0	640	77
Timber Products Processing	5	5	10	20	12

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating.

INDUSTRIAL OCCURRENCE OF CHLOROFORM

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	7	7	0.8	28	13
Coal Mining (b)	51	40	1.0	480	60
Iron and Steel Manufacturing (a)	27	23	5.0	280	<53
Leather Tanning and Finishing	6	3	<10	10	<10
Aluminum Forming	21	16	8.0	66	<21
Foundries	53	24	7.0	1,400	<150
Photographic Equipment/Supplies (d)	5	4	5.0	61	33
Gum and Wood Chemicals	2	2	10	1,100	560
Pharmaceutical Manufacturing	5	5	<1.0	170	<28
Nonferrous Metals Manufacturing (f) (h)	81	30	ND	2,900	98
Ore Mining and Dressing (b)	28	8	NA	10	5.1
Organic Chemicals and Plastics and Synthetic Resins	46	NA	NA	NA	6.3
Paint and Ink Formulation (c)	19	12	11	4,700	<450
Petroleum Refining (b)	16	7	<5.0	66	<20
Pulp and Paperboard Mills (h)	142	79	ND	1,200	31
Rubber Processing	5	5	0.93	4.1	1.9
Steam Electric Power Plants (e)	11	2	0.25	<10	<5.1
Textile Mills (b) (g)	95	19	2.0	1,000	78
Timber Products Processing	5	5	3.0	23	11

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CHLOROFORM

Treatment process	Number of data points Pilot scale	Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	1	1	74 - >99	ND - 18	
Chemical Oxidation					III.3.1.2
-ozone	1		NM	BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		7	46 - >99	ND - 550	
-combined precipitants		3	94	4.0 - 4,700	
-lime		6	>99	ND - BDL	
-sodium carbonate		1	33	2.0	
-sodium hydroxide		1	55	5.0	
-unspecified		1	NM	11	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1		NM	0.2	
Chemical Reduction		2	NM	BDL - 2.0	III.3.1.4
Coagulation and Flocculation		2	35	25 - 48	III.3.1.5
Filtration	2	9	50	BDL - 500	III.3.1.9
Flotation		6	20 - >99	ND - 24	III.3.1.10
Oil Separation		3	NM	20 - 67	III.3.1.14
Reverse Osmosis	5		0 - 93*	BDL - 31	III.3.1.16
Sedimentation		9	0 - 74	2.0 - 230	III.3.1.18
Stripping	5		49 - >99	ND - 65,000	III.3.1.19
Solvent Extraction		1	NM	ND	III.3.1.20
Ultrafiltration		2	>46	<43 - 62	III.3.1.21
Activated Sludge	1	20	9 - >99	ND - 58	III.3.2.1
Lagoons					III.3.2.2
-aerated		5	0 - >99	ND - 1,000	
Trickling Filters	1		NM	19	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to chloroform.

Freshwater Aquatic Life

The available data for chloroform indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 28,900 µg/L, and would occur at lower concentrations among species that are more sensitive than the three tested species. Twenty-seven-day LC50 values indicate that chronic toxicity occurs at concentrations as low as 1,240 µg/L, and could occur at lower concentrations among species or other life stages that are more sensitive than the earliest life cycle stage of the rainbow trout.

Saltwater Aquatic Life

The data base for saltwater species is limited to one test and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of chloroform through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration would be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 1.90 µg/L, 0.19 µg/L, and 0.019 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 157 µg/L, 15.7 µg/L, and 1.57 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Carbon tetrachloride

Formula:

```
   Cl
   |
Cl-C-Cl
   |
   Cl
```

Alternate Names: Tetrachloromethane; Methane tetrachloride; Perchloromethane; Benzinoform

CAS #: 56-23-5

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 153.8
melting point, °C: -22.9
boiling point (760 torr), °C: 76.5
vapor pressure (20°C), torr: 90
solubility in water (20°C), mg/L: 785
log octanol/water partition coefficient: 2.64
Henry's law constant (25°C): 30.2×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.12.4-5

Probable Fate [1-7]:

photolysis: Not important in aquatic environment

oxidation: Information not available for aquatic systems, slow rate of reaction with hydroxyl radicals

hydrolysis: Not likely to occur

volatilization: Volatilization is rapid and is an important transport process for the removal of tetrachloromethane from aquatic systems

sorption: Little data available, but adsorption onto sediments rich in organic material possible

biological processes: Weak to moderate bioaccumulation; no biomagnification; may be biodegraded in acclimated sewage systems

other reactions/interactions: Unknown

Carbon Adsorption Data, Carbon tetrachloride (1-8):

ADSORBABILITY

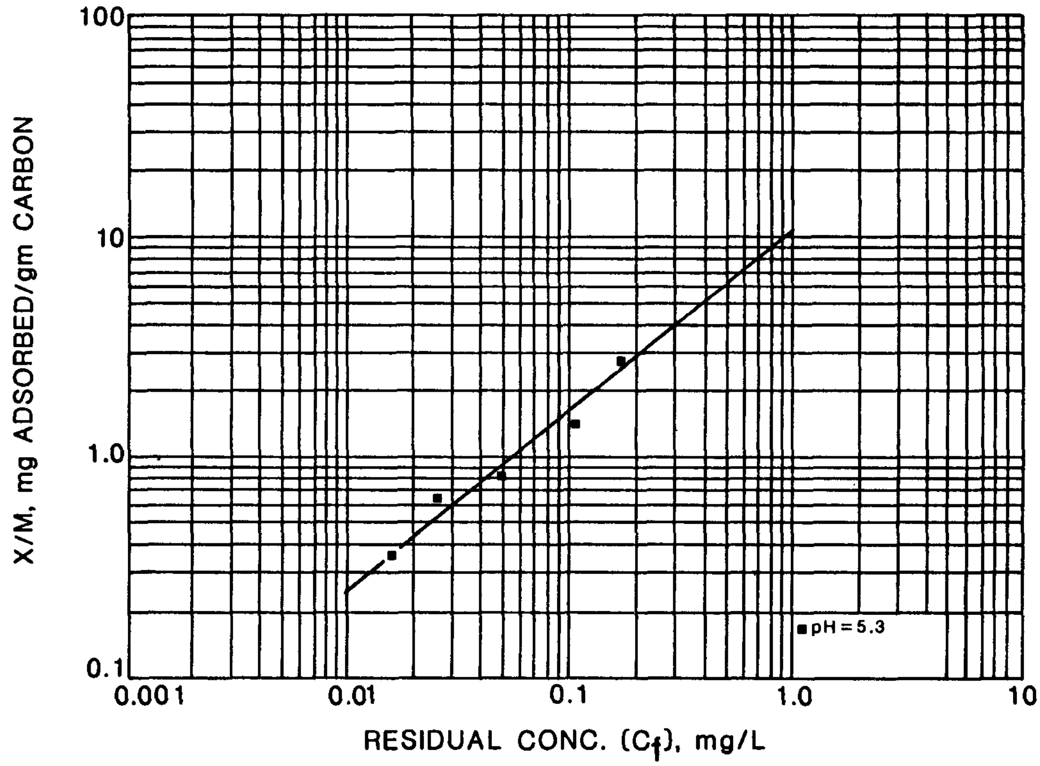
FREUNDLICH PARAMETERS	pH		
	5.3		
K	11.1		
1/n	0.83		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_0, mg/L	0.1	0.01	0.001
1.0	550	4,100	28,000
0.1		370	2,800
0.01			250

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. Purge and Trap

Date: 1/24/83

INDUSTRIAL OCCURRENCE OF CARBON TETRACHLORIDE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	2.0	850	430
Coal Mining (b)	47	0			
Inorganic Chemicals Manufacturing (b)	1	1		23	
Iron and Steel Manufacturing (a)	9	2	30	110	70
Electrical/Electronic Components (c)	3	0			
Foundries	53	15	<10	480	<44
Metal Finishing (b) (g)	88	65	ND	10,000	800
Photographic Equipment/Supplies (d)	6	1		3.6	
Porcelain Enameling (h)	1	1		<10	
Pharmaceutical Manufacturing	1	1		29	
Nonferrous Metals Manufacturing (f) (g)	59	8	ND	2,300	81
Ore Mining and Dressing (b)	33	1		1.0	
Organic Chemicals and Plastics and Synthetic Resins	32	NA	NA	NA	1,800
Paint and Ink Formulation (c)	26	10	1.0	30,000	<3,000
Petroleum Refining (b)	16	1		<10	
Rubber Processing	2	2	4.7	35	20
Steam Electric Power Plants (e)	11	1		<1.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Carbon tetrachloride was not detected during the screening program, and was not detected in the verification program.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF CARBON TETRACHLORIDE

Industry	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, μg/L		
			Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	1.0	200	100
Coal Mining (b)	51	0			
Iron and Steel Manufacturing (a)	6	1		40	
Foundries	53	7	<10	55	<16
Pharmaceutical Manufacturing	1	1		<1.0	
Nonferrous Metals Manufacturing (e) (f)	45	8	ND	1,700	89
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	25	NA	NA	NA	5.2
Paint and Ink Formulation	19	2	<65	1,800	<930
Petroleum Refining (b)	16	3	<10	<10	<10
Rubber Processing	2	2	<0.17	14	<7.1
Steam Electric Power Plants (d)	11	0			

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Verification data plus surveillance and analysis program data.
(e) Detections >10 μg/L.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CARBON TETRACHLORIDE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	2		64* - 64*	BDL - BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		2	94	<10 - 1,800	
-combined precipitants		4	>99 - >99	ND - 65	
-lime		3	NM	ND - BDL	
-sodium hydroxide		1	NM	ND	
-unspecified		1	>99	ND	
Chemical Reduction		1	NM	BDL	III.3.1.4
Filtration		3	89 - >99	ND - 55	III.3.1.9
Flotation		3	75	BDL - 210	III.3.1.10
Oil Separation		1	NM	43	III.3.1.14
Sedimentation		1	>99	ND	III.3.1.18
Activated Sludge	1	1	98	BDL - 0.1	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	NM	61	

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to carbon tetrachloride.

Freshwater Aquatic Life

The available date for carbon tetrachloride indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 35,200 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of carbon tetrachloride to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for carbon tetrachloride indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 50,000 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of carbon tetrachloride to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of carbon tetrachloride through ingestion of contaminated water and contaminated aquatic organisms the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 4.0 µg/L, 0.40 µg/L, and 0.04 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 69.4 µg/L, 6.94 µg/L, and 0.69 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. This risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Chloroethane

Formula:

```
   H H
   | |
 H-C-C-Cl
   | |
   H H
```

Alternate Names: Ethyl chloride; monochloroethane; Hydrochloric ether; Muriatic ether

CAS #: 75-00-3

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 64.52
melting point, °C: -136
boiling point (760 torr), °C: 12.3
vapor pressure (20°C), torr: 1,000
solubility in water (20°C), mg/L: 5,740
log octanol/water partition coefficient: 1.54
Henry's law constant (25°C): 1.46×10^{-2} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: See page I.12.5-5

Probable Fate [1-7]:

photolysis: Information not available pertaining to rate of photodissociation in aqueous environment

oxidation: Photooxidation in the aquatic environment probably occurs at a slow rate

hydrolysis: Probably cannot compete with volatilization

volatilization: Probable primary transport mechanism

sorption: No data available

biological processes: Data lacking, biodegradation may be possible in acclimated systems. Bioaccumulation is not expected to be important fate

other reactions/interactions: Unknown

Carbon Adsorption Data, Chloroethane (1-8):

ADSORBABILITY

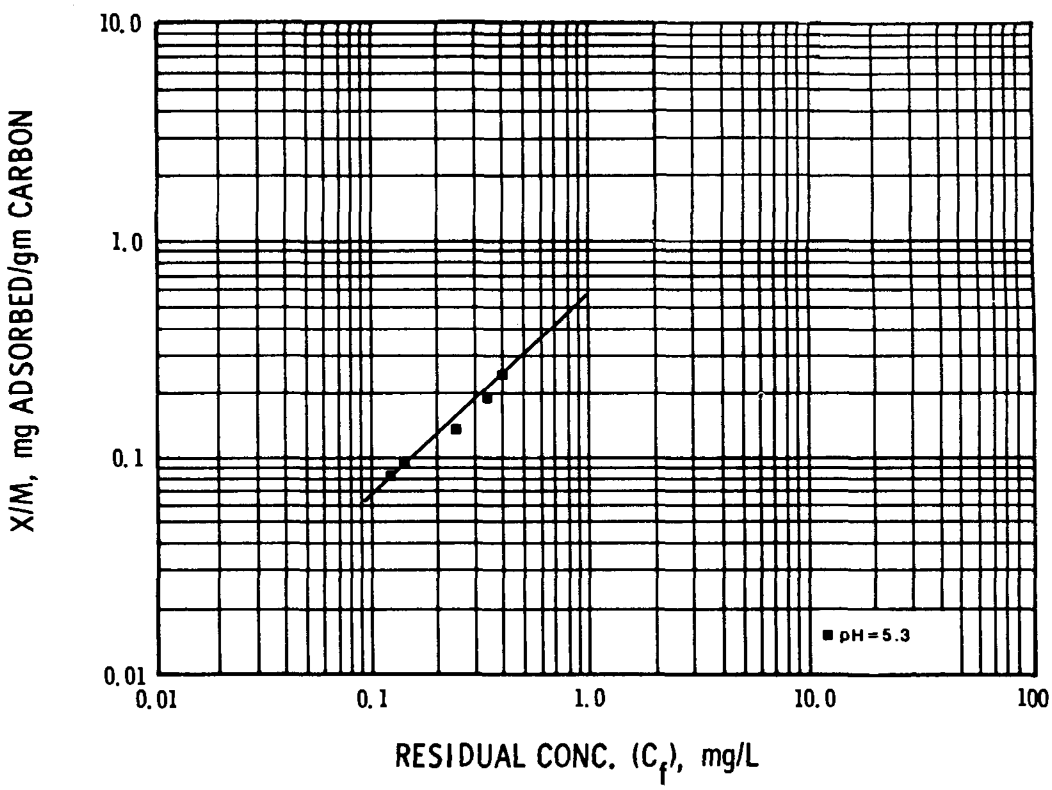
FREUNDLICH PARAMETERS	pH		
	5.3		
K	0.59		
1/n	0.95		
Corr. Coef. r	1.0		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	14,000	>100,000	>100,000
0.1		12,000	>100,000
0.01			11,000

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

INDUSTRIAL OCCURRENCE OF CHLOROETHANE

	Raw wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Foundries	53	0			
Photographic Equipment/Supplies (b)	7	0			
Pharmaceutical Manufacturing	2	2	8,000	13,000	10,000
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	41

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF CHLOROETHANE

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Gum and Wood Chemicals	1	1		520	
Pharmaceutical Manufacturing	2	2	100	410	260
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	8	NA	NA	NA	2.5

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CHLOROETHANE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption -granular	9		27 - >99	ND - 240,000	III.3.1.1
Chemical Precipitation with Sedimentation -alum	1		NM	17	III.3.1.3

ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to chlorinated ethanes.

Freshwater Aquatic Life

The available freshwater data for chlorinated ethanes indicate that toxicity increases greatly with increasing chlorination, and that acute toxicity occurs at concentrations as low as 118,000 µg/L for 1,2-dichloroethane, 18,000 µg/L for two trichloroethanes, 9,320 µg/L for two tetrachloroethanes, 7,240 µg/L for pentachloroethane, and 980 µg/L for hexachloroethane. Chronic toxicity occurs at concentrations as low as 20,000 µg/L for 1,2-dichloroethane, 9,400 µg/L for 1,1,2-trichloroethane, 2,400 µg/L for 1,1,2,2-tetrachloroethane, 1,100 µg/L for pentachloroethane, and 540 µg/L for hexachloroethane. Acute and chronic toxicity would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available saltwater data for chlorinated ethanes indicate that toxicity increases greatly wth increasing chlorination and that acute toxicity to fish and invertebrate species occurs at concentrations as low as 113,000 µg/L for 1,2-dichloroethane, 31,200 µg/L for 1,1,1-trichloroethane, 9,020 µg/L for 1,1,2,2-tetrachloroethane, 390 µg/L for pentachloroethane, and 940 µg/L for hexachloroethane. Chronic toxicity occurs at concentrations as low as 281 µg/L for pentachloroethane. Acute and chronic toxicity would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure to 1,2-dichloroethane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 9.4 µg/L, 0.94 µg/L, and 0.094 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 2,430 µg/L, 243 µg/L, and 24.3 µg/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the protection of human health from the toxic properties of 1,1,1-trichloroethane ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 18.4 mg/L.

For the protection of human health from the toxic properties of 1,1,1-trichloroethane ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 1.03 g/L.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 1,1,2-trichloroethane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 6.0 µg/L, 0.6 µg/L, and 0.06 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 418 µg/L, 41.8 µg/L, and 4.18 µg/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 1,1,2,2-tetrachloroethane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 1.7 µg/L, 0.17 µg/L, and 0.017 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 107 µg/L, 10.7 µg/L, and 1.07 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of hexachloroethane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 19 µg/L, 1.9 µg/L, and 0.19

µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 87.4 µg/L, 8.74 µg/L, and 0.87 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for monochloroethane.

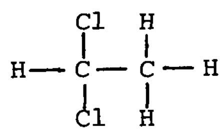
Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for 1,1-dichloroethane.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for 1,1,1,2-tetrachloroethane.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for pentachloroethane.

Compound: 1,1-Dichloroethane

Formula:



Alternate Names: Ethylidene chloride;
Ethylidene dichloride

CAS #: 75-34-3

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 98.96
melting point, °C: -97.0
boiling point (760 torr), °C: 57.3
vapor pressure (25°C), torr: 180
solubility in water (20°C), mg/L: 5,500
log octanol/water partition coefficient: 1.79
Henry's law constant (25°C): 5.45 x 10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.12.5-5

Probable Fate [1-7]:

photolysis: Information lacking

oxidation: Photooxidation in aquatic environment probably occurs at a slow rate

hydrolysis: Probably cannot compete with volatilization

volatilization: Owing to high vapor pressure, volatilization to the atmosphere should be major transport process

sorption: No data available

biological processes: Data lacking; bioaccumulation not expected, biodegradation may be possible in acclimated systems

other reactions/interactions: Unknown

Carbon Adsorption Data, 1,1-Dichloroethane (1-8):

ADSORBABILITY

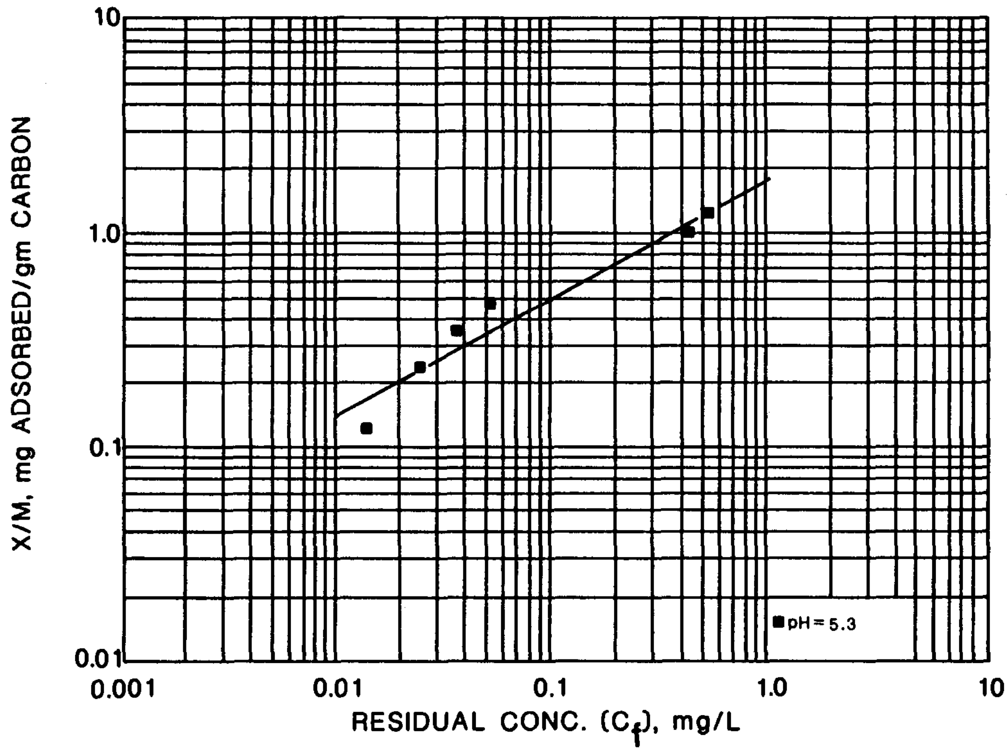
FREUNDLICH PARAMETERS	pH		
	5.3		
K	1.79		
1/n	0.53		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	1,700	6,500	22,000
0.1		600	2,200
0.01			200

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

Date: 1/24/83 I.12.6-2

INDUSTRIAL OCCURRENCE OF 1,1-DICHLOROETHANE

	Raw wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	0.5	<3.0	<1.8
Coal Mining (b)	47	0			
Leather Tanning and Finishing	21	1		20	
Aluminum Forming	1	1		100	
Battery Manufacturing (g) (h)	18	9	ND	30	<10
Coil Coating	18	1	77	77	77
Electrical/Electronic Components (c)	25	2	<10	10	<10
Foundries	53	1		55	
Metal Finishing (b) (g)	13	12	ND	1,100	420
Photographic Equipment/Supplies (d)	7	0			
Nonferrous Metals Manufacturing (e) (g)	19	1	ND	180	20
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	11	NA	NA	NA	200
Paint and Ink Formulation (c)	26	4	<5.0	16	<10
Pulp and Paperboard Mills (g)	12	3	5.0	22	12
Textile Mills (b) (f)	70	5	1.0	14	7.0

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF 1,1-DICHLOROETHANE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Aluminum Forming	1	0			
Coil Coating (f)	6	2	0.0	0.0	0.0
Foundries	53	0			
Nonferrous Metals Manufacturing (c) (e)	33	1	ND	20	1.4
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	10	NA	NA	NA	9.1
Paint and Ink Formulation (b)	18	2	<10	180	<95
Pulp and Paperboard Mills	12	0			
Textile Mills (a) (d)	64	1		2.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,1-DICHLOROETHANE

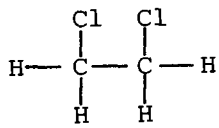
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	8	1	42 - >99	ND - 45,000	
Chemical Oxidation					III.3.1.2
-ozone	1		NM	BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-lime		1	NM	4.0	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1		NM	BDL	
Filtration	3	4	0 - >99	ND - 180	III.3.1.9
Oil Separation		1	NM	93	III.3.1.14
Sedimentation		1	0	2.0	III.3.1.18
Activated Sludge		3	>99 - >99	ND - ND	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: 1,2-Dichloroethane

Formula:



Alternate Names: Ethylene dichloride;
Glycol dichloride

CAS #: 107-06-2

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 98.98
melting point, °C: -35.4
boiling point (760 torr), °C: 83.5
vapor pressure (20°C), torr: 61
solubility in water (20°C), mg/L: 8,690
log octanol/water partition coefficient: 1.48
Henry's law constant (25°C): 1.10×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.12.5-5

Probable Fate [1-7]:

photolysis: Information not available

oxidation: Photooxidation in the aquatic environment occurs at a slow rate

hydrolysis: Hydrolysis is probably too slow to be an important process

volatilization: Due to high vapor pressure, volatilization to the atmosphere is rapid and is major transport process

sorption: Information not available

biological processes: May be biodegraded in acclimated systems

other reactions/interactions: Unknown

Carbon Adsorption Data, 1,2-Dichloroethane (1-8):

ADSORBABILITY

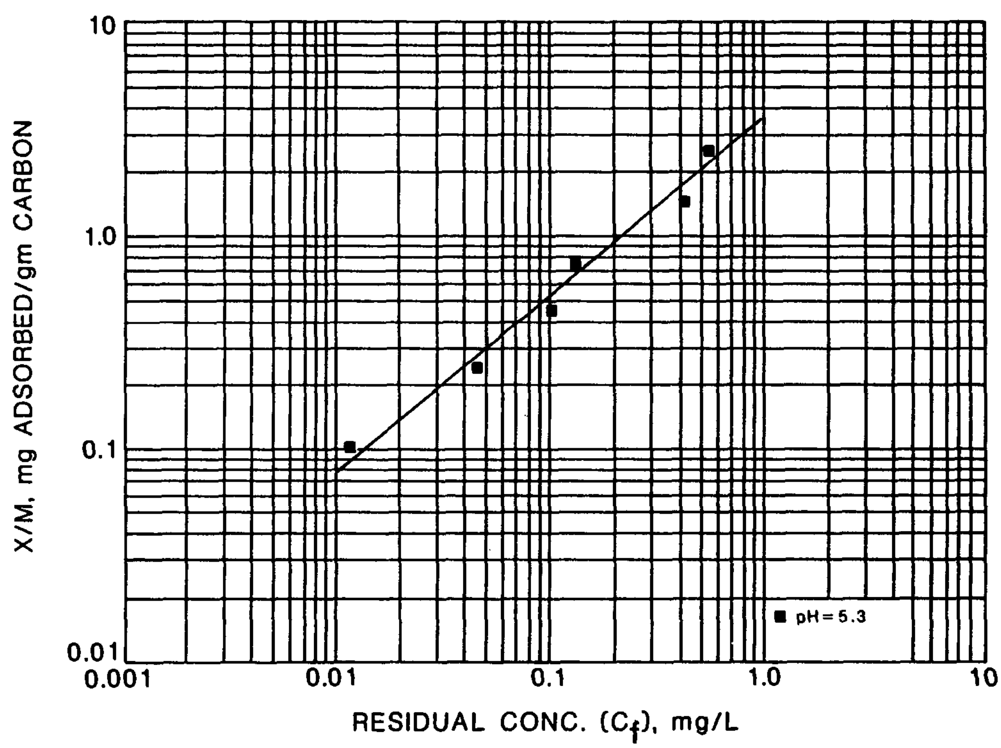
FREUNDLICH PARAMETERS	pH		
	5.3		
K	3.57		
1/n	0.83		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	1,700	13,000	86,000
0.1		1,200	8,600
0.01			780

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

INDUSTRIAL OCCURRENCE OF 1,2-DICHLOROETHANE

Industry	Number of samples	Number of detections	Raw wastewater Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	<2.0	500	<250
Coal Mining (b)	47	0			
Inorganic Chemicals Manufacturing (b)	1	1		79	
Leather Tanning and Finishing	18	0			
Electrical/Electronic Components (c)	3	1		<10	
Foundries	53	4	5.0	170	<49
Metal Finishing (b) (g)	13	10	ND	2,100	550
Photographic Equipment/Supplies (d)	26	17	0.02	6,000	2,400
Pharmaceutical Manufacturing	5	5	<1.0	14,000	<3,000
Nonferrous Metals Manufacturing (e) (g)	85	12	ND	560	21
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	29	NA	NA	NA	12,000
Paint and Ink Formulation (c)	26	8	<5.0	210	<58
Petroleum Refining (b)	16	1		16	
Pulp and Paperboard Mills (g)	15	3	ND	5.0	1.0
Textile Mills (b) (f)	70	2	4.0	6.0	5.0

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF 1,2-DICHLOROETHANE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	51	2	1.0	1.0	1.0
Foundries	53	2	<10	<10	<10
Photographic Equipment/Supplies (c)	17	11	0.23	80	24
Pharmaceutical Manufacturing	5	5	<1.0	300	<71
Nonferrous Metals Manufacturing (d) (e) (f)	70	8	ND	240	11
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	27	NA	NA	NA	180
Paint and Ink Formulation (b)	18	4	<5.0	170	<70
Petroleum Refining (a)	16	1		<10	
Pulp and Paperboard Mills (e)	15	3	ND	2	0.5

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Meanis not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,2-DICHLOROETHANE

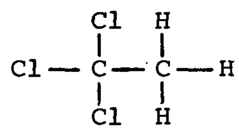
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	12		21 - >99	ND - 7.6 × 10E5	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		2	>99	ND - 90	
-combined precipitants		2	>99	ND - ND	
Filtration		1	NM	170	III.3.1.9
Stripping	6		70 - 99	22 - 4.4 × 10E5	III.3.1.19
Solvent Extraction	2		84 - >99	<20,000 - 97,000	III.3.1.20
Activated Sludge		3	>99	ND - 290	III.3.2.1

ND, not detected; NM, not meaningful.

RESERVED

Compound: 1,1,1-Trichloroethane

Formula:



Alternate Names: Methyl chloroform; Chlorotene; Genklene; Baltana

CAS #: 71-55-6

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 133.4
melting point, °C: -30.4
boiling point (760 torr), °C: 74.1
vapor pressure (20°C), torr: 96.0
solubility in water (20°C), mg/L: 480-4,400
log octanol/water partition coefficient: 2.17
Henry's law constant (25°C): 4.92×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, rapid adaptation
water quality criteria: See page I.12.5-5

Probable Fate [1-7]:

photolysis: Information lacking, does not appear to be a major aquatic fate

oxidation: Information lacking, probably not important aquatic fate

hydrolysis: Slow hydrolysis to acetic and hydrochloric acids and vinylidene chloride suggested

volatilization: Volatilization to the atmosphere is rapid and is a major transport process

sorption: Information lacking, may be important fate mechanism

biological processes: Information lacking, some bioaccumulation and biodegradation indicated for acclimated systems

other reactions/interactions: Unknown

Carbon Adsorption Data, 1,1,1-Trichloroethane (1-8):

ADSORBABILITY

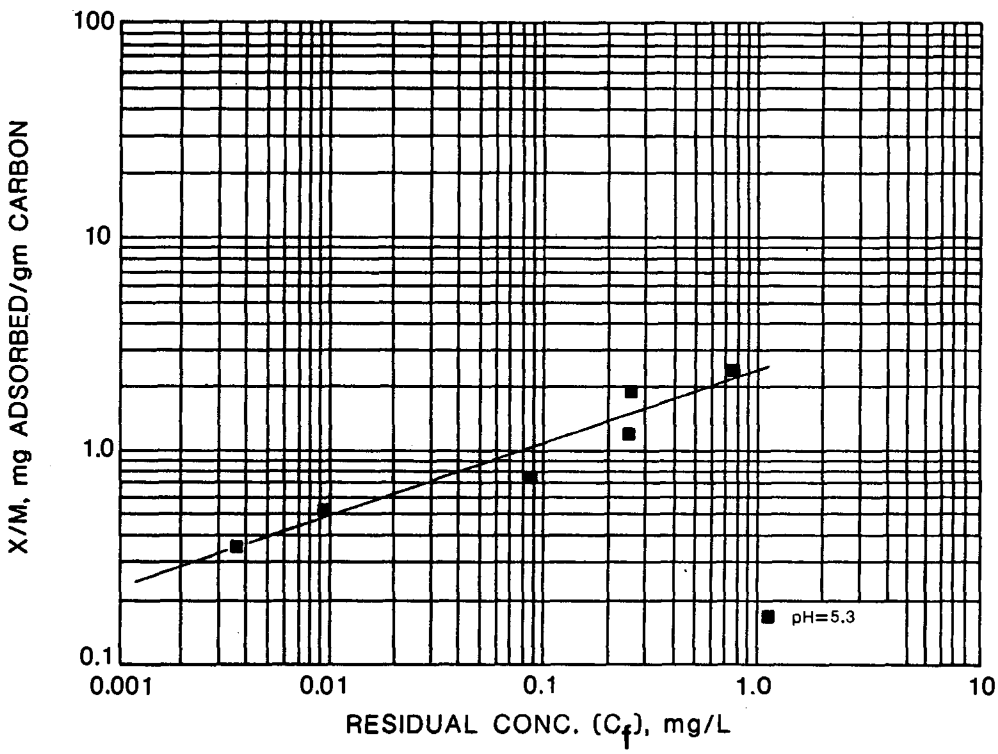
FREUNDLICH PARAMETERS	pH		
	5.3		
K	2.48		
1/n	0.34		
Corr. Coef. r	0.97		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	800	1,900	4,300
0.1		180	430
0.01			39

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C.-Purge and Trap

INDUSTRIAL OCCURRENCE OF 1,1,1-TRICHLOROETHANE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	19	9	<2.0	3,300	<660
Coal Mining (b)	47	4	3.0	23	8.0
Inorganic Chemicals Manufacturing (b)	1	1		0.14	
Iron and Steel Manufacturing (a)	9	7	<10	420	<110
Leather Tanning and Finishing	18	3	<10	10	<10
Aluminum Forming	1	1		530	
Battery Manufacturing (h) (i)	44	31	ND	30	<10
Coil Coating (j)	43	20	0.0	3,100	190
Electrical/Electronic Components (c)	28	12	3.0	7,700	<1,400
Foundries	53	10	<10	16,000	<1,600
Metal Finishing (b) (h)	94	78	ND	1.3 x 10E6	34,000
Photographic Equipment/Supplies (d) (j)	33	13	0.0	1,600	110
Porcelain Enameling (k)	1	1		<10	
Gum and Wood Chemicals	1	1		640	
Nonferrous Metals Manufacturing (f) (h)	58	5	ND	40	3.6
Ore Mining and Dressing (b)	33	9	NA	10	6.7
Organic Chemicals and Plastics and Synthetic Resins	33	NA	NA	NA	100
Paint and Ink Formulation (c)	26	14	5.0	500	<150
Petroleum Refining (b)	16	0			
Pulp and Paperboard Mills (h)	81	35	ND	2,000	130
Rubber Processing	1	1		1.1	
Steam Electric Power Plants (e)	11	1		0.68	
Textile Mills (b) (g)	73	21	2.0	1,200	89

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.
(j) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(k) 1,1,1-trichloroethane was not detected during the screening program and was not detected in the verification program.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF 1,1,1-TRICHLOROETHANE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Auto and Other Laundries (a)	3	2	14	860	440
Coal Mining (b)	51	11	1.0	3.0	2.0
Iron and Steel Manufacturing (a)	12	7	5.0	200	<46
Aluminum Forming	1	1		3.0	
Coil Coating (i)	9	3	0.0	21	6.8
Foundries	53	14	9.0	2,200	<180
Photographic Equipment/Supplies (d)	8	5	0.15	3.3	1.7
Gum and Wood Chemicals	1	1		830	
Nonferrous Metals Manufacturing (f) (h)	36	0	ND	10	1.5
Ore Mining and Dressing (b)	28	5	NA	10	7.3
Organic Chemicals and Plastics and Synthetic Resins	30	NA	NA	NA	5.7
Paint and Ink Formulation (c)	18	11	5.0	560	<92
Petroleum Refining (b)	16	0			
Pulp and Paperboard Mills (h)	72	12	ND	17	3.0
Rubber Processing	1	1		0.33	
Steam Electric Power Plants (e)	11	0			
Textile Mills (b) (g)	67	6	1.0	130	37

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,1,1-TRICHLOROETHANE

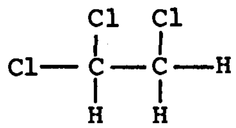
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	1	1	>99 - >99	ND - 1.9	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		3	>55	10 - <170	
-combined precipitants		3	NM	44 - 120	
-lime		6	NM	ND - 28	
-sodium hydroxide		2	0 - >99	ND - 1.0	
-unspecified		1	NM	0.1	
Chemical Reduction		2	75	0.3 - 1.0*	III.3.1.4
Filtration		9	86 - >99	ND - 4,400	III.3.1.9
Flotation		4	22 - >99	ND - 860	III.3.1.10
Oil Separation		1	NM	190	III.3.1.14
Sedimentation		6	19 - 88	2.0 - 2,500	III.3.1.18
Stripping	1		9	42,000	III.3.1.19
Ultrafiltration		1	99	5.0	III.3.1.21
Activated Sludge		8	94 - >99	ND - 33	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	96	22	

ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: 1,1,2-Trichloroethane

Formula:



Alternate Names: Vinyl trichloride

CAS #: 79-00-5

Physical, Chemical, and Biological Properties [1-7, 1-20, 1-28]:

molecular weight: 133.4
melting point, °C: -36.5
boiling point (760 torr), °C: 113
vapor pressure (20°C), torr: 19
solubility in water (20°C), mg/L: 4,500
log octanol/water partition coefficient: 2.17
Henry's law constant (25°C): 8.46×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: N-not significantly degraded
water quality criteria: See page I.12.5-5

Probable Fate [1-7]:

photolysis: No data available pertaining to rate of photolysis in aquatic environment

oxidation: Oxidation in aquatic systems not expected to be important fate

hydrolysis: Too slow to be significant

volatilization: Volatilization is important fate mechanism

sorption: Information lacking, may be important fate mechanism

biological processes: Bioaccumulation not important; resistant to degradation by microorganisms

other reactions/interactions: Information unavailable

Carbon Adsorption Data, 1,1,2-Trichloroethane (1-8):

ADSORBABILITY

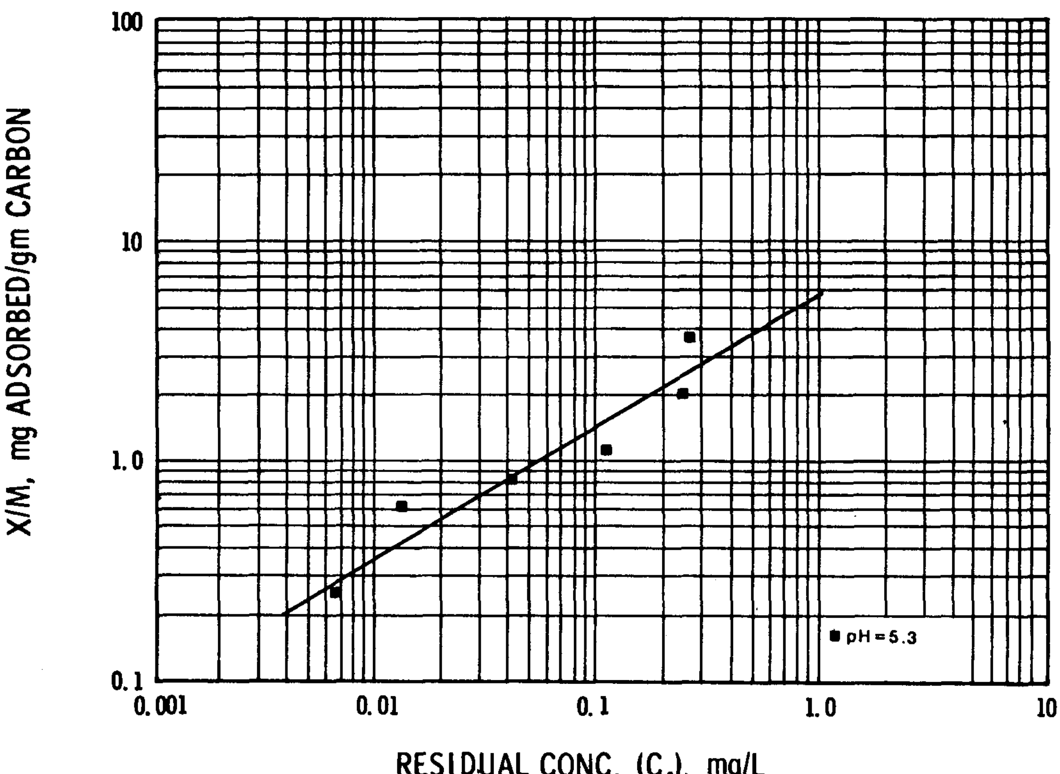
FREUNDLICH PARAMETERS	pH		
	5.3		
K	5.81		
1/n	0.60		
Corr. Coef. r	0.97		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	620	2,700	11,000
0.1		250	1,100
0.01			99

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. Purge and Trap

INDUSTRIAL OCCURRENCE OF 1,1,2-TRICHLOROETHANE

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L — Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	<0.7	3,000	<1,500
Coal Mining (b)	47	0			
Inorganic Chemicals Manufacturing (b)	1	1		0.4	
Leather Tanning and Finishing	18	1		10	
Electrical/Electronic Components (c)	3	0			
Foundries	53	3	<10	20	<13
Metal Finishing (b) (e)	97	61	ND	1,300	160
Photographic Equipment/Supplies (d)	7	0			
Porcelain Enameling	1	0			
Nonferrous Metals Manufacturing (e) (f)	72	2	ND	29	1.1
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	17	NA	NA	NA	130
Paint and Ink Formulation (c)	26	5	<5.0	2,800	<570
Rubber Processing	1	1		<0.1	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Pulp and Paperboard Mills.

RESERVED

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,1,2-TRICHLOROETHANE

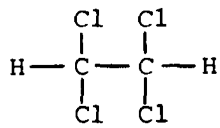
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	1		>99	ND	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	NM	<11	
-combined precipitants		4	>99 - >99	ND - <5.0	
-lime		1	NM	ND	
-sodium hydroxide		1	50	1.0	
Filtration		2	NM	7.0 - 2,100	III.3.1.9
Stripping	5		98 - >99	ND - 200	III.3.1.19
Solvent Extraction	1		90	16,000	III.3.1.20
Ultrafiltration		1	NM	ND	III.3.1.21
Activated Sludge	1		NM	BDL	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: 1,1,2,2-Tetrachloroethane

Formula:



Alternate Names: sym-Tetrachloroethane;
Acetylene tetrachloride

CAS #: 79-34-5

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 167.8
melting point, °C: -36
boiling point (760 torr), °C: 146
vapor pressure (20°C), torr: 5
solubility in water (20°C), mg/L: 2,900
log octanol/water partition coefficient: 2.56
Henry's law constant (25°C): 4.32×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: N-not significantly degraded
water quality criteria: See page I.12.5-5

Probable Fate [1-7]:

photolysis: Probably not significant in aquatic environment

oxidation: Not important in aquatic environment

hydrolysis: Too slow to be important

volatilization: Probable primary transport process

sorption: Data inconclusive

biological processes: Too slow to compete with volatilization

other reactions/interactions: Unknown

Carbon Adsorption Data, 1,1,2,2-Tetrachloroethane (1-8):

ADSORBABILITY

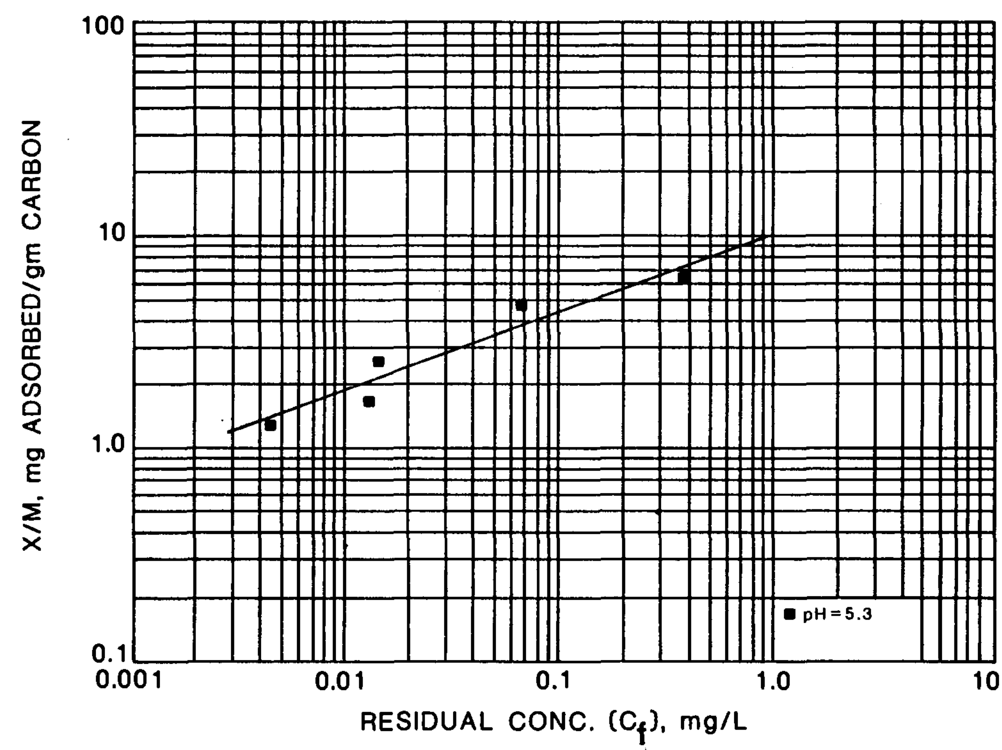
FREUNDLICH PARAMETERS	pH		
	5.3		
K	10.6		
1/n	0.37		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	200	510	1,200
0.1		50	120
0.01			11

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C.-Purge and Trap

INDUSTRIAL OCCURRENCE OF 1,1,2,2-TETRACHLOROETHANE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, μg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	47	0			
Inorganic Chemicals Manufacturing (b)	1	1		0.04	
Leather Tanning and Finishing	18	3	10	18	13
Foundries	53	1		<10	
Metal Finishing (b) (h)	6	4	ND	570	140
Photographic Equipment/Supplies (d)	7	0			
Porcelain Enameling (i)	2	2	<10	<10	<10
Nonferrous Metals Manufacturing (f) (h)	99	5	ND	35	2.5
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	12	NA	NA	NA	7.5
Paint and Ink Formulation (c)	1	0			
Petroleum Refining (b)	16	0			
Rubber Processing	1	1		<0.1	
Steam Electric Power Plants (e)	11	1		24	
Textile Mills (b) (g)	68	2	1.0	21	11

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 μg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) 1,1,2,2-Tetrachloroethane was not detected during the screening program and was not detected in the verification program.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Pulp and Paperboard Mills.

RESERVED

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,1,2,2-TETRACHLOROETHANE

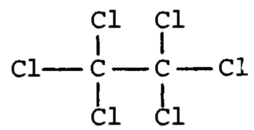
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	1		>99	680	
Filtration		2	NM	0.7 - 18	III.3.1.9
Stripping	5		99 - >99	ND - 78,000	III.3.1.19
Solvent Extraction	1		91	4,200	III.3.1.20
Ultrafiltration		1	NM	ND	III.3.1.21
Activated Sludge	1	1	>99	ND - BDL	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: Hexachloroethane

Formula:



Alternate Names: Perchloroethane;
Carbon hexachloride

CAS #: 67-72-1

Physical, Chemical, and Biological Properties [1-4, 1-7, 1-15]:

molecular weight: 236.7
melting point, °C: 187 (sealed tube)
boiling point (777 torr), °C: 186 (sublimes)
vapor pressure (20°C), torr: 0.4
solubility in water (22°C), mg/L: 50
log octanol/water partition coefficient: 3.34 (calculated)
Henry's law constant (25°C): 9.85×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.12.5-5

Probable Fate [1-7]:

photolysis: Not important in aquatic environment

oxidation: Not important in aquatic environment

hydrolysis: Information not available

volatilization: Some volatilization occurs, importance as a fate mechanism unknown

sorption: No data available

biological processes: High log octanol/water partition coefficient indicates possibility of bioaccumulation. Biodegradation may occur in acclimated systems

other reactions/interactions: Unknown

Carbon Adsorption Data, Hexachloroethane (1-8):

ADSORBABILITY

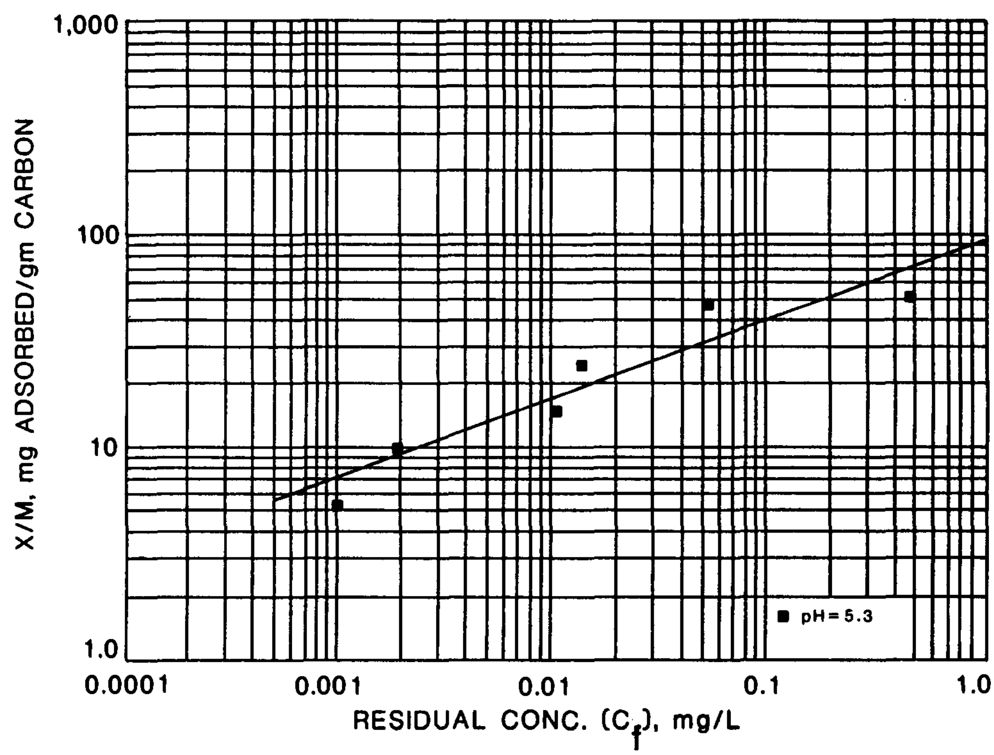
FREUNDLICH PARAMETERS	pH		
	5.3		
K	96.5		
1/n	0.38		
Corr. Coef. r	0.93		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	20	60	140
0.1		5.3	14
0.01			1.3

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

REMARKS: Compound contained an impurity which was estimated to be 20% using integrated areas from computer output.

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF HEXACHLOROETHANE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	49	0			
Inorganic Chemicals Manufacturing (b)	1	1		10	
Foundries	53	1		<10	
Photographic Equipment/Supplies (b)	13	1		49	
Nonferrous Metals Manufacturing (c) (d)	15	1	ND	23	1.5
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	2,200

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF HEXACHLOROETHANE

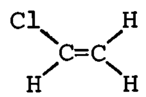
Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	53	1		3.0	
Foundries	53	0			
Photographic Equipment/Supplies (b)	2	1		1.0	
Nonferrous Metals Manufacturing (c) (d)	7	0	ND	5.0	NA
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	0.01

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: Vinyl chloride

Formula: 

Alternate Names: Chloroethene; Monochloroethylene; Monovinylchloride; MVC; Chloroethylene

CAS #: 75-01-4

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 62.50
melting point, °C: -154
boiling point (760 torr), °C: -13.4
vapor pressure (25°C), torr: 2,660
solubility in water (25°C), mg/L: 1.1
log octanol/water partition coefficient: 0.60
Henry's law constant (25°C): 3.6×10^{-2} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: See page I.12.12-5

Probable Fate [1-7]:

photolysis: Light-induced transformations of vinyl chloride can occur through indirect photolysis in water containing photosensitizers, direct photolysis insignificant

oxidation: Experiments indicate that vinyl chloride is decomposed in water by reactive radicals, when present in sufficient concentration

hydrolysis: Owing to rapid volatilization, hydrolysis should not be a significant aquatic fate

volatilization: Volatilization to the atmosphere is rapid and is a major transport process

sorption: Sorption by inorganic and organic materials not expected to be important fate mechanism

biological processes: Resistant to biodegradation. Bioaccumulation is not believed to be important fate process

other reactions/interactions: Vinyl chloride could be converted to more highly chlorinated compounds in aqueous environment where high concentrations of chlorine/chloride exist

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF VINYL CHLORIDE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (b)	47	0			
Foundries	53	0			
Photographic Equipment/Supplies (c) (e)	22	1		0.0	
Nonferrous Metals Manufacturing	9	0			
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	12	NA	NA	NA	750
Soap and Detergent Manufacturing (a)	1	1		12	
Textile Mills (b) (d)	70	1		11	

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Mean calculated using medians.
(e) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF VINYL CHLORIDE

Industry	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Nonferrous Metals Manufacturing	4	0			
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	29

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR VINYL CHLORIDE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption -granular	1		52	1,100	III.3.1.1

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to vinyl chloride.

Freshwater Aquatic Life

No freshwater organisms have been tested with vinyl cloride and no statement can be made concerning acute or chronic toxicity.

Saltwater Aquatic Life

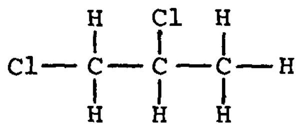
No saltwater organisms have been tested with vinyl chloride and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of vinyl chloride through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 20 μg/L, 2.0 μg/L, and 0.2 μg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, exlcuding consumption of water, the levels are 5,246 μg/L, 525 μg/L, and 52.5 μg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: 1,2-Dichloropropane

Formula:



Alternate Names: Propylene chloride;
Propylene dichloride

CAS #: 78-87-5

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 113.0
melting point, °C: -100
boiling point (760 torr), °C: 96.8
vapor pressure (20°C), torr: 42
solubility in water (20°C), mg/L: 2,700
log octanol/water partition coefficient: 2.28
Henry's law constant (25°C): 2.82×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-Significant degradation, gradual adaptation
water quality criteria: See page I.12.13-5

Probable Fate [1-7]:

photolysis: Unknown

oxidation: Unknown

hydrolysis: Probably cannot compete with volatilization

volatilization: Volatilization most important transport process

sorption: Potential adsorption on clays

biological processes: This compound can be used as a carbon source by several soil bacteria; biodegradation may be possible in acclimated systems

other reactions/interactions: Unknown

Carbon Adsorption Data, 1,2-Dichloropropane (1-8):

ADSORBABILITY

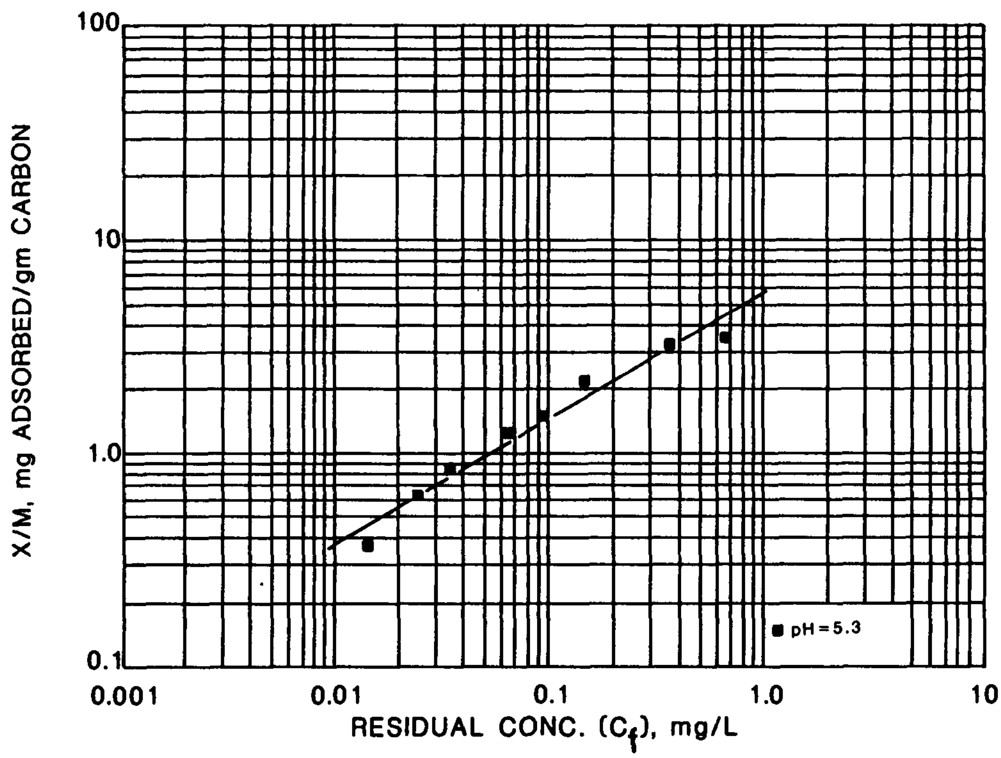
FREUNDLICH PARAMETERS	pH		
	5.3		
K	5.86		
1/n	0.60		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	600	2,700	11,000
0.1		240	1,100
0.01			96

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

INDUSTRIAL OCCURRENCE OF 1,2-DICHLOROPROPANE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Foundries	53	0			
Metal Finishing (a) (e)	7	4	ND	2.0	0.5
Photographic Equipment/Supplies (c)	6	1		37	
Ore Mining and Dressing (a)	32	0			
Organic Chemicals and Plastics and Synthetic Resins	14	NA	NA	NA	350
Paint and Ink Formulation (b)	25	4	<10	480	<130
Textile Mills (a) (d)	70	4	2.0	100	49

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 1,2-DICHLOROPROPANE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	14	NA	NA	NA	25
Paint and Ink Formulation (b)	18	2	12	200	110

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,2-DICHLOROPROPANE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	2		65* - >99	ND - BDL	
Chemical Precipitation with Sedimentation					III.3.1.3
-combined precipitants		1	58	200	
Filtration		1	NM	BDL	III.3.1.9
Flotation		1	NM	930	III.3.1.10
Activated Sludge		2	>99 - >99	ND - ND	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to dichloropropanes.

Freshwater Aquatic Life

The available data for dichloropropanes indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 23,000 and 5,700 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

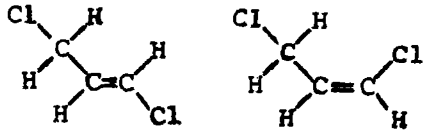
The available data for dichloropropanes indicate that acute and chronic toxicity to saltwater aquatic life occurs at concentrations as low as 10,300 and 3,040 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for dichloropropanes.

Compound: 1,3-Dichloropropene

Formula:



(*trans*) (*cis*)

Alternate Names: 1,3-Dichloropropylene

CAS #: 542-75-6

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 111.0
melting point, °C: Not available
boiling point (760 torr), °C: 104 (cis isomer); 112 (trans isomer)
vapor pressure (20°C), torr: 25
solubility in water (25°C), mg/L: 2,700 (cis isomer); 2,800 (trans isomer)
log octanol/water partition coefficient: 1.98
Henry's law constant (25°C): 3.55×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.12.14-5

Probable Fate [1-7]:

photolysis: No data available; direct photolysis of this compound in water expected to be slow

oxidation: Not important in aquatic environment

hydrolysis: Very slow hydrolysis to 3-chloroallyl alcohol occurs

volatilization: Volatilization should be a major transport process

sorption: Sorption occurs on soils, especially those high in organic content

biological processes: Bioaccumulation may occur but will be slight; microbial degradation possible especially in acclimated sewage systems

other reactions/interactions: Unknown

Carbon Adsorption Data, 1,3-Dichloropropene, (1,2-Dichloropropene) (1-8):

ADSORBABILITY

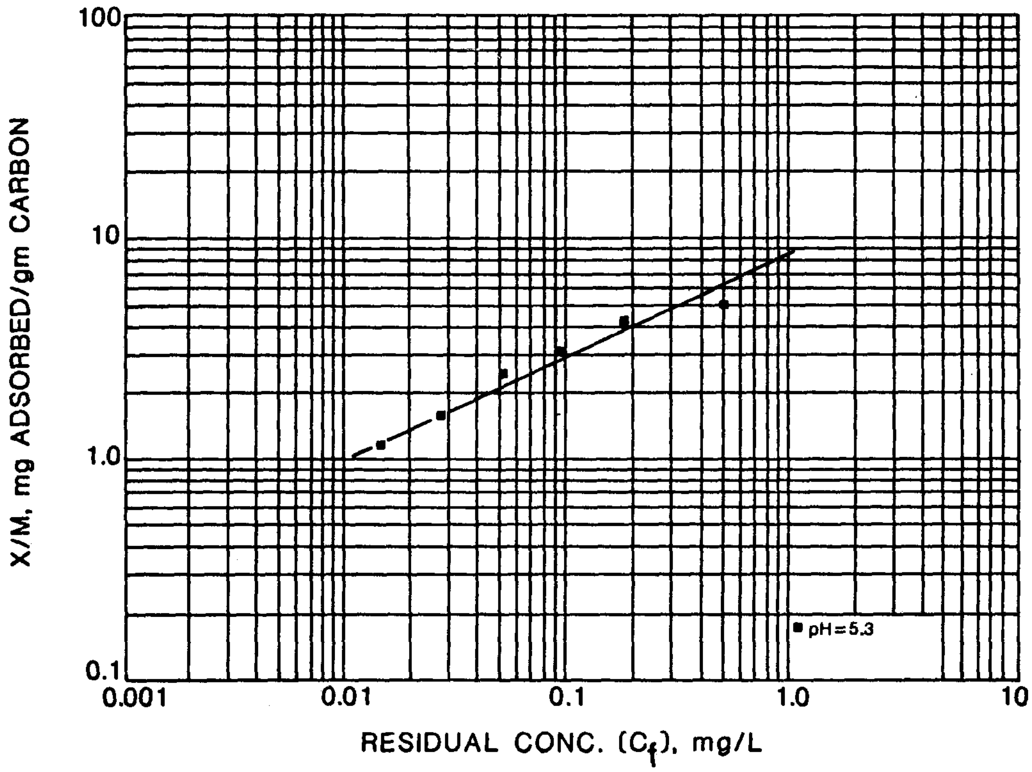
FREUNDLICH PARAMETERS	pH		
	5.3		
K	8.21		
1/n	0.46		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	320	1,000	3,000
0.1		93	300
0.01			27

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. Purge and Trap

INDUSTRIAL OCCURRENCE OF 1,3-DICHLOROPROPENE

	Raw wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Foundries	53	0			
Photographic Equipment/Supplies (c)	7	0			
Ore Mining and Dressing (a)	32	0			
Organic Chemicals and Plastics and Synthetic Resins	10	NA	NA	NA	3,400
Paint and Ink Formulation (b)	1	0			
Textile Mills (a) (d)	68	1		2.0	

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 1,3-DICHLOROPROPENE

Industry	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	10	NA	NA	NA	79
Paint and Ink Formulation (b)	1	0			
Textile Mills (a) (c)	62	2	1.0	10	6.0

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CIS 1,3-DICHLOROPROPENE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Sludge	1		NM	5.6	III.3.2.1

NM, not meaningful.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR TRANS 1,3-DICHLOROPROPENE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Sludge		1	NM	3.9	III.3.2.1

NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to dichloropropenes.

Freshwater Aquatic Life

The available data for dichloropropenes indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 6,060 and 244 μg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for dichloropropenes indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 790 μg/L, and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of dichloropropenes to sensitive saltwater aquatic life.

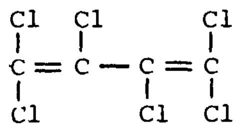
Human Health

For the protection of human health from the toxic properties of dichloropropenes ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 87 μg/L.

For the protection of human health from the toxic properties of dichloropropenes ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 14.1 mg/L.

Compound: Hexachlorobutadiene

Formula:



Alternate Names: HCBD; Hexachloro-1,3-butadiene

CAS #: 87-68-3

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 260.8
melting point °C: -21
boiling point (760 torr), °C: 215
vapor pressure (20°C), torr: 0.15
solubility in water (20°C), mg/L: 2
log octanol/water partition coefficient: 3.74
Henry's law constant (25°C): 10.3×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.12.15-5

Probable Fate [1-7]:

photolysis: Absorption of sunlight too weak to make photolysis important

oxidation: Information not available

hydrolysis: Information not available

volatilization: Volatilization may be an important transport process

sorption: Strongly adsorbed by humus and organic soil matter

biological processes: Bioaccumulation occurs in some aquatic organisms; no information on biodegradation in the environment; May occur in acclimated sewage systems

other reactions/interactions: Unknown

Carbon Adsorption Data, Hexachlorobutadiene (1-8):

ADSORBABILITY

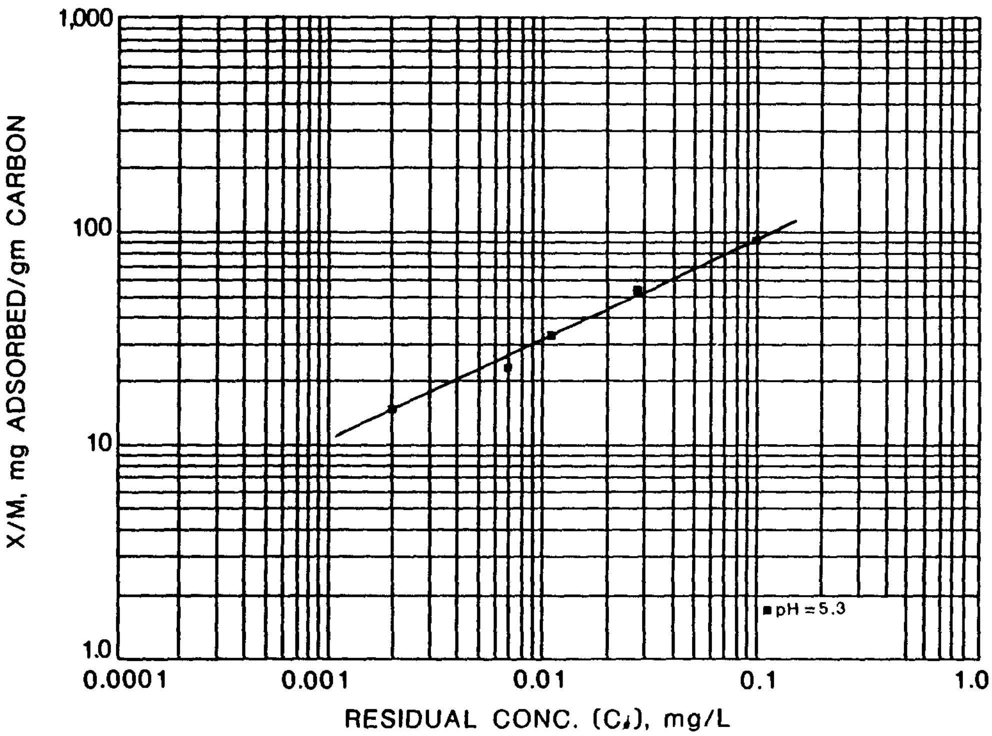
FREUNDLICH PARAMETERS	pH		
	5.3		
K	258		
1/n	0.45		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	9.8	30	87
0.1		2.8	8.6
0.01			0.78

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C.-Purge and Trap

Date: 1/24/83

INDUSTRIAL OCCURRENCE OF HEXACHLOROBUTADIENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Inorganic Chemicals Manufacturing (a)	1	1		4	
Foundries	53	0			
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	62

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF HEXACHLOROBUTADIENE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	0			
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	5	NA	NA	NA	0.01

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

RESERVED

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to hexachlorobutadiene.

Freshwater Aquatic Life

The available data for hexachlorobutadiene indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 90 and 9.3 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

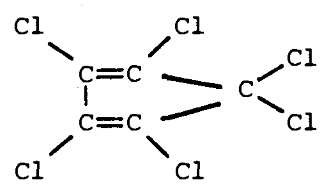
The available data for hexachlorobutadiene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 32 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of hexachlorobutadiene to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of hexachlorobutadiene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 4.47 µg/L, 0.45 µg/L, and 0.045 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 500 µg/L, 50 µg/L, and 5.0 µg/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Hexachlorocyclopentadiene

Formula:



Alternate Names: HCCPD;
Perchlorocyclopentadiene

CAS #: 77-47-4

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 272.8
melting point, °C: -9.9
boiling point (760 torr), °C: 239
vapor pressure (25°C), torr: 0.081
solubility in water (25°C), mg/L: 1.8
log octanol/water partition coefficient: 3.99
Henry's law constant (25°C): 16.4×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.12.16-5

Probable Fate [1-7]:

photolysis: Near-surface photolysis is an important process

oxidation: No specific data available

hydrolysis: Acid-catalyzed hydrolysis to tetrachlorocyclopentadienone could occur only if HCCPD is adsorbed onto clay surface

volatilization: Appears to be important in flowing waters

sorption: Based on data for hexachlorobutadiene, adsorption onto organic matter may be important

biological processes: Bioaccumulated in many organisms; biodegradation in the environment is unknown; may occur in acclimated sewage systems

other reactions/interactions: Not important

Carbon Adsorption Data, Hexachlorocyclopentadiene (1-8):

ADSORBABILITY

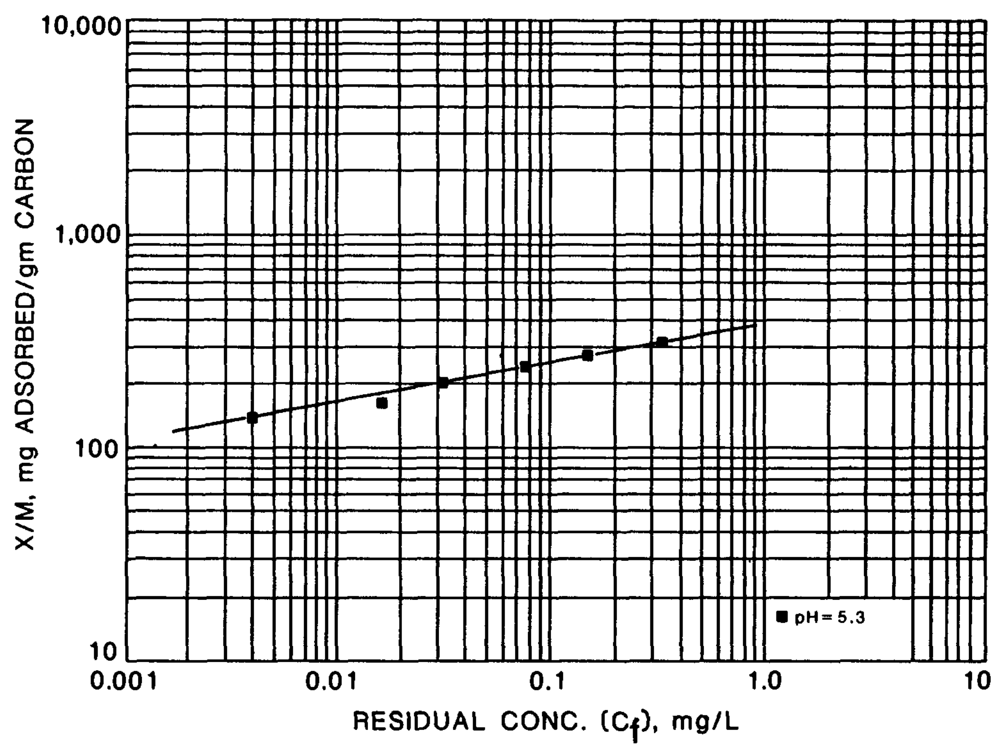
FREUNDLICH PARAMETERS	pH		
	5.3		
K	370		
1/n	0.17		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	3.6	5.9	8.9
0.1		0.54	0.88
0.01			0.08

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

INDUSTRIAL OCCURRENCE OF HEXACHLOROCYCLOPENTADIENE

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Foundries	53	1		<10	
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	33	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF HEXACHLOROCYCLOPENTADIENE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	0			
Ore Mining and Dressing (a)	28	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

RESERVED

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to hexachlorocyclopentadiene.

Freshwater Aquatic Life

The available data for hexachlorocyclopentadiene indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 7.0 and 5.2 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for hexachlorocyclopentadiene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 7.0 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of hexachlorocyclopentadiene to sensitive saltwater aquatic life.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for hexachlorocyclopentadiene. Based on available toxicity data, for the protection of public health, the derived level is 206 µg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1.0 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Compound: Methyl bromide

Formula:

```
  H
  |
H-C-Br
  |
  H
```

Alternate Names: Bromomethane; Terabol; Monobromomethane; Embafume

CAS #: 74-83-9

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 94.94
melting point, °C: -93.6
boiling point (760 torr), °C: 4.6
vapor pressure (20°C), torr: 1,420
solubility in water (20°C), mg/L: 900
log octanol/water partition coefficient: 1.1
Henry's law constant (25°C): 0.22 atmos. m^3 $mole^{-1}$ (calculated)
biodegradablilty: Not available
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Probably not significant in aquatic systems

oxidation: Information not available for the aquatic environment

hydrolysis: Unvolatilized methyl bromide should undergo hydrolysis with a half-life of less than 20 days

volatilization: Rapid volatilization is the dominant transport process

sorption: Too slow to compete with volatilization

biological processes: Not expected to be important; no data found

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF METHYL BROMIDE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Electrical/Electronic Components (b)	3	0			
Metal Finishing (a) (d)	7	4	ND	2.0	0.5
Photographic Equipment/Supplies (c)	7	0			
Ore Mining and Dressing (a)	33	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF METHYL BROMIDE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Ore Mining and Dressing (a)	28	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: Dichlorobromomethane

Formula:

```
    Br
    |
Cl-C-Cl
    |
    H
```

Alternate Names: Bromodichloromethane

CAS #: 75-27-4

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 163.8
melting point, °C: -57.1
boiling point (760 torr), °C: 90
vapor pressure (20°C), torr: 50
solubility in water (25°C), mg/L: Not available
log octanol/water partition coefficient: 1.88
Henry's law constant (25°C): 2.12×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.12.18-5

Probable Fate [1-7]:

photolysis: Information not available

oxidation: Information not available

hydrolysis: Too slow to be important

volatilization: Volatilization has been demonstrated, probably an important transport mechanism

sorption: No information, but adsorption onto activated carbon has been demonstrated

biological processes: Moderate potential for bioaccumulation; metabolization by some aquatic species is known to occur; biodegradation may occur in acclimated sewage systems

reactions/interactions: Dichlorobromomethane may be formed by a haloform reaction following chlorination of drinking water if sufficient bromide is present

Carbon Adsorption Data, Dichlorobromomethane (1-8):

ADSORBABILITY

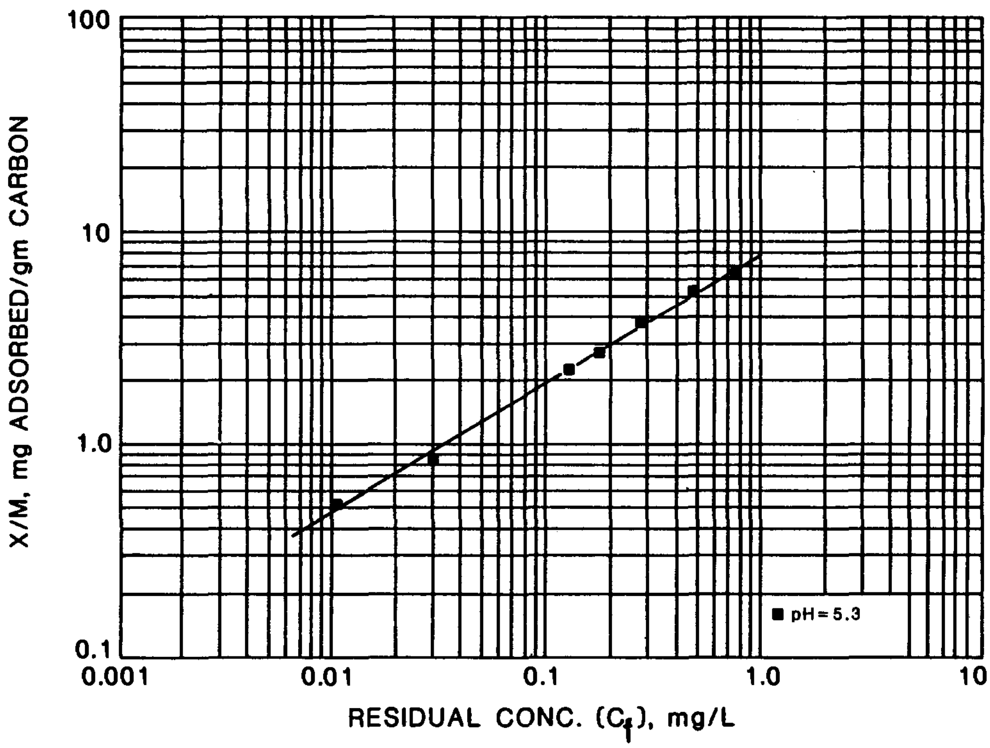
FREUNDLICH PARAMETERS	pH		
	5.3		
K	7.9		
1/n	0.61		
Corr. Coef. r	1.00		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	500	2,100	8,700
0.1		190	860
0.01			78

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

INDUSTRIAL OCCURRENCE OF DICHLOROBROMOMETHANE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, μg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	23	5	<0.9	27	<11
Coal Mining (b)	47	0			
Inorganic Chemicals Manufacturing (b)	1	1		35	
Leather Tanning and Finishing	18	2	10	10	10
Electrical/Electronic Components (c)	4	2	<6.0	<10	<8.0
Foundries	53	6	2.0	37	<12
Metal Finishing (b) (g)	18	11	ND	10	2.0
Photographic Equipment/Supplies (d)	22	2	0.03	0.47	0.25
Porcelain Enameling	3	3	<10	<10	<10
Pharmaceutical Manufacturing	1	1		<1.0	
Nonferrous Metals Manufacturing (e) (g)	68	3	ND	19	1.3
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	16	NA	NA	NA	15
Paint and Ink Formulation (c)	28	1		27	
Petroleum Refining (b)	16	1		24	
Pulp and Paperboard Mills (g)	54	1	ND	14	6.9
Rubber Processing	1	1		<0.33	
Textile Mills (b) (f)	70	1		7.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 μg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating.

INDUSTRIAL OCCURRENCE OF DICHLOROBROMOMETHANE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	6	0			
Coal Mining (b)	51	0			
Foundries	53	5	<10	23	<13
Pharmaceutical Manufacturing	1	1		<1.0	
Nonferrous Metals Manufacturing (d) (f)	60	5	ND	18	3.0
Ore Mining and Dressing (b)	28	2	NA	10	6.6
Organic Chemicals and Plastics and Synthetic Resins	11	NA	NA	NA	7.3
Paint and Ink Formulation (c)	18	0			
Petroleum Refining (b)	16	0			
Pulp and Paperboard Mills (f)	45	4	ND	5.0	0.5
Rubber Processing	1	1		<0.13	
Textile Mills (b) (e)	64	2	2.0	10	6.0
Timber Products Processing	2	2	10	10	10

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR DICHLOROBROMOMETHANE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Activated Carbon Adsorption -granular	1		NM	BDL	III.3.1.1
Filtration	1	1	NM	BDL - <10	III.3.1.9
Flotation		1	>99	ND	III.3.1.10
Sedimentation		1	NM	2.0	III.3.1.18
Activated Sludge	1	2	>99	ND - 1.5	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to halomethanes.

Freshwater Aquatic Life

The available data for halomethanes indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 11,000 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of halomethanes to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for halomethanes indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 12,000 and 6,400 μg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. A decrease in algal cell numbers occurs at concentrations as low as 11,500 μg/L.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of chloromethane, bromomethane, dichloromethane, bromodichloromethane, tribromomethane, dichlorodifluoromethane, trichlorofluoromethane, or combinations of these chemicals through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 1.9 μg/L, 0.19 μg/L, and 0.019 μg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 157 μg/L, 15.7 μg/L, and 1.57 μg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Chlorodibromomethane

Formula:

```
      Br
      |
   Br-C-Cl
      |
      H
```

Alternate Names: Dibromochloromethane

CAS #: 124-48-1

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 208.3
melting point, °C: <-20
boiling point (48 torr), °C: 119-120
vapor pressure (10.5°C), torr: 15
solubility in water (temp. unknown), mg/L: Not available
log octanol/water partition coefficient: 2.09
Henry's law constant (25°C): 0.783×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Information not available

oxidation: Information not available; not likely to occur

hydrolysis: Too slow to be important

volatilization: Volatilization has been demonstrated, probable important transport mechanism

sorption: No information, but adsorption onto activated carbon has been demonstrated

biological processes: Information not available, but bioaccumulation may occur; resistant to microbial degradation

other reactions/interactions: May be formed by haloform reaction after chlorination of water if sufficient bromide is present

Carbon Adsorption Data, Chlorodibromomethane (1-8):

ADSORBABILITY

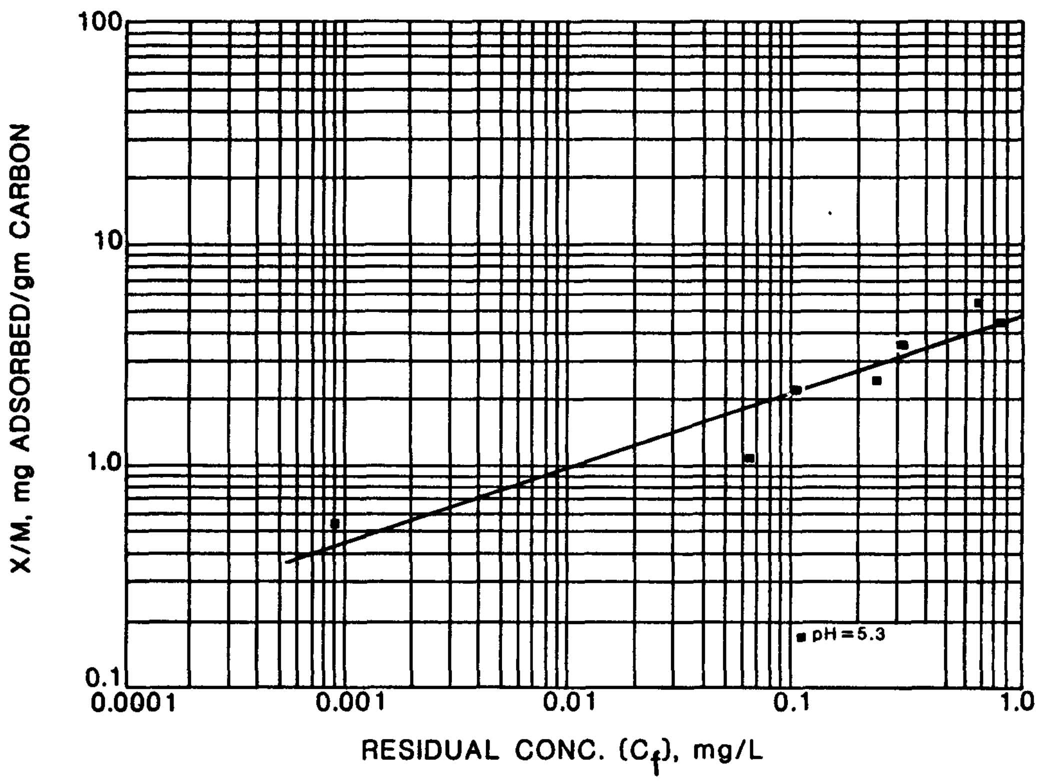
FREUNDLICH PARAMETERS	pH		
	5.3		
K	4.8		
1/n	0.34		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	410	980	2,200
0.1		89	210
0.01			19

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. Purge and Trap

INDUSTRIAL OCCURRENCE OF CHLORODIBROMOMETHANE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	5	3	<0.3	12	<5.4
Coal Mining (b)	47	0			
Inorganic Chemicals Manufacturing (b)	1	1		2	
Electrical/Electronic Components (c)	28	5	5.0	<10	<9.0
Foundries	53	1		<10	
Metal Finishing (b) (f)	16	10	ND	10	2.0
Photographic Equipment/Supplies (d)	22	10	1.4	12	5.2
Nonferrous Metals Manufacturing (e) (f)	68	6	ND	81	5.4
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	12	NA	NA	NA	11
Paint and Ink Formulation (c)	26	2	22	43	32
Pulp and Paperboard Mills (f)	12	1	ND	5.0	1.5

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF CHLORODIBROMOMETHANE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	1		<10	
Photographic Equipment/Supplies (c)	3	3	32	32	32
Nonferrous Metals Manufacturing (d) (f)	36	5	ND	2,800	250
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	6.7
Paint and Ink Formulation (b)	19	0			
Pulp and Paperboard Mills	3	0			
Textile Mills (a) (e)	62	1		1.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CHLORODIBROMOMETHANE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Chemical Precipitation with Sedimentation					III.3.1.3
-alum	1		NM	ND	
Coagulation and Flocculation	1		75*	BDL	III.3.1.5
Filtration		1	NM	<10	III.3.1.9
Sedimentation		3	>99	ND - 1.0*	III.3.1.18

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: Bromoform

Formula:

```
   Br
   |
Br-C-Br
   |
   H
```

Alternate Names: Tribromomethane; Methenyl tribromide

CAS #: 75-25-2

Physical, Chemical, and Biological Properties [1-7, 1-15]

molecular weight: 252.8
melting point, °C: 8.3
boiling point (760 torr), °C: 150
vapor pressure (34°C), torr: 10
solubility in water, mg/L: 3,010 at 15°C; 3,190 at 30°C
log octanol/water partition coefficient: 2.30
Henry's law constant (25°C): 0.532 x 10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: Not included

Probable Fate [1-7]:

photolysis: Information not available for aquatic environment

oxidation: Information not available for aquatic environment

hydrolysis: Much too slow to be important

volatilization: Specific information not available; some volatilization may occur

sorption: Specific information not available; carbon data suggests that some sorption may occur on other particulates

biological processes: Specific information not available; potential for bioaccumulation; appears to be resistant to microbial degradation

other reactions/interactions: Possibly produced by haloform reaction

Carbon Adsorption Data, Bromoform (1-8):

ADSORBABILITY

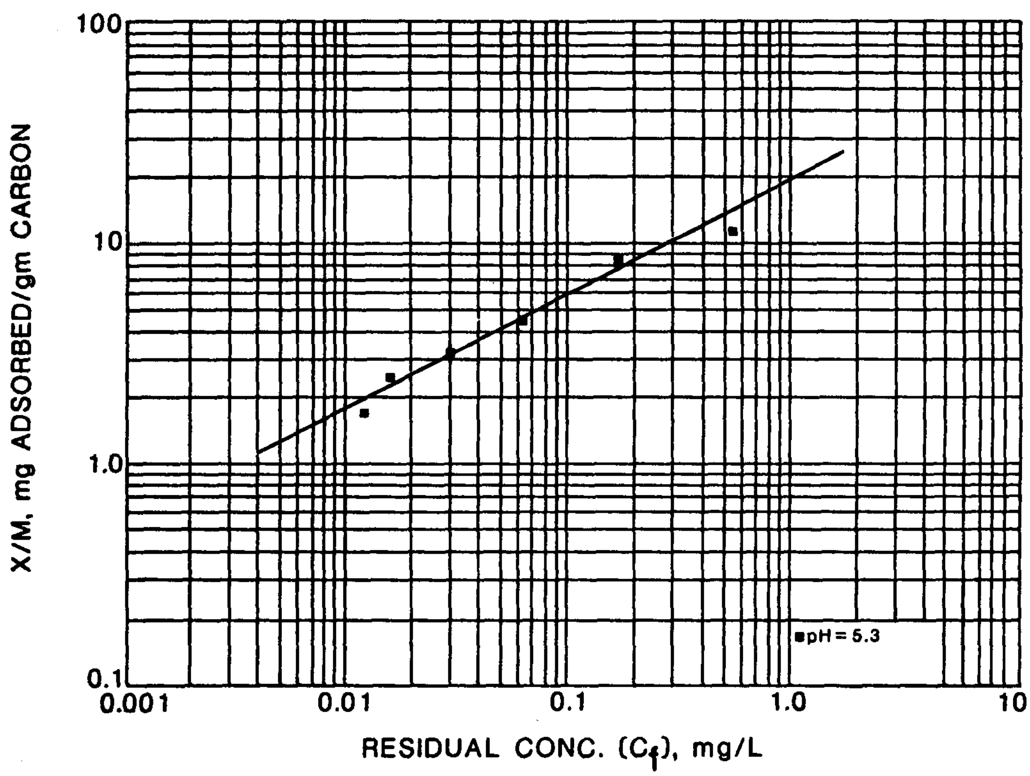
FREUNDLICH PARAMETERS	pH		
	5.3		
K	19.6		
1/n	0.52		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	150	560	1,900
0.1		51	190
0.01			17

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. Purge and Trap

INDUSTRIAL OCCURRENCE OF BROMOFORM

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Inorganic Chemicals Manufacturing (a)	1	1		0.06	
Foundries	53	2	<10	<10	<10
Metal Finishing (a) (d)	5	3	ND	10	3
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d)	66	5	ND	65	6.8
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	7.5
Pulp and Paperboard Mills (d)	18	1	ND	120	20

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF BROMOFORM

		Treated wastewater			
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Nonferrous Metals Manufacturing (b) (c)	49	3	ND	44	2.1
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	4	NA	NA	NA	7.5
Pulp and Paperboard Mills (c)	18	1	ND	62	10

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BROMOFORM

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Activated Sludge		1	NM	3.0	III.3.2.1

NM, not meaningful.

RESERVED

Compound: Dichlorodifluoromethane

Formula:

```
   Cl
   |
F--C--Cl
   |
   F
```

Alternate Names: Fluorocarbon-12;
Freon-12

CAS #: 75-71-8

Physical, Chemical, and Biological Properties [1-7, 1-28]:

molecular weight: 129.9
melting point, °C: -158
boiling point (760 torr), °C: -29.8
vapor pressure (20°C), torr: 4,306
solubility in water (25°C), mg/L: 280
log octanol/water partition coefficient: 2.16
Henry's law constant (25°C): 2.88 atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: See page I.12.18-5

Probable Fate [1-7]:

photolysis: Probably not important in aquatic systems

oxidation: Not important in aquatic systems

hydrolysis: Too slow to be important

volatilization: Very rapid volatilization removes most of the compound from water

sorption: Some potential for adsorption exists, but is greatly limited by volatilization

biological processes: Potential for bioaccumulation and transformation is offset by volatilization

other reactions/interactions: Not important

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF DICHLORODIFLUOROMETHANE

Industry	Raw wastewater: Number of samples	Raw wastewater: Number of detections	Detected concentrations, µg/L: Minimum	Detected concentrations, µg/L: Maximum	Detected concentrations, µg/L: Mean
Coal Mining (a)	47	0			
Foundries	53	0			
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	33	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF DICHLORODIFLUOROMETHANE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	51	0			
Foundries	53	0			
Ore Mining and Dressing (a)	28	0			

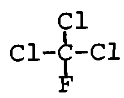
See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: Trichlorofluoromethane

Formula:



Alternate Names: Fluorocarbon-11;
Freon-11

CAS #: 75-69-4

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 137.4
melting point, °C: -111
boiling point (760 torr), °C: 23.8
vapor pressure (20°C), torr: 667
solubility in water (25°C), mg/L: 1,100
log octanol/water partition coefficient: 2.53
Henry's law constant (25°C): 58.3×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.12.18-5

Probable Fate [1-7]:

photolysis: Not important in aquatic systems

oxidation: Not expected to be important

hydrolysis: Not important under environmental conditions

volatilization: Rapid volatilization is the major transport process

sorption: Potential for adsorption is greatly limited by volatilization

biological processes: Rapid volatilization precludes bioaccumulation or degradation

other reactions/interactions: Not important

Carbon Adsorption Data, Trichlorofluoromethane (1-8):

ADSORBABILITY

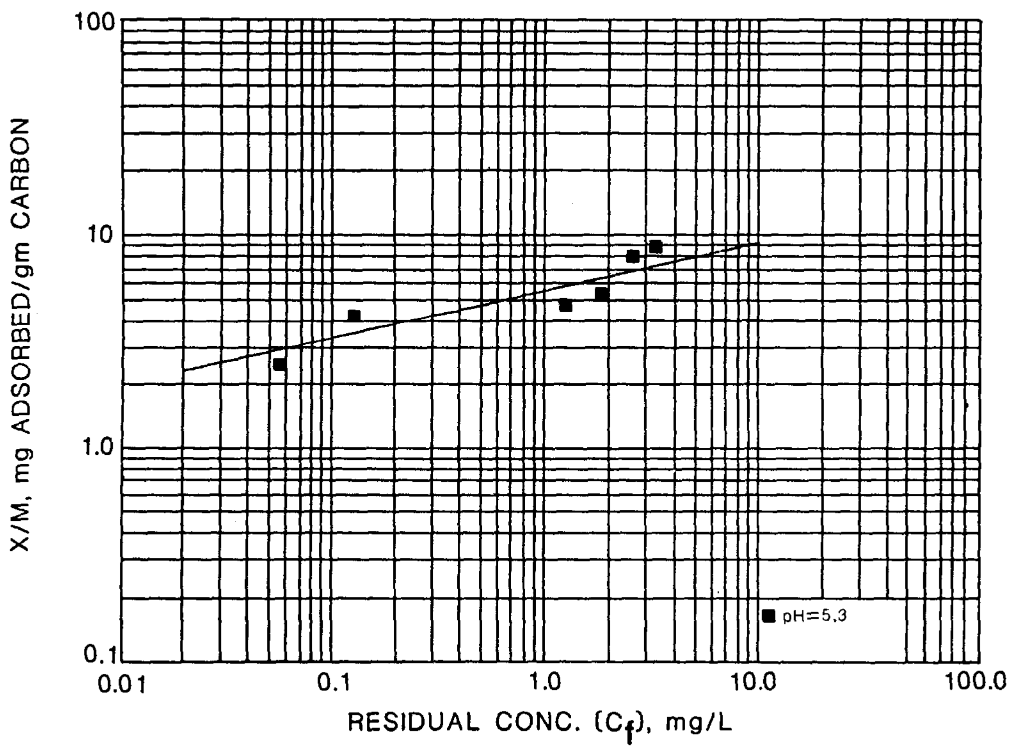
FREUNDLICH PARAMETERS	pH		
	5.3		
K	5.6		
1/n	0.24		
Corr. Coef. r	0.90		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	280	530	930
0.1		48	92
0.01			8.4

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

INDUSTRIAL OCCURRENCE OF TRICHLOROFLUOROMETHANE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	1		2.0	
Coal Mining (b)	47	0			
Leather Tanning and Finishing	18	0			
Electrical/Electronic Components (c)	3	0			
Foundries	53	0			
Metal Finishing (b) (g)	2	2	2.6 × 10E5	2.9 × 10E5	2.8 × 10E5
Photographic Equipment/Supplies (d)	14	1		8.1	
Nonferrous Metals Manufacturing (e) (g)	9	1	ND	100	12
Ore Mining and Dressing (b)	33	5	NA	10	5.0
Organic Chemicals and Plastics and Synthetic Resins	11	NA	NA	NA	5.5
Pulp and Paperboard Mills (g)	12	1	ND	8.0	2.0
Textile Mills (b) (f)	76	2	27	45	36

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF TRICHLOROFLUOROMETHANE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	1		5.0	
Coal Mining (b)	51	7	14	37	21
Foundries	53	0			
Photographic Equipment/Supplies (c)	8	1		1.3	
Nonferrous Metals Manufacturing	11	0			
Ore Mining and Dressing (b)	28	3	NA	10	4.7
Organic Chemicals and Plastics and Synthetic Resins	9	NA	NA	NA	6.7
Pulp and Paperboard Mills	3	0			
Textile Mills (b) (d)	67	7	2.0	2,100	330

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR TRICHLOROFLUOROMETHANE

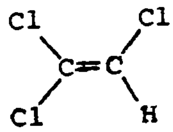
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	2		NM	BDL - 69	
Filtration	2	2	NM	BDL - 6.0	III.3.1.9
Flotation		1	>99	ND	III.3.1.10
Activated Sludge		6	96	1.7 - 2,100	III.3.2.1
Lagoons					III.3.2.2
-non-aerated		1	>99	ND	

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: Trichloroethylene

Formula:



Alternate Names: Trichloroethene;
Ethylene trichloride;
Ethinyl trichloride;
Tri-Clene

CAS #: 79-01-6

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 131.4
melting point, °C: -73
boiling point (760 torr), °C: 87
vapor pressure (20°C), torr: 57.9
solubility in water (20°C), mg/L: 1,100
log octanol/water partition coefficient: 2.29
Henry's law constant (25°C): 11.7×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.12.23-5

Probable Fate [1-7]:

photolysis: Little information on aqueous systems; probably does not occur

oxidation: Not important except for photooxidation

hydrolysis: Not important under environmental conditions

volatilization: Rapid volatilization is the major transport process

sorption: Some sorption on particulates especially those high in organic content. However, this process cannot compete with volatilization as a transport process

biological processes: Evidence of bioaccumulation, but not magnification, exists; may be biodegraded by acclimated sewage systems

other reactions/interactions: Not important

Carbon Adsorption Data, Trichloroethylene (1-8):

ADSORBABILITY

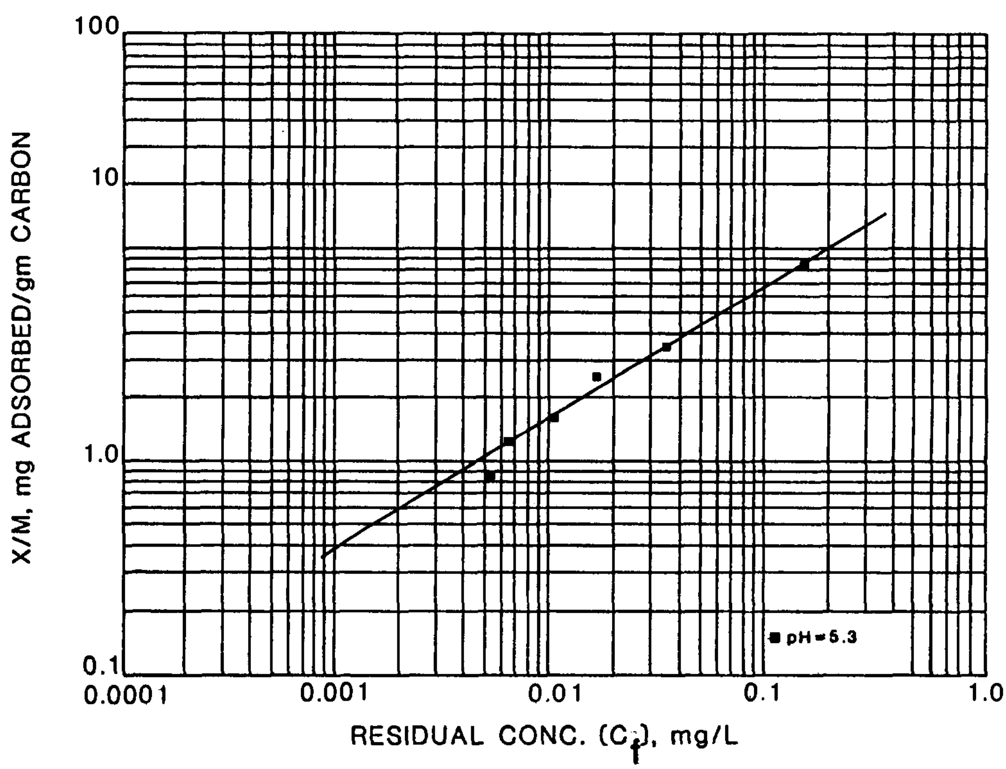
FREUNDLICH PARAMETERS	pH		
	5.3		
K	28		
1/n	0.62		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	130	620	2,600
0.1		56	260
0.01			23

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. Purge and Trap

INDUSTRIAL OCCURRENCE OF TRICHLOROETHYLENE

	Raw wastewater				
	Number of	Number of	Detected concentrations, μg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	18	11	<0.5	800	<240
Coal Mining (b)	47	1		3.0	
Inorganic Chemicals Manufacturing (b)	1	1		20	
Leather Tanning and Finishing	18	2	10	20	15
Aluminum Forming	1	1		430	
Battery Manufacturing (h) (j)	53	23	ND	10	<5.7
Coil Coating (k)	43	16	0.0	3,100	170
Electrical/Electronic Components (c)	28	13	6.0	3,500	<300
Foundries	53	13	<10	280	<72
Metal Finishing (b) (h)	124	92	ND	1.3 × 10E5	8,500
Photographic Equipment/Supplies (d)	36	18	0.02	120	14
Porcelain Enameling	1	1		<10	
Nonferrous Metals Manufacturing (f) (h)	95	17	ND	900	59
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	33	NA	NA	NA	43
Paint and Ink Formulation (c)	28	19	<5.0	40,000	<2,600
Petroleum Refining (b)	16	0			
Pulp and Paperboard Mills (h)	69	28	ND	850	49
Rubber Processing	1	1		<0.1	
Soap and Detergent Manufacturing (a) (i)	3	3	0.4	27	9.7
Steam Electric Power Plants (e)	11	2	0.57	<4.0	<2.3
Textile Mills (b) (g)	78	24	1.0	5,600	300

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 μg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Data presented are for phenanthrene/trichloroethylene.
(j) Detections may include values less than 5 μg/L.
(k) Reference reports 0.0 μg/L for detections less than detection limit 10 μg/L.

Information represents data from the USEPA verification program except as noted.

INDUSTRIAL OCCURRENCE OF TRICHLOROETHYLENE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	2	2	6	30	18
Coal Mining (b)	51	3	1.0	3.0	2.0
Iron and Steel Manufacturing (a)	10	5	3.0	64	<20
Coil Coating (i)	8	3	0.0	14	4.7
Foundries	53	15	<10	140	<30
Photographic Equipment/Supplies (d)	8	5	0.1	5.0	1.3
Porcelain Enameling	1	1		11	
Nonferrous Metals Manufacturing (f) (h)	81	12	ND	330	16
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	29	NA	NA	NA	5.9
Paint and Ink Formulation (c)	18	8	<10	300	<84
Petroleum Refining (b)	16	1		<10	
Pulp and Paperboard Mills (h)	63	3	ND	11	0.7
Rubber Processing	1	1		<0.1	
Steam Electric Power Plants (e)	10	0			
Textile Mills (b) (g)	94	16	1.0	130	33

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR TRICHLOROETHYLENE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Chemical Oxidation					III.3.1.2
-ozone	1		NM	0.9	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		5	10 - >99	ND - 190	
-combined precipitants		3	>99 - >99	ND - 300	
-lime		5	>99	ND - 0.1	
-sodium carbonate		1	NM	1.0	
-sodium hydroxide		1	NM	11	
-unspecified		1	NM	14	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1		NM	2.1	
Chemical Reduction		2	NM	0.1* - 1.0	III.3.1.4
Filtration	5	7	0 - >99	ND - 2,000	III.3.1.9
Flotation		2	86	6.0 - 30	III.3.1.10
Reverse Osmosis	2		17*	BDL - 0.4	III.3.1.16
Sedimentation		4	21 - 93	33 - 3,000	III.3.1.18
Stripping	3		23 - >99	ND - 34,000	III.3.1.19
Activated Sludge		13	0 - >99	ND - 84	III.3.2.1
Trickling Filters	1		NM	1	III.3.2.5

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to trichloroethylene.

Freshwater Aquatic Life

The available data for trichloroethylene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 45,000 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of trichloroethylene to sensitive freshwater aquatic life but adverse behavioral effects occur to one species at concentrations as low as 21,900 μg/L.

Saltwater Aquatic Life

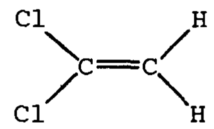
The available data for trichloroethylene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 2,000 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of trichloroethylene to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of trichloroethylene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 27 μg/L, 2.7 μg/L, and 0.27 μg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 807 μg/L, 80.7 μg/L, and 8.07 μg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: 1,1-Dichloroethylene

Formula:



Alternate Names: 1,1-Dichloroethene; Vinylidine chloride; Vinylidene chloride; 1,1-DCE

CAS #: 75-35-4

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 96.94
melting point, °C: -122
boiling point (760 torr), °C: 37
vapor pressure (25°C), torr: 591
solubility in water (20°C), mg/L: 400
log octanol/water partition coefficient: 1.48 (calculated)
Henry's law constant (25°C): 15.0×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.12.24-5

Probable Fate [1-7]:

photolysis: Aquatic photodissociation is precluded by volatilization

oxidation: Information not available for the aquatic environment

hydrolysis: Too slow to be important

volatilization: Rapid volatilization is the main transport process

sorption: Probably cannot compete with volatilization as a transport process

biological processes: Very low potential for bioaccumulation; biodegradation probably too slow to be important; may occur in acclimated sewage systems

other reactions/interactions: Not important

Carbon Adsorption Data, 1,1-Dichloroethylene (1-8):

ADSORBABILITY

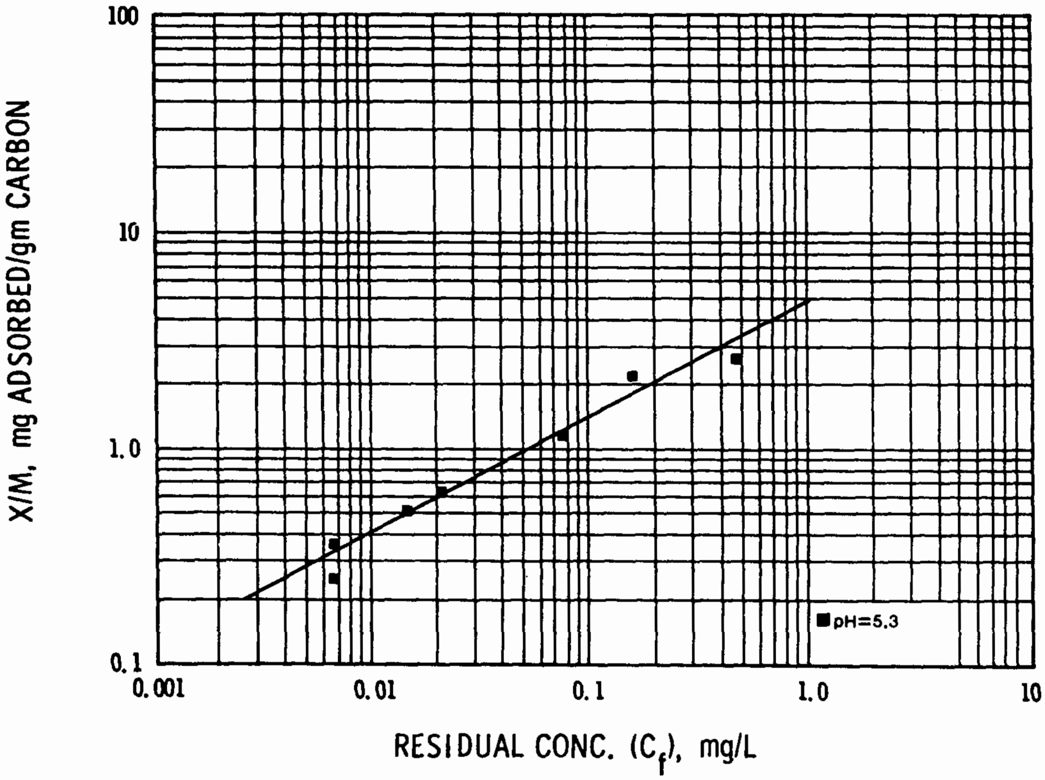
FREUNDLICH PARAMETERS	pH		
	5.3		
K	4.91		
1/n	0.54		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	640	2,400	8,600
0.1		220	850
0.01			77

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF 1,1-DICHLOROETHYLENE

	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Auto and Other Laundries (a)	5	3	<2.0	23	<9.3
Coal Mining (b)	47	3	3.0	3.0	3.0
Inorganic Chemicals Manufacturing (b)	1	1		0.03	
Iron and Steel Manufacturing (a)	6	3	18	140	61
Battery Manufacturing (h) (i)	17	5	ND	<10	<5.0
Coil Coating (j)	30	2	0.0	36	18
Electrical/Electronic Components (c)	28	5	<10	71	<25
Foundries	53	0			
Metal Finishing (b) (h)	128	72	ND	10,000	650
Photographic Equipment/Supplies (d)	7	0			
Porcelain Enameling (k)	1	0			
Pharmaceutical Manufacturing	4	4	10	20	14
Nonferrous Metals Manufacturing (f) (h)	85	9	ND	6,100	170
Ore Mining and Dressing (b)	32	2	NA	10	6.6
Organic Chemicals and Plastics and Synthetic Resins	22	NA	NA	NA	200
Paint and Ink Formulation (c)	27	9	<5.0	620	<79
Rubber Processing	1	1		<1.7	
Soap and Detergent Manufacturing (a)	3	3	11	25	18
Steam Electric Power Plants (e)	11	0			
Textile Mills (b) (g)	72	4	10	84	41

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.
(j) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.
(k) 1,1-dichloroethylene was not detected during the screening program and was not detected in the verification program.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 1,1-DICHLOROETHYLENE

Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
	Treated wastewater				
Coal Mining (a)	51	3	3.0	3.0	3.0
Coil Coating	3	0			
Foundries	53	0			
Pharmaceutical Manufacturing	2	2	10	10	10
Nonferrous Metals Manufacturing (d) (f)	59	8	ND	4,100	120
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	15	NA	NA	NA	6.8
Paint and Ink Formulation (b)	18	4	6.0	22	<12
Rubber Processing	1	1		<1.7	
Steam Electric Power Plants (c)	12	1		<10	
Textile Mills (a) (e)	64	4	1.0	44	15

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Verification data plus surveillance and analysis program data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,1-DICHLOROETHYLENE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption					III.3.1.1
-granular	1	1	>99	ND - 1.4	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		2	>99	ND - <10	
-combined precipitants		2	>99	ND - 22	
Filtration	2	4	40 - 76*	ND - 130	III.3.1.9
Sedimentation		2	87	40 - 70	III.3.1.18
Activated Sludge		2	41	<1.7 - 5.8	III.3.2.1

ND, not detected; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to dichloroethylenes.

Freshwater Aquatic Life

The available data for dichloroethylenes indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 11,600 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of dichlorethylenes to sensitive freshwater aquatic life.

Saltwater Aquatic Life

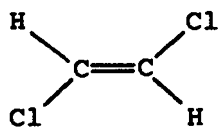
The available data for dichlorethylenes indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 224,000 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of dichloroethylenes to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 1,1-dichloroethylene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 0.33 µg/L, 0.033 µg/L, and 0.0033 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 18.5 µg/L, 1.85 µg/L, and 0.185 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for 1,2-dichloroethylene.

Compound: 1,2-Trans-dichloroethylene

Formula: 

Alternate Names: Trans-1,2-dichloroethene;
Trans-acetylene dichloride;
Dioform; sym dichloroethylene

CAS #: 540-59-0

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 96.94
melting point, °C: -50
boiling point (760 torr), °C: 47.5
vapor pressure (14°C), torr: 200
solubility in water (20°C), mg/L: 600
log octanol/water partition coefficient: 1.48 (calculated)
Henry's law constant (25°C): 5.32×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, rapid adaptation
water quality criteria: See page I.12.24-5

Probable Fate [1-8]:

photolysis: Information not available for the aquatic environment

oxidation: Information not available for the aquatic environment

hydrolysis: Probably too slow to be important

volatilization: Rapid volatilization is the major transport process

sorption: Not important

biological processes: Very low potential for bioaccumulation; biodegradation probably too slow to be important; may degrade in acclimated sewage systems

other reactions/interactions: Not important

Carbon Adsorption Data, 1,2-Trans-dichloroethylene (1-8):

ADSORBABILITY

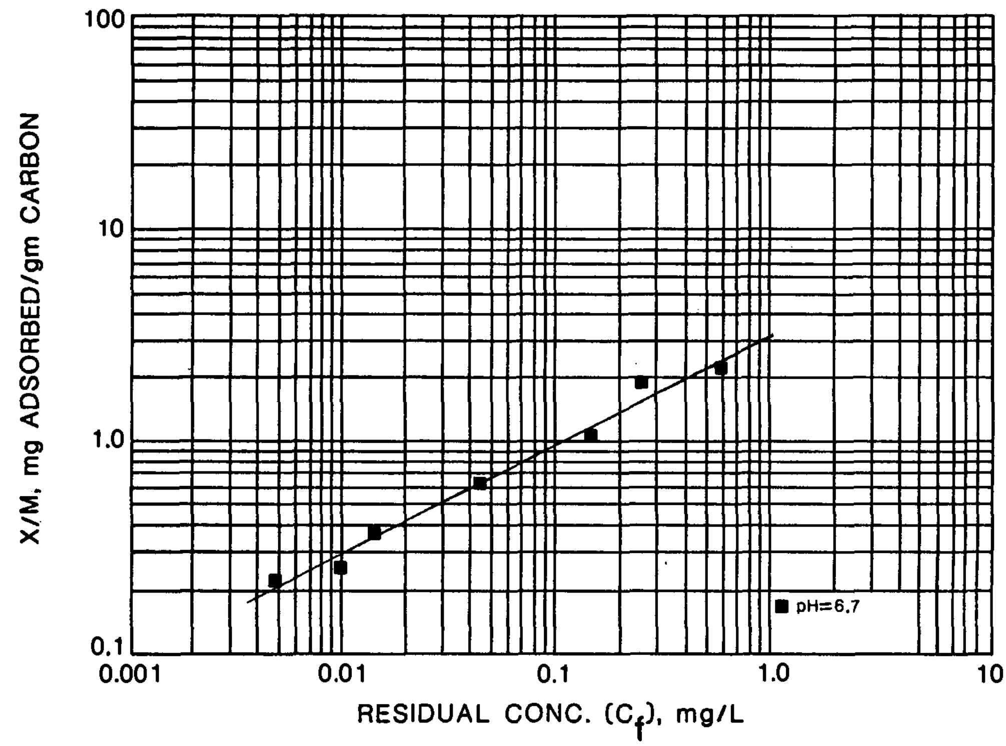
FREUNDLICH PARAMETERS	pH		
	6.7		
K	3.05		
1/n	0.51		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	950	3,400	11,00
0.1		310	1,100
0.01			100

(a) Carbon doses in mg/L at pH 6.7



ANALYTICAL METHOD: G.C. - Purge and Trap

INDUSTRIAL OCCURRENCE OF 1,2-TRANS-DICHLOROETHYLENE

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	5	3	<2.0	460	<160
Coal Mining (b)	47	1		10	
Leather Tanning and Finishing	18	1		30	
Aluminum Forming	24	7	<0.3	110	<18
Battery Manufacturing (g) (h)	17	4	ND	<10	<5.0
Coil Coating (i)	30	3	0.0	43	25
Electrical/Electronic Components (c)	3	0			
Foundries	53	2	<11	43	<27
Metal Finishing (b) (g)	22	17	ND	1,700	190
Photographic Equipment/Supplies (d)	13	1		2,200	
Pharmaceutical Manufacturing	1	1		10	
Nonferrous Metals Manufacturing (e) (g)	78	11	ND	480	16
Ore Mining and Dressing (b)	32	0			
Organic Chemicals and Plastics and Synthetic Resins	28	NA	NA	NA	61
Paint and Ink Formulation (c)	25	3	<5.0	260	<92
Petroleum Refining (b)	16	1		20	
Soap and Detergent Manufacturing (a)	1	1		3.3	
Textile Mills (b) (f)	68	6	2.0	360	66

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Detections may include values less than 5 µg/L.
(i) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 1,2-TRANS-DICHLOROETHYLENE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	51	11	ND	10	2.0
Coil Coating	3	0			
Foundries	53	2	<10	<10	<10
Pharmaceutical Manufacturing	1	1		10	
Nonferrous Metals Manufacturing (c) (e)	51	4	ND	75	4.4
Ore Mining and Dressing (a)	28	1		270	
Organic Chemicals and Plastics and Synthetic Resins	25	NA	NA	NA	12
Paint and Ink Formulation (b)	18	6	<5.0	190	<48
Petroleum Refining (a)	16	1		<10	
Textile Mills (a) (d)	62	1		7.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 1,2-TRANS-DICHLOROETHYLENE

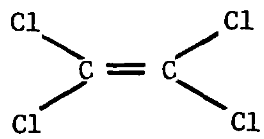
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption					III.3.1.1
-granular	3	1	84 - 98	1.1 - 1,100	
Chemical Oxidation					III.3.1.2
-ozone	1		NM	2.1	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		1	27	190	
-combined precipitants		1	NM	<5.0	
-unspecified		1	NM	21	
Chemical Precipitation with Filtration					III.3.1.3
-lime	1		NM	BDL	
Filtration		4	NM	31 - 690	III.3.1.9
Sedimentation		3	38 - 44	5.0 - 19	III.3.1.18
Stripping	5		9 - >99	ND - 1.3 x 10E6	III.3.1.19
Activated Sludge		2	32 - >99	ND - 8.2	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

Compound: Tetrachloroethylene

Formula:



Alternate Names: Tetrachloroethene; Ethylene tetrachloride; Perchloroethylene

CAS #: 127-18-4

Physical, Chemical, and Biological Properties [1-7, 1-15]:

molecular weight: 165.8
melting point, °C: -22.7
boiling point (760 torr), °C: 121
vapor pressure (20°C), torr: 14
solubility in water (20°C), mg/L: 150-200
log octanol/water partition coefficient: 2.88
Henry's law constant (25°C): 28.7×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: A-significant degradation, gradual adaptation
water quality criteria: See page I.12.26-5

Probable Fate [1-7]:

photolysis: Information not available for the aquatic environment

oxidation: Not significant in the aquatic environment

hydrolysis: Probably too slow to be important

volatilization: Rapid volatilization is the primary transport process

sorption: Too slow to compete with volatilization

biological processes: Moderate potential for bioaccumulation; possible biodegradation by higher organisms; may degrade in acclimated sewage systems

other reactions/interactions: Not important

Carbon Adsorption Data, Tetrachloroethylene (1-8):

ADSORBABILITY

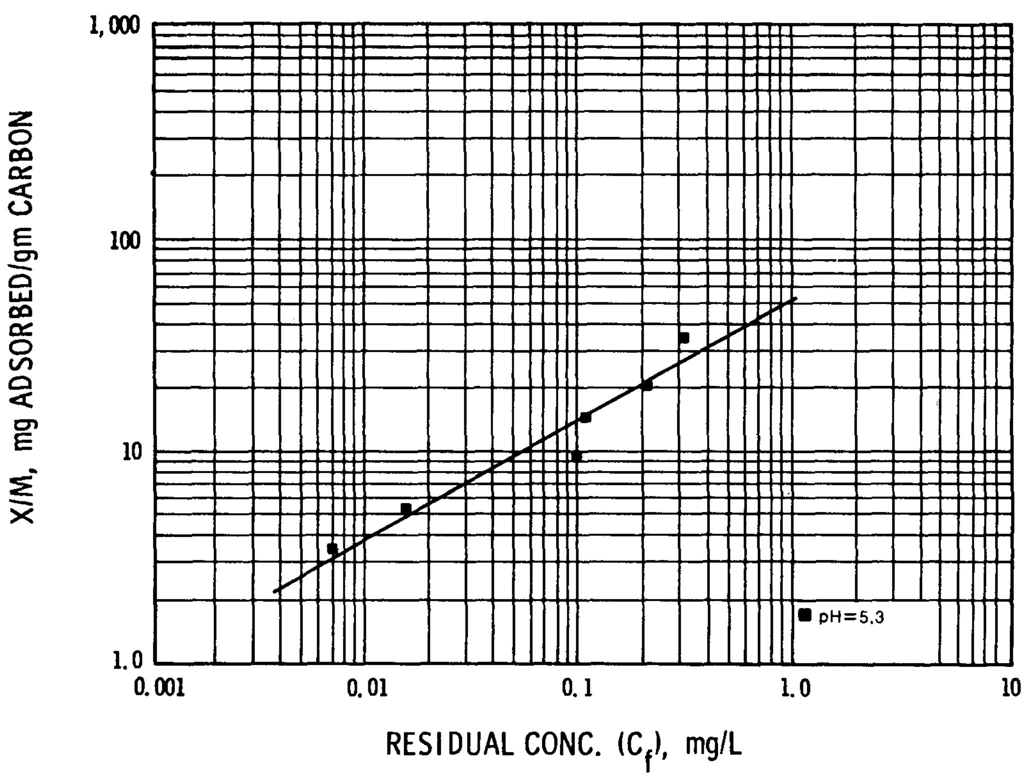
FREUNDLICH PARAMETERS	pH		
	5.3		
K	50.8		
1/n	0.56		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION.(a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	64	260	940
0.1		23	93
0.01			8.5

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: G.C. - Purge and Trap

INDUSTRIAL OCCURRENCE OF TETRACHLOROETHYLENE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	27	20	0.5	93,000	<11.000
Coal Mining (b)	47	0			
Inorganic Chemicals Manufacturing (b)	1	1		36	
Iron and Steel Manufacturing (a)	9	5	<10	1,200	<370
Leather Tanning and Finishing	18	4	10	150	56
Aluminum Forming	4	4	5.0	<4,000	<19,000
Battery Manufacturing (h) (i)	18	5	ND	<10	<6.0
Electrical/Electronic Components (c)	28	15	0.2	800	<120
Foundries	53	9	<10	370	<110
Metal Finishing (b) (h)	115	78	ND	1.1 × 10E5	4,200
Photographic Equipment/Supplies (d)	21	10	0.01	96	8.9
Porcelain Enameling	4	2	<10	<10	<10
Nonferrous Metals Manufacturing (f) (h)	95	18	ND	310	15
Ore Mining and Dressing (b)	33	2	NA	11	7.8
Organic Chemicals and Plastics and Synthetic Resins	19	NA	NA	NA	5,100
Paint and Ink Formulation (c)	29	21	<5.0	4,900	<680
Petroleum Refining (b)	16	1		>50	
Pulp and Paperboard Mills (h)	96	17	ND	220	13
Rubber Processing	1	1		1.4	
Soap and Detergent Manufacturing (a)	1	1		15	
Steam Electric Power Plants (e)	11	2	0.4	<10	<5.2
Textile Mills (b) (g)	78	24	1.0	1,100	180

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.
(i) Detections may include values less than 5 µg/L.
(j) Tetrachloroethylene was not detected during the screening program, and was not detected in the verification program.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating.

INDUSTRIAL OCCURRENCE OF TETRACHLOROETHYLENE

	Treated wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	6	5	2.0	1,000	460
Coal Mining (b)	51	17	1.0	81	12
Iron and Steel Manufacturing (a)	12	6	5.0	70	<24
Aluminum Forming	16	14	<0.3	3,000	<250
Foundries	53	19	1.0	1,000	<88
Photographic Equipment/Supplies (d)	8	6	1.3	2.5	1.9
Nonferrous Metals Manufacturing (f) (h)	81	11	ND	190	14
Ore Mining and Dressing (b)	28	1		1.1	
Organic Chemicals and Plastics and Synthetic Resins	14	NA	NA	NA	47
Paint and Ink Formulation (c)	19	8	6.0	700	<190
Petroleum Refining (b)	16	2	<10	<10	<10
Pulp and Paperboard Mills (h)	87	6	ND	57	2.3
Rubber Processing	1	1		<0.1	
Steam Electric Power Plants (e)	11	0			
Textile Mills (b) (g)	96	19	1.0	370	59

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Verification data plus surveillance and analysis program data.
(f) Detections >10 µg/L.
(g) Mean calculated using medians.
(h) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR TETRACHLOROETHYLENE

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption					III.3.1.1
-granular	2	1	68	BDL - 32	
Chemical Precipitation with Sedimentation					III.3.1.3
-alum		6	>99 - >99	ND - 700	
-combined precipitants		3	95 - >99	ND - 7.0	
-lime		2	NM	ND - 1.0	
-sodium carbonate		1	NM	17	
-sodium hydroxide		1	>99	ND	
-unspecified		1	NM	<10	
Coagulation and Flocculation		2	38	BDL - 5.0	III.3.1.5
Filtration	4	8	0 - >99	ND - 210	III.3.1.9
Flotation		6	0 - >99	ND - 1,000	III.3.1.10
Oil Separation		3	13 - >99	ND - 71	III.3.1.14
Sedimentation		7	50 - >99	ND - 93	III.3.1.18
Stripping	3		37 - >99	ND - 6,800	III.3.1.19
Ultrafiltration		2	93 - 99	16 - 200	III.3.1.21
Activated Sludge		12	55 - >99	ND - 40	III.3.2.1
Lagoons					III.3.2.2
-aerated		1	>99	ND	

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to tetrachloroethylene.

Freshwater Aquatic Life

The available data for tetrachloroethylene indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 5,280 and 840 μg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

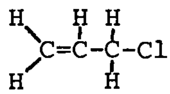
The available data for tetrachloroethylene indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 10,200 and 450 μg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of tetrachloroethylene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 8.0 μg/L, 0.8 μg/L, and 0.08 μg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 88.5 μg/L, 8.85 μg/L, and 0.88 μg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Allyl chloride

Formula:



Alternate Names: Chloroallylene; 3-Chloro-1-propene; 3-Chloropropylene; 2-Propenyl chloride

CAS #: 107-05-1

Physical, Chemical, and Biological Properties [1-18, 1-28]:

molecular weight: 76.53
melting point, °C: -134
boiling point (760 torr), °C: 44-45
vapor pressure (25°C), torr: 368
solubility in water (25°C), mg/L: Slightly soluble
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): >0.4 atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate:

photolysis: Information not available for the aquatic environment

oxidation: Information not available for the aquatic environment

hydrolysis: Slow hydrolysis to allyl alcohol

volatilization: Major transport fate

sorption: Information unavailable

biological processes: Information unavailable

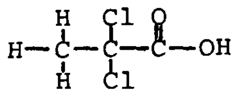
other reactions/interactions: Unknown

Carbon Adsorption Data: Not available

RESERVED

Compound: 2,2-Dichloropropionic acid

Formula:



Alternate Names: 2,2-Dichloropropanoic acid

CAS #: 75-99-0

Physical, Chemical, and Biological Properties [1-4]:

molecular weight: 143
melting point, °C: Not available
boiling point (760 torr), °C: 185-190
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: Very soluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate:

photolysis: C-Cl bond can photolyze

oxidation: Probably not important

hydrolysis: Slow hydrolysis to α-ketopropionic acid

volatilization: Probably not important

sorption: Information not available

biological processes: Information not available

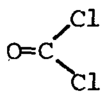
other reactions/interactions: Unknown

Carbon Adsorption Data: Not available

RESERVED

Compound: Phosgene

Formula:



Alternate Names: Chloroformyl chloride;
Carbonyl chloride;
Carbonic acid dichloride

CAS #: 75-44-5

Physical, Chemical, and Biological Properties [1-6]:

molecular weight: 98.92
melting point, °C: -118
boiling point (760 torr), °C: 8.1
vapor pressure (20°C), torr: 1,220
solubility in water (25°C), mg/L: Not available, compound decomposes
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate:

photolysis: Can occur, but cannot compete with hydrolysis

oxidation: Not important

hydrolysis: Rapid hydrolysis to CO_2 and HCl principal fate

volatilization: Probably does not compete with hydrolysis

sorption: Data not available

biological processes: Data not available

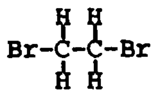
other reactions/interactions: Unknown

Carbon Adsorption Data: Not available

RESERVED

Compound: Ethylene dibromide

Formula:



Alternate Names: Ethylene bromide; 1,2-Dibromoethane; Glycoldibromide; EDB

CAS #: 106-93-4

Physical, Chemical, and Biological Properties [1-6, 1-28]:

molecular weight: 187.9
melting point, °C: 9.97
boiling point (760 torr), °C: 132
vapor pressure (20°C), torr: 11
solubility in water (30°C), mg/L: 4,310
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 8.82×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate:

photolysis: Information not available for the aquatic environment

oxidation: Information not available for the aquatic environment

hydrolysis: Slow

volatilization: Probable major transport mechanism

sorption: Information not available

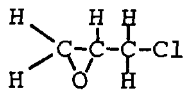
biological processes: Information not available

other reactions/interactions: Unknown

Carbon Adsorption Data: Not available

RESERVED

Compound: Epichlorohydrin

Formula: 

Alternate Names: 3-Chloro-1,2-epoxypropane;
(Chloromethyl) ethylene oxide

CAS #: 106-89-8

Physical, Chemical, and Biological Properties [1-18, 1-28]:

molecular weight: 92.53
melting point, °C: -48.0
boiling point (760 torr), °C: 116
vapor pressure (16.6°), torr: 10
solubility in water (25°C), mg/L: Insoluble
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 3.42×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate:

photolysis: Information not available for the aquatic environment

oxidation: Information not available for the aquatic environment

hydrolysis: Slow

volatilization: Probable major transport mechanism

sorption: Information unavailable

biological processes: Information unavailable

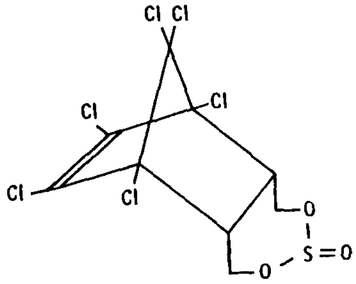
other reactions/interactions: Unknown

Carbon Adsorption Data: Not available

RESERVED

Compound: α-Endosulfan

Formula:



Alternate Names: 6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzo(3)-dioxathiepin-3-oxide

Cas #: 115-29-7

Physical, Chemical, and Biological Properties [1-2, 1-21]:

molecular weight: 407
melting point, °C: 108-110
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: 1×10^{-5}
solubility in water (temp. unknown), mg/L: 0.53
log octanol/water partition coefficient: 3.55
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.1-5

Probable Fate [1-2]:

photolysis: C-Cl bond photolysis is possible, could be important

oxidation: Probably not important

hydrolysis: Hydrolysis of sulfite group may be rapid; probably important above pH 7

volatilization: Could be important

sorption: Is an important process

biological processes: Bioaccumulates: resistant to biodegradation

other reactions/interactions: Unknown

Carbon Adsorption Data, α-Endosulfan (1-8):

ADSORBABILITY

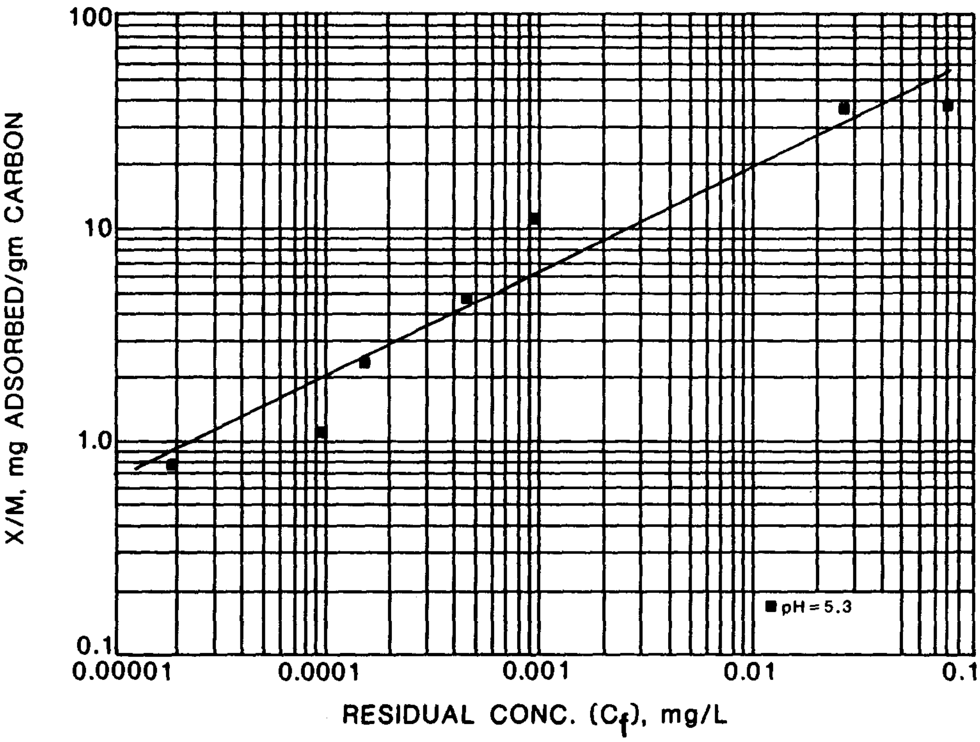
FREUNDLICH PARAMETERS	pH		
	5.3		
K	194		
1/n	0.50		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	15	50	160
0.1		4.6	16
0.01			1.4

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

REMARKS: Data were obtained on a mixture containing 62% alpha and 38% beta isomers.

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF ALPHA-ENDOSULFAN

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	45	3	0.1	2.2	1.5
Aluminum Forming	5	2	1.2	1.8	1.5
Foundries	53	10	<5.0	<5.0	<5.0
Metal Finishing (a) (e)	9	6	ND	28	10
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (e) (f)	56	1	ND	15	3.2
Ore Mining and Dressing (a)	33	1		10	
Petroleum Refining (a)	17	0			
Textile Mills (a) (d)	50	1		1.0	

ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ALPHA-ENDOSULFAN

			Treated wastewater		
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Aluminum Forming	17	5	0.01	28	6.0
Foundries	53	2	<5.0	<5.0	<5.0
Nonferrous Metals Manufacturing (b) (c) (d)	34	0	ND	0.6	0.2
Ore Mining and Dressing (a)	28	0			
Petroleum Refining (a)	17	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ALPHA-ENDOSULFAN

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Oil Separation		1	>99	ND	III.3.1.14
Sedimentation		1	NM	BDL	III.3.1.18
Ultrafiltration		1	NM	BDL	III.3.1.21

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to endosulfan.

Freshwater Aquatic Life

For endosulfan the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.056 μg/L as a 24-hour average and the concentration should not exceed 0.22 μg/L at any time.

Saltwater Aquatic Life

For endosulfan the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0087 μg/L as a 24-hour average and the concentration should not exceed 0.034 μg/L at any time.

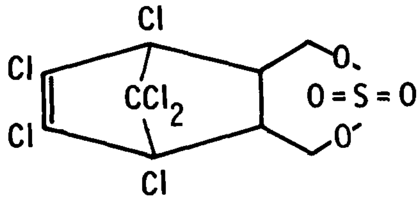
Human Health

For the protection of human health from the toxic properties of endosulfan ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 74 μg/L.

For the protection of human health from the toxic properties of endosulfan ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 159 μg/L.

Compound: Endosulfan sulfate

Formula:



Alternate Names: 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3,3-dioxide

Case #: 1031-07-8

Physical, Chemical, and Biological Properties [1-2, 1-8]:

molecular weight: 423
melting point, °C: 198-201
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (temp. unknown), mg/L: 0.117
log octanol/water partition coefficient: 3.66
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.1-5

Probable Fate [1-1]:

photolysis: No information available

oxidation: Probably not important

hydrolysis: Probably an important process

volatilization: No information available

sorption: Sorption is probably an important fate

biological processes: Resistant to biodegradation

other reactions/interactions: Unknown

Carbon Adsorption Data, Endosulfan sulfate (1-8):

ADSORBABILITY

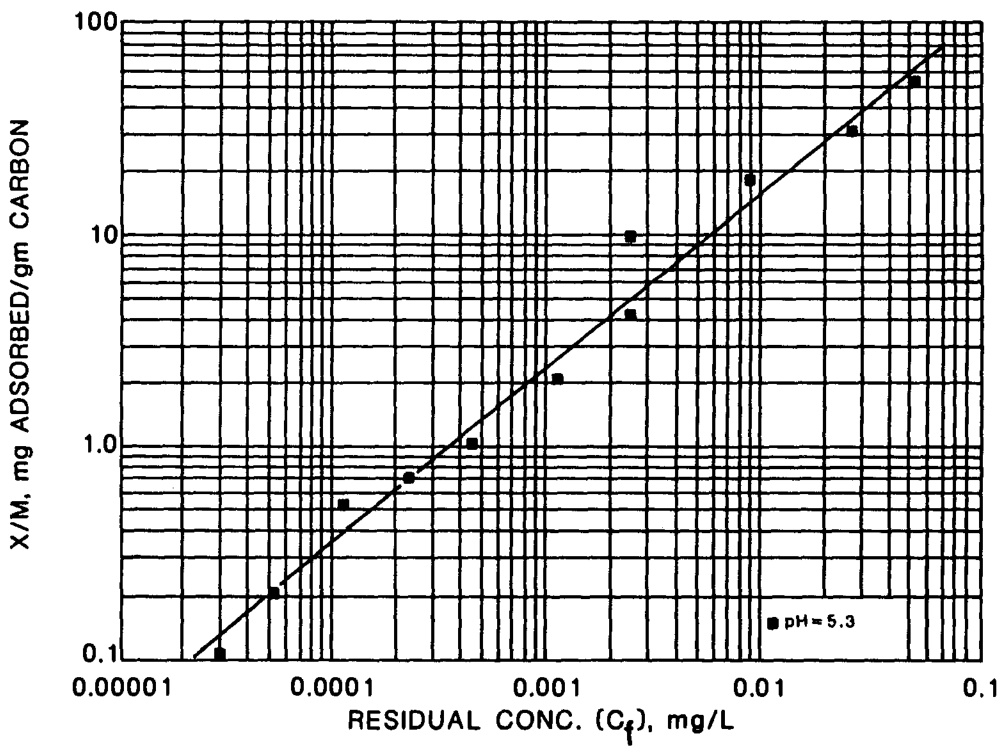
FREUNDLICH PARAMETERS	pH		
	5.3		
K	686		
1/n	0.81		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	8.5	60	390
0.1		5.5	39
0.01			3.5

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF ENDOSULFAN SULFATE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Foundries	53	6	<5.0	<5.0	<5.0
Metal Finishing (a) (d)	4	4	0.9	16	10
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d)	26	0	ND	0.03	NA
Ore Mining and Dressing (a)	33	0			
Petroleum Refining (a)	17	1		<5.0	

NA, not available; ND, not detected. See Section 1.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ENDOSULFAN SULFATE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Foundries	53	4	<5.0	<5.0	<5.0
Nonferrous Metals Manufacturing (b) (c)	8	0	ND	0.2	0.1
Ore Mining and Dressing (a)	28	0			
Petroleum Refining (a)	17	0			

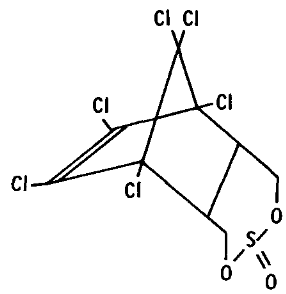
ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: β-Endosulfan

Formula:



Alternate Names: 6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzo(e)dioxathiepin-3-oxide

CAS #: 115-29-7

Physical, Chemical, and Biological Properties [1-2, 1-21]:

molecular weight: 407
melting point, °C: 207-209
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: 1×10^{-5}
solubility in water (temp. unknown), mg/L: 0.28
log octanol/water partition coefficient: 3.62
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.1-5

Probable Fate [1-2]:

photolysis: C-Cl bond photolysis is possible, could be important

oxidation: Probably not important

hydrolysis: Hydrolysis of sulfite group could be rapid, probably important above pH 7

volatilization: Could be important

sorption: Is an important process

biological processes: Resistant to biodegradation

other reactions/interactions: Unknown

Carbon Adsorption Data, β-Endosulfan (1-8):

ADSORBABILITY

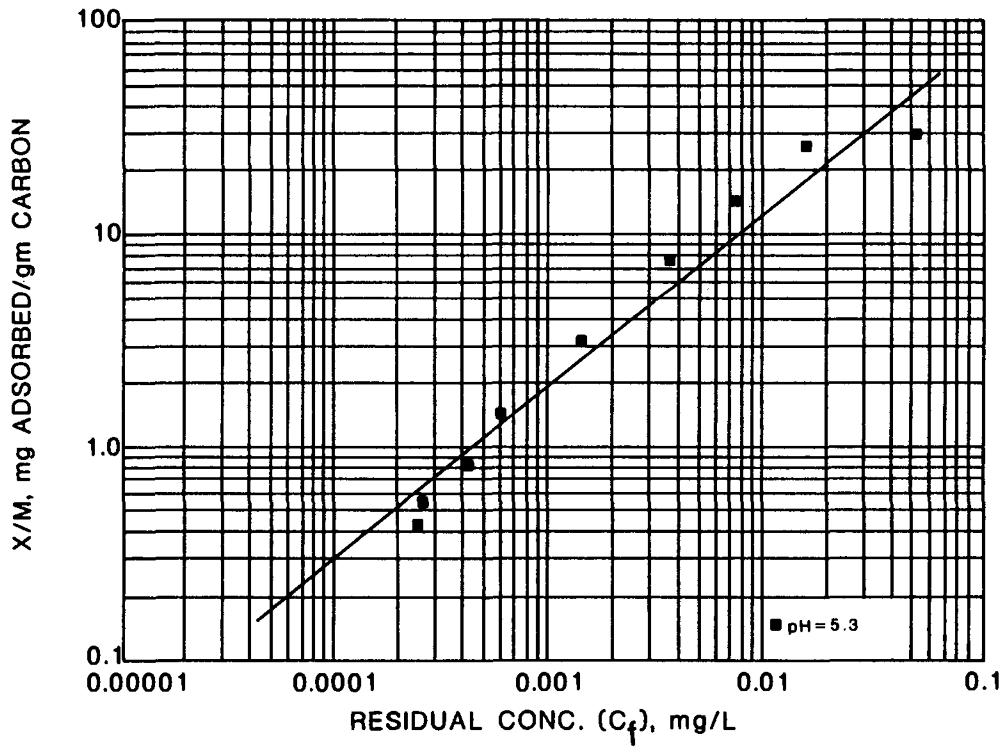
FREUNDLICH PARAMETERS	pH		
	5.3		
K	615		
1/n	0.83		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	10	74	500
0.1		6.7	50
0.01			4.5

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

REMARKS: Data were obtained on a mixture containing 62% alpha and 38% beta isomers.

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF BETA-ENDOSULFAN

Industry	Raw wastewater Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	45	2	2.2	2.2	2.2
Foundries	53	7	<5.0	<5.0	<5.0
Metal Finishing (a) (e)	2	2	0.2	6.0	3.0
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (e) (f)	42	1	ND	15	3.1
Ore Mining and Dressing (a)	33	0			
Petroleum Refining (a)	17	1		13	
Textile Mills (a) (d)	50	1		5.0	

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BETA-ENDOSULFAN

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, μg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Foundries	53	7	<5.0	<5.0	<5.0
Nonferrous Metals Manufacturing (b) (c) (d)	38	0	ND	0.2	0.1
Ore Mining and Dressing (a)	28	0			
Petroleum Refining (a)	17	0			

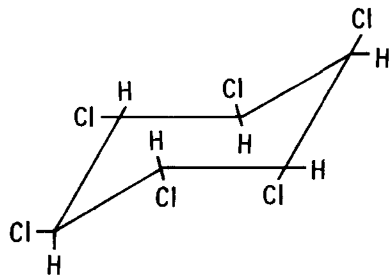
ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 μg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: α-BHC

Formula:



Alternate Names: Hexachlorocyclohexane;
Benzenehexachloride;
HCCH; HCH; TBH

CAS #: 319-84-6

Physical, Chemical, and Biological Properties [1-2, 1-6]:

molecular weight: 290.8
melting point, °C: 157-158
boiling point (760 torr), °C: Decomposes at 288
vapor pressure (20°C), torr: 2.5×10^{-5}
solubility in water (25°C), mg/L: 2.0
log octanol/water partition coefficient: 3.81
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.4-5

Probable Fate [1-2]:

photolysis: C-Cl bond photolysis can occur, not important in aquatic systems

oxidation: Not an important process

hydrolysis: Very slow, not important

volatilization: Information contradictory as to how important process is

sorption: Important for transport to anaerobic sediments

biological processes: Some bioaccumulation; biodegradation could be important

other reactions/interactions: Unknown

Carbon Adsorption Data, α-BHC (1-8):

ADSORBABILITY

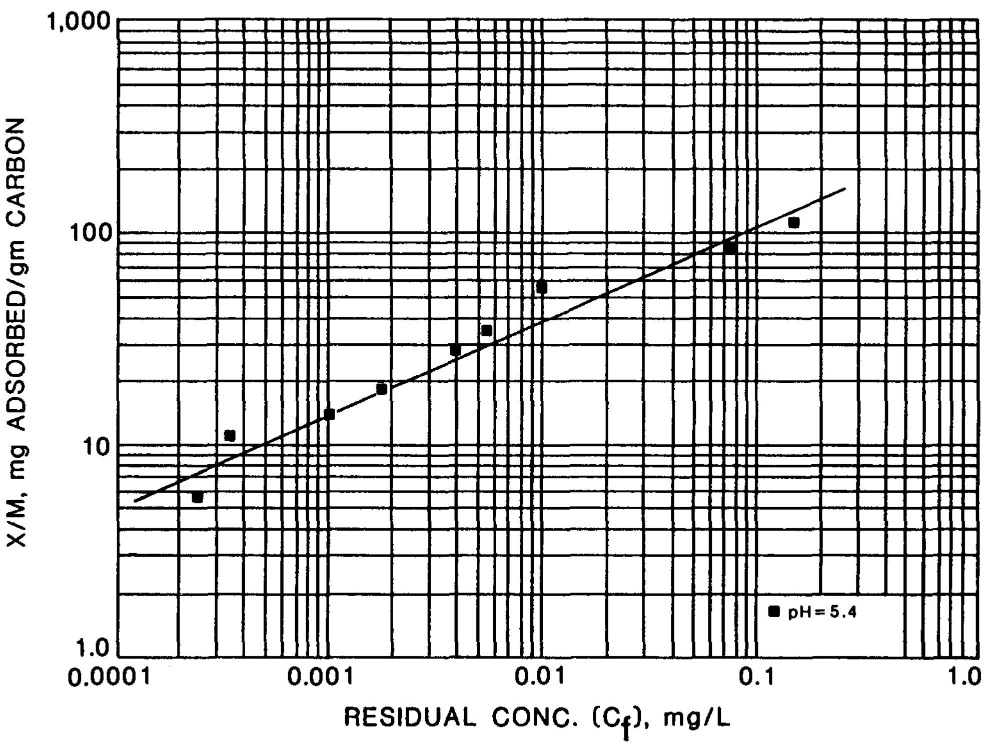
FREUNDLICH PARAMETERS	pH		
	5.4		
K	303		
1/n	0.43		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	8.0	24	64
0.1		2.2	6.4
0.01			0.6

(a) Carbon doses in mg/L at pH 5.4



ANALYTICAL METHOD: Solvent extraction - G.C.

REMARKS: Isotherm measured using a mixture containing 71% alpha isomer and isomer and 29% beta isomer.

Date: 10/8/82 I.13.4-2

INDUSTRIAL OCCURRENCE OF ALPHA-BHC

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	45	5	1.1	2.6	2.1
Leather Tanning and Finishing (g)	18	0			
Aluminum Forming	3	1		4.0	
Electrical/Electronic Components (b)	3	0			
Foundries	53	9	<5.0	26	<7.0
Metal Finishing (a) (f)	10	7	ND	18	6.0
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (f) (h)	77	0	ND	0.2	0.1
Ore Mining and Dressing (a)	33	5	NA	10	5.3
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	10
Paint and Ink Formulation (b)	1	0			
Petroleum Refining (a)	17	1		<10	
Textile Mills (a) (e)	50	5	2.0	5.0	4.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Data presented are for alpha-BHC/beta-BHC.
(h) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ALPHA-BHC

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	3	0.1	2.2	1.5
Aluminum Forming	21	8	0.01	18	4.3
Foundries	53	13	<5.0	6.0	<5.0
Nonferrous Metals Manufacturing (c) (e) (f)	47	0	ND	0.7	0.1
Ore Mining and Dressing (a)	28	3	NA	5.0	5.0
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	10
Paint and Ink Formulation (b)	1	0			
Petroleum Refining	17	0			
Textile Mills (a) (d)	50	1		1.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ALPHA - BHC

Treatment process	Number of data points Pilot scale	Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Activated Carbon Adsorption -granular	1		NM	1.9	III.3.7.1
Coagulation and Flocculation	1		91*	BDL	III.3.1.5
Filtration	1	1	77	1.9 - 6.0	III.3.1.9
Oil Separation		2	86*	ND - BDL	III.3.1.14
Sedimentation		1	NM	BDL	III.3.1.18
Ultrafiltration		1	79*	BDL	III.3.1.21

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to hexachlorocyclohexane.

Lindane

Freshwater Aquatic Life

For lindane the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.080 µg/L as a 24-hour average and the concentration should not exceed 2.0 µg/L at any time.

Saltwater Aquatic Life

For saltwater aquatic life the concentration of lindane should not exceed 0.16 µg/L at any time. No data are available concerning the chronic toxicity of lindane to sensitive saltwater aquatic life.

BHC

Freshwater Aquatic Life

The available data for a mixture of isomers of BHC indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 100 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of a mixture of isomers of BHC to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for a mixture of isomers of BHC indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 0.34 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of a mixture of isomers of BHC to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of alpha-HCH through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 92 ng/L, 9.2 ng/L, and 0.92 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 310 ng/L, 31.0 ng/L, and 3.1 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of beta-HCH through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 163 ng/L, 16.3 ng/L, and 1.63 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, exluding consumption of water, the levels are 547 ng/L, 54.7 ng/L, and 5.47 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of tech-HCH through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 123 ng/L, 12.3 ng/L, and 1.23 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 414 ng/L, 41.4 ng/L, and 4.14 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of gamma-HCH through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentrations should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 186 ng/L, 18.6 ng/L, and 1.86 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 625 ng/L, 62.5 ng/L, and 6.25

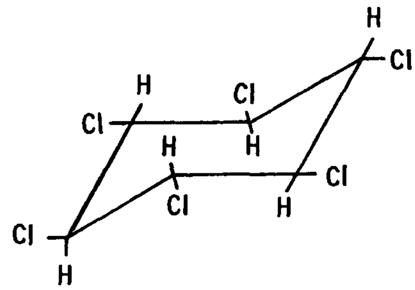
ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for delta-HCH.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for epsilon-HCH.

Compound: β-BHC

Formula:



Alternate Names: Hexachlorocyclohexane;
Benzene hexachloride;
HCCH; HCH; TBH

CAS #: 319-85-7

Physical, Chemical, and Biological Properties [1-2, 1-6]:

molecular weight: 290.8
melting point, °C: 309
boiling point (760 torr), °C: Sublimes
vapor pressure (20°C), torr: 2.8×10^{-7}
solubility in water (25°C), mg/L: 0.24
log octanol/water partition coefficient: 3.80
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.4-5

Probable Fate [1-2]:

photolysis: C-Cl photolysis can occur, not important in aquatic systems

oxidation: Not an important process

hydrolysis: Very slow, not important

volatilization: Information contradictory as to how important process is

sorption: Important for transport to anaerobic sediments

biological processes: Some bioaccumulation; biodegradation could be important

other reactions/interactions: Unknown

Carbon Adsorption Data, β-BHC (1-8):

ADSORBABILITY

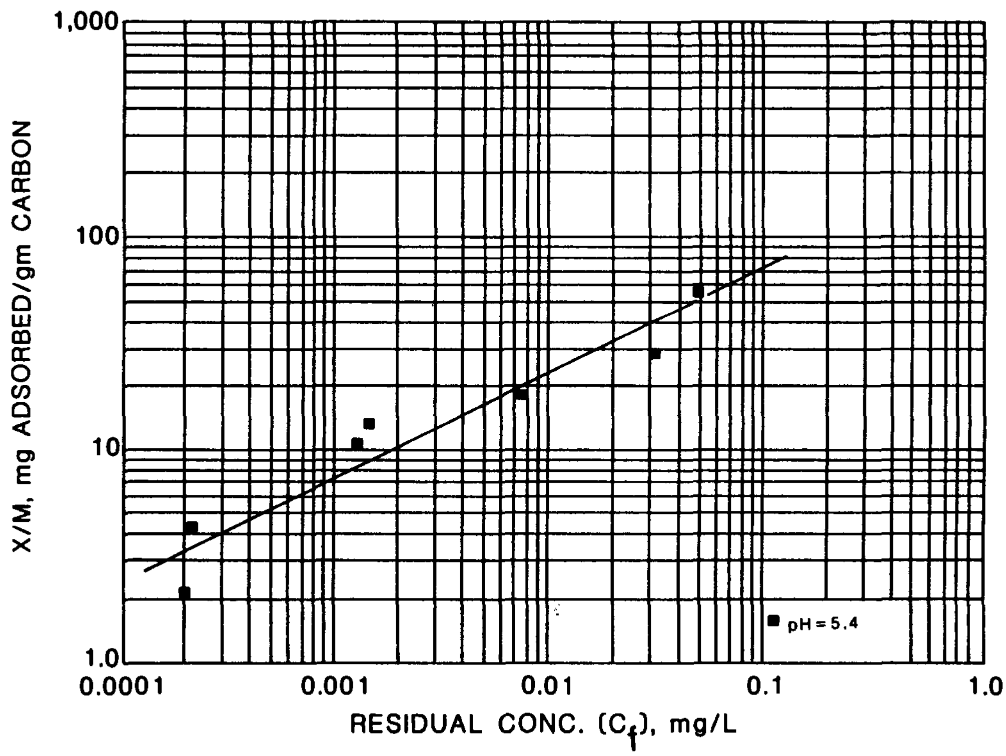
FREUNDLICH PARAMETERS	pH		
	5.4		
K	220		
1/n	0.49		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	13	43	130
0.1		3.9	13
0.01			1.2

(a) Carbon doses in mg/L at pH 5.4



ANALYTICAL METHOD: Solvent extraction - G.C.

REMARKS: Isotherm measured using a mixture containing 71% beta isomer and 29% alpha isomer.

Date: 1/24/83

INDUSTRIAL OCCURRENCE OF BETA-BHC

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	45	6	0.33	2.2	1.5
Leather Tanning and Finishing (g)	18	0			
Aluminum Forming	3	1		18	
Electrical/Electronic Components (b)	4	0			
Foundries	53	8	<5.0	70	<15
Metal Finishing (a) (f)	7	4	ND	4.0	1.0
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (f) (h)	85	0	ND	4.5	0.3
Ore Mining and Dressing (a)	33	5	NA	10	6.1
Petroleum Refining (a)	17	3	0.7	<5.0	<3.6
Textile Mills (a) (e)	50	2	1.0	1.0	1.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Data presented are for alpha-BHC/beta-BHC.
(h) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF BETA-BHC

Industry	Number of samples	Number of detections	Treated wastewater Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	47	3	0.26	2.2	1.6
Aluminum Forming	11	13	0.02	5.0	<0.55
Foundries	53	12	<5.0	55	<11
Nonferrous Metals Manufacturing (b) (d) (e)	55	0	ND	0.3	0.1
Ore Mining and Dressing (a)	28	1		5.0	
Petroleum Refining (a)	17	1		<5.0	
Textile Mills (a) (c)	50	1		1.0	

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Mean calculated using medians.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR BETA - BHC

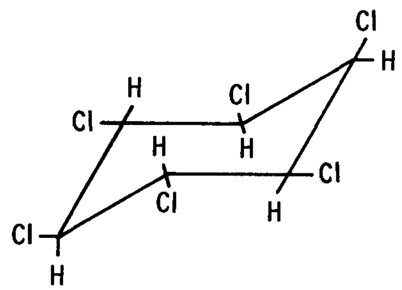
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Filtration		1	21	55	III.3.1.9
Oil Separation		2	NM	BDL - BDL	III.3.1.14
Sedimentation		1	NM	BDL	III.3.1.18
Ultrafiltration		1	50*	BDL	III.3.1.21
Activated Sludge		1	>99	ND	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful; *approximate value.

RESERVED

Compound: δ-BHC

Formula:



Alternate Names: Benzenehexachloride; Hexachlorocyclohexane; HCCH; HCH; TBH

CAS #: 319-86-8

Physical, Chemical, and Biological Properties [1-2, 1-6]:

molecular weight: 290.8
melting point, °C: 138-139
boiling point (760 torr), °C: Not available
vapor pressure (20°C), torr: 1.7×10^{-5}
solubility in water (25°C), mg/L: 31.4
log octanol/water partition coefficient: 4.14
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.4-5

Probable Fate [1-2]:

photolysis: C-Cl bond photolysis can occur, not important in aquatic systems

oxidation: Not an important process

hydrolysis: Very slow, not important

volatilization: Information contradictory as to how important process is

sorption: Important for transport to anaerobic sediments

biological processes: Some bioaccumulation; biodegradation could be important

other reactions/interactions: Unknown

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF DELTA-BHC

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	45	5	0.1	2.2	1.4
Electrical/Electronic Components (b)	3	0			
Foundries	53	7	<5.0	20	<7.0
Metal Finishing (a) (e)	11	7	ND	11	2.6
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (f) (g)	50	0	ND	4.0	0.35
Ore Mining and Dressing (a)	33	2	NA	5.0	5.0
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	10
Paint and Ink Formulation (b)	1	0			
Petroleum Refining (a)	17	2	<5.0	12	<8.5
Textile Mills (a) (e)	50	2	3.0	5.0	4.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF DELTA-BHC

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	3	0.1	2.2	1.5
Aluminum Forming	1	0			
Foundries	53	9	<5.0	20	<7.2
Nonferrous Metals Manufacturing (c) (d) (e)	37	0	ND	0.5	0.2
Ore Mining and Dressing (a)	28	2	NA	5.0	5.0
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	10
Paint and Ink Formulation (b)	1	0			
Petroleum Refining (a)	17	0			

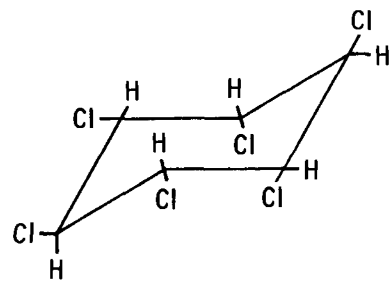
NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: gamma-BHC

Formula:



Alternate Names: Hexachlorocyclohexane; Benzenehexachloride; HCCH; HCH; TBH; Main isomer in Lindane (at least 99 percent)

CAS #: 58-89-9

Physical, Chemical, and Biological Properties [1-2, 1-6, 1-9]:

molecular weight: 290.8
melting point, °C: 112
boiling point (760 torr), °C: Not available
vapor pressure (20°C), torr: 9.4×10^{-6}
solubility in water (25°C), mg/L: 7.5
log octanol/water partition coefficient: 3.72
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.4-5

Probable Fate [1-2]:

photolysis: C-Cl bond photolysis can occur, not important in aquatic systems

oxidation: Probably not an important process

hydrolysis: Very slow, not important

volatilization: Not important

sorption: Important for transport to anaerobic sludges

biological processes: Biotransformation most important process

other reactions/interactions: Unknown

Carbon Adsorption Data, gamma-BHC (1-8):

ADSORBABILITY

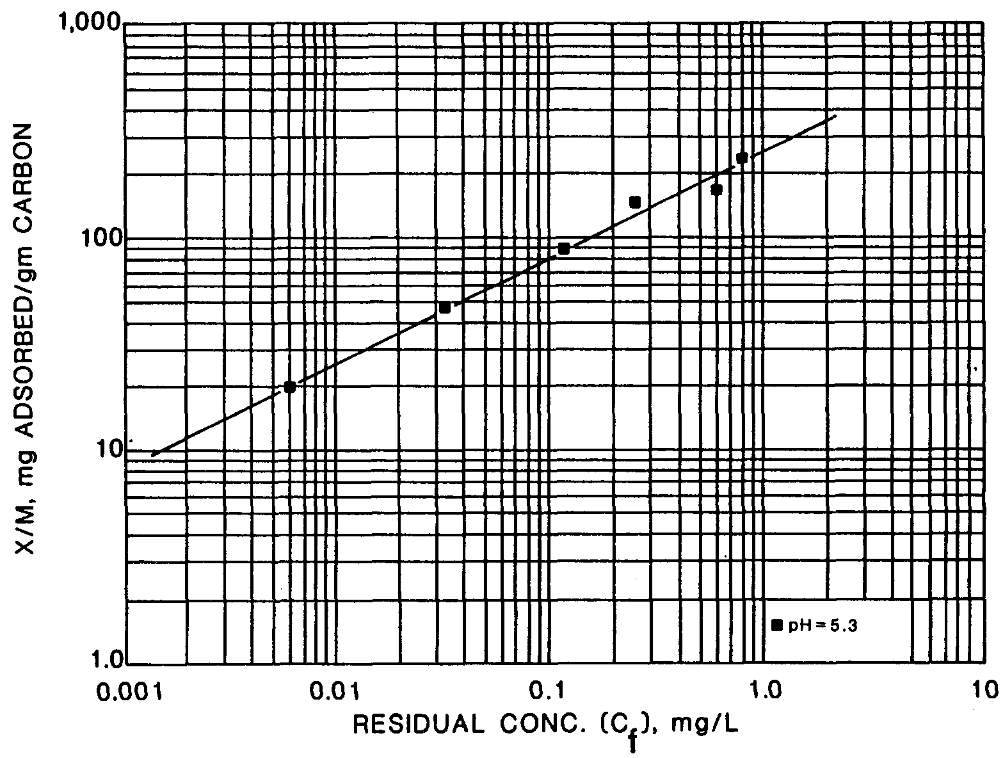
FREUNDLICH PARAMETERS	pH		
	5.3		
K	256		
1/n	0.49		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	11	40	115
0.1		3.4	11
0.01			1.0

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF GAMMA-BHC

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (b)	45	5	0.43	2.2	1.9
Electrical/Electronic Components (c)	4	0			
Foundries	53	16	<5.0	20	<6.1
Metal Finishing (b) (g)	5	4	ND	9.0	4.0
Photographic Equipment/Supplies (d)	8	0			
Nonferrous Metals Manufacturing (e) (g) (h)	75	0	ND	0.2	0.06
Ore Mining and Dressing (b)	33	4	NA	10	6.2
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Petroleum Refining (b)	17	1		<5.0	
Soap and Detergent Manufacturing (a)	1	1		2.2	
Textile Mills (b) (f)	50	3	5.0	5.0	5.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 µg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.
(h) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF GAMMA-BHC

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	2	2.2	2.2	2.2
Foundries	53	20	<5.0	20	<5.8
Nonferrous Metals Manufacturing (b) (d) (e)	55	0	ND	0.1	0.1
Ore Mining and Dressing (a)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	0.01
Petroleum Refining (a)	17	0			
Textile Mills (a) (c)	50	2	1.0	5.0	3.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Man calculated using medians.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR GAMMA - BHC

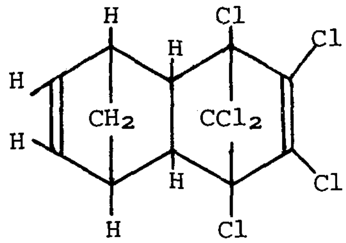
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Filtration		1	64*	BDL	III.3.1.9
Activated Sludge		1	>99	ND	III.3.2.1

BDL, below detection limit; ND, not detected; *approximate value.

RESERVED

Compound: Aldrin

Formula:



Alternate Names: 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-oxo-1,4-endo-5,8-dimethanonaphthalene; HHDN

CAS #: 309-00-2

Physical, Chemical, and Biological Properties [1-2, 1-4, 1-15, 1-22]:

molecular weight: 365
melting point, °C: 104
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: 6×10^{-6}
solubility in water (25°C), mg/L: 0.017-0.18
log octanol/water partition coefficient: 5.17
Henry's law constant (25°C): 0.496×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.8-5

Probable Fate [1-2]:

photolysis: Direct photolysis is slow; indirect photolysis may be important

oxidation: Reacts to form dieldrin

hydrolysis: Too slow to be important

volatilization: Probably an important process

sorption: Can be an important process

biological processes: Biotransformation of aldrin to dieldrin is probably the dominant transformation process in aquatic systems; resistant to biodegradation

other reactions/interactions: Unknown

Carbon Adsorption Data, Aldrin (1-8):

ADSORBABILITY

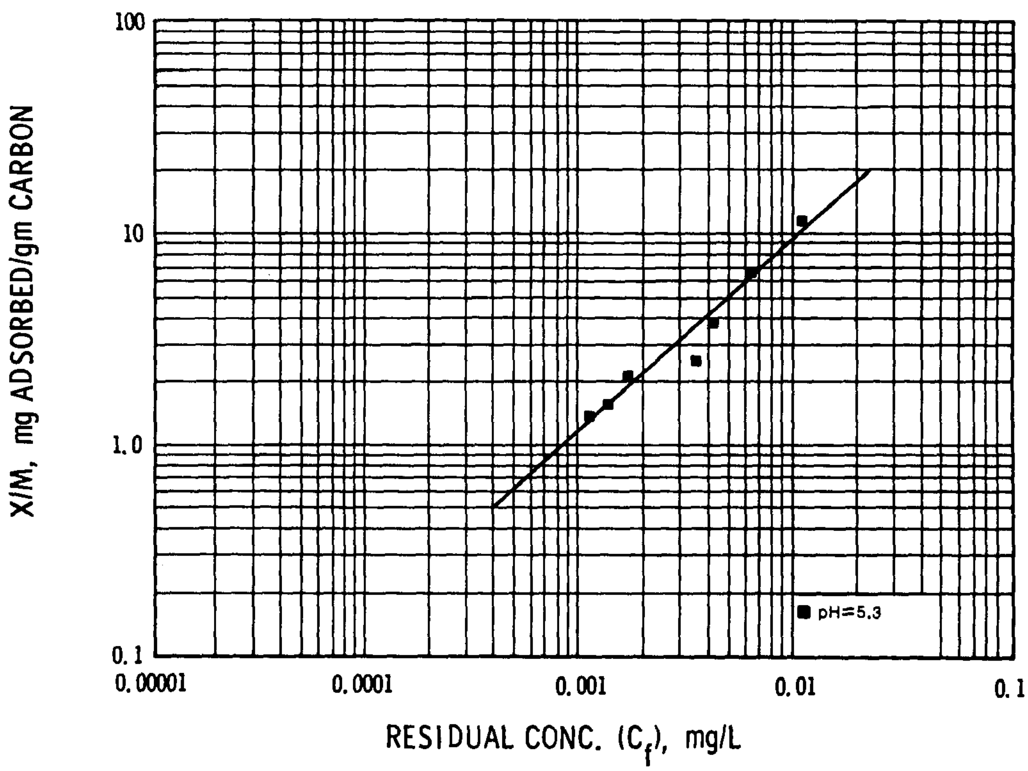
FREUNDLICH PARAMETERS	pH		
	5.3		
K	651		
1/n	0.92		
Corr. Coef. r	0.97		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	11	110	880
0.1		9.7	88
0.01			8.0

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF ALDRIN

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	45	1		6.4	
Electrical/Electronic Components (b)	3	0			
Foundries	53	9	<5.0	<10	<6.0
Metal Finishing (a) (e)	4	3	ND	11	5.0
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (e) (f)	55	0	ND	7.0	0.48
Ore Mining and Dressing (a)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	10
Petroleum Refining (a)	17	2	<5.0	12	<8.5

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ALDRIN

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	47	2	2.2	2.2	2.2
Foundries	53	11	<5.0	10	<5.4
Nonfèrrous Metals Manufacturing (b) (c) (d)	39	0	ND	0.5	0.2
Ore Mining and Dressing (a)	28	2	NA	10	6.6
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	10
Petroleum Refining (a)	17	0			

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

RESERVED

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a)(1) of the Clean Water Act. These summaries apply to aldrin.

Freshwater Aquatic Life

For freshwater aquatic life the concentration of aldrin should not exceed 3.0 µg/L at any time. No data are available concerning the chronic toxicity of aldrin to sensitive freshwater aquatic life.

Saltwater Aquatic Life

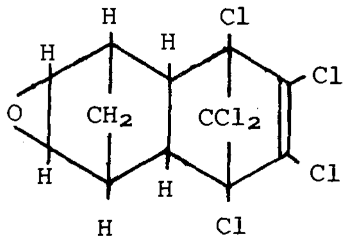
For saltwater aquatic life the concentration of aldrin should not exceed 1.3 µg/L at any time. No data are available concerning the chronic toxicity of aldrin to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of aldrin through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 0.74 ng/L, 0.074 ng/L, and 0.0074 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 0.79 ng/L, 0.079 ng/L, and 0.0079 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Dieldrin

Formula:



Alternate Names: HEOD; 1,2,3,4,10,10-Hexachloro-6,7,-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, exo-5,8-dimethanonaphthalene

CAS #: 60-57-1

Physical, Chemical, and Biological Properties [1-1, 1-2, 1-3, 1-4]:

molecular weight: 381
melting point, °C: 175-176
boiling point (760 torr), °C: Not available
vapor pressure (20°C), torr: 1.78×10^{-7}
solubility in water (25°C), mg/L: 0.20
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 5.8×10^{-5} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.9-5

Probable Fate [1-1]:

photolysis: Direct photolysis may be important

oxidation: Probably not important

hydrolysis: Hydrolysis of epoxide, too slow to be important

volatilization: Is an important process

sorption: Probably an important process

biological processes: Moderate bioaccumulation; resistant to biodegradation

other reactions/interactions: Unknown

Carbon Adsorption Data, Dieldrin (1-8):

ADSORBABILITY

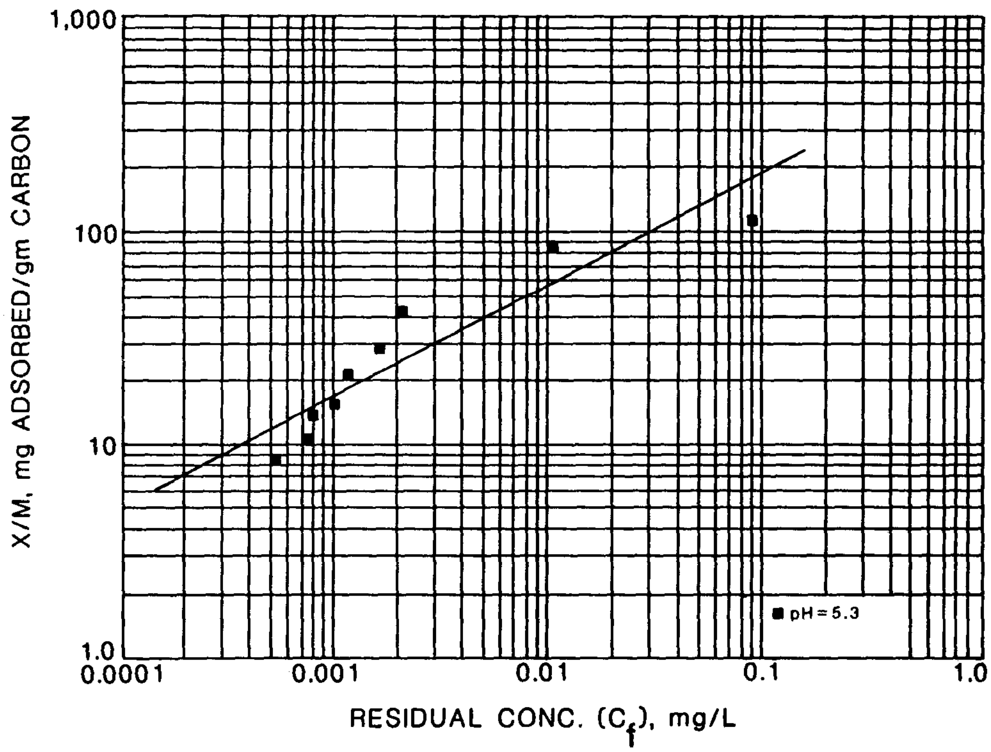
FREUNDLICH PARAMETERS	pH		
	5.3		
K	606		
1/n	0.51		
Corr. Coef. r	0.94		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	4.8	17	56
0.1		1.6	5.5
0.01			0.5

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF DIELDRIN

Industry	Raw wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	45	3	2.2	2.3	2.3
Electrical/Electronic Components (b)	3	0			
Foundries	53	12	<5.0	20	<6.2
Metal Finishing (a) (f)	10	6	ND	3.0	0.51
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (f) (g)	75	0	ND	0.2	0.1
Ore Mining and Dressing (a)	33	0			
Textile Mills (a) (e)	50	3	2.0	5.0	4.0

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF DIELDRIN

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Foundries	53	6	<5.0	<5.0	<5.0
Nonferrous Metals Manufacturing (b) (d) (e)	55	0	ND	0.4	0.1
Ore Mining and Dressing (a)	28	2	NA	10	6.6
Textile Mills (a) (c)	50	2	1.0	5.0	3.0

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Mean calculated using medians.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

RESERVED

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to dieldrin.

Freshwater Aquatic Life

For dieldrin the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0019 mg/L as a 24-hour average and the concentration should not exceed 2.5 mg/L at any time.

Saltwater Aquatic Life

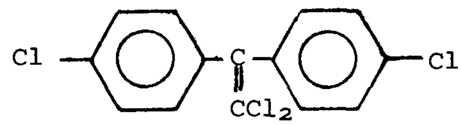
For dieldrin the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0019 mg/L as a 24-hour average and the concentration should not exceed 0.71 mg/L at any time.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of dieldrin through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentrations should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 0.71 mg/L, 0.071 ng/L, and 0.0071 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 0.76 mg/L, 0.076 ng/L, 0.076 ng/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: 4,4'-DDE

Formula:



Alternate Names: Dichlorodiphenyl dichloroethylene; 1,1-Dichloro-2,2-bis(ρ-chlorophenyl)-ethylene

CAS #: 72-55-9

Physical, Chemical, and Biological Properties [1-2, 1-8, 1-28]:

molecular weight: 318
melting point, °C: 88-90
boiling point (760 torr), °C: Not available
vapor pressure (20°C), torr: 6.5×10^{-6}
solubility in water (25°C), µg/L: 1.2-120
log octanol/water partition coefficient: 5.69
Henry's law constant (25°C): 2.34×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.11-5

Probable Fate [1-2]:

photolysis: Photooxidation to chlorinated biphenyls and chlorinated benzophenones occurs; could be important in aquatic systems

oxidation: No information available

hydrolysis: Not important

volatilization: Probably an important process

sorption: Is an important process

biological processes: Bioaccumulation is an important process; resistant to biodegradation

other reactions/interactions: Not important

Carbon Adsorption Data, 4,4'DDE (1-8):

ADSORBABILITY

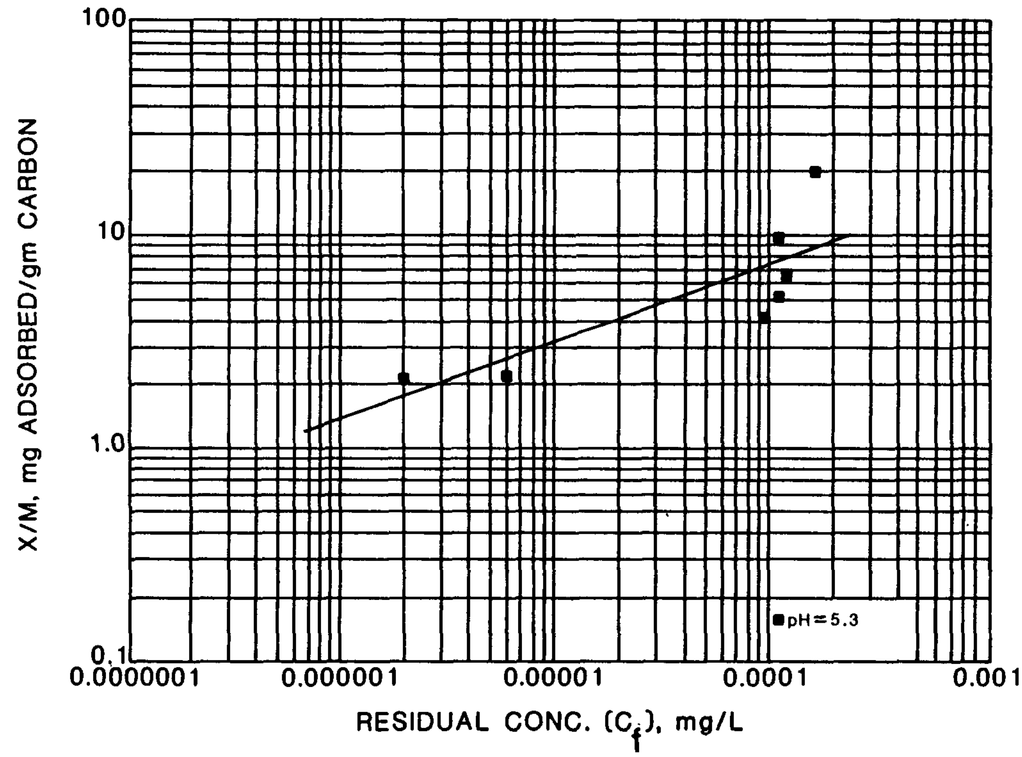
FREUNDLICH PARAMETERS	pH		
	5.3		
K	232		
1/n	0.37		
Corr. Coef. r	0.82		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	9.0	23	55
0.1		2.1	5.5
0.01			0.5

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF 4,4'DDE

Industry	Raw wastewater: Number of samples	Raw wastewater: Number of detections	Detected concentrations, µg/L: Minimum	Detected concentrations, µg/L: Maximum	Detected concentrations, µg/L: Mean
Coal Mining (a)	45	1		2.2	
Aluminum Forming	3	1		2.0	
Foundries	53	16	<5.0	20	<6.9
Metal Finishing (a) (d)	4	4	0.01	53	14
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d)	70	0	ND	0.4	NA
Ore Mining and Dressing (a)	33	1		5.0	
Petroleum Refining (a)	17	1		7.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 4,4'DDE

Industry	Number of samples	Number of detections	Treated wastewater: Detected concentrations, µg/L, Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Aluminum Forming	16	14	<0.01	7.0	<0.76
Foundries	53	9	<5.0	<10	<5.6
Nonferrous Metals Manufacturing (b) (c) (d)	45	0	ND	0.2	0.05
Ore Mining and Dressing (a)	28	0			
Petroleum Refining (a)	17	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 4,4'DDE

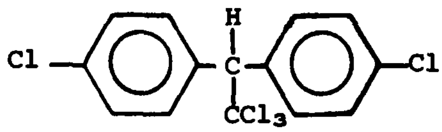
Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Coagulation and Flocculation		1	NM	BDL	III.3.1.5
Oil Separation		2	NM	BDL - BDL	III.3.1.14
Sedimentation		1	NM	BDL	III.3.1.18
Ultrafiltration		1	64*	BDL	III.3.1.21

BDL, below detection limit; NM, not meaningful; *approximate value.

RESERVED

Compound: 4,4'-DDT

Formula:



Alternate Names: Dichloro-diphenyl-trichloroethane;
Chloro-phenotane; Dicophane;
1,1,1-Trichloro-2,2,-bis(p-chlorophenyl)ethane

CAS #: 50-29-3

Physical, Chemical, and Biological Properties [1-1, 1-2, 1-3]:

molecular weight: 354.5
melting point, °C: 108-109
boiling point (760 torr), °C: 185
vapor pressure (20°C), torr: 1.9×10^{-7}
solubility in water (25°C), µg/L: <1.5-5.5
log octanol/water partition coefficient: 3.98
Henry's law constant: Not available
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.11-5

Probable Fate [1-1]:

photolysis: Photooxidation to DDE occurs slowly; indirect photolysis may be important

oxidation: Information not available for aquatic environment

hydrolysis: May be important under certain conditions

volatilization: Is an important process

sorption: Is an important process

biological processes: Biotransformation and bioaccumulation are important processes; resistant to biodegradation

other reactions/interactions: Unknown

Carbon Adsorption Data, 4,4'DDT (1-8):

ADSORBABILITY

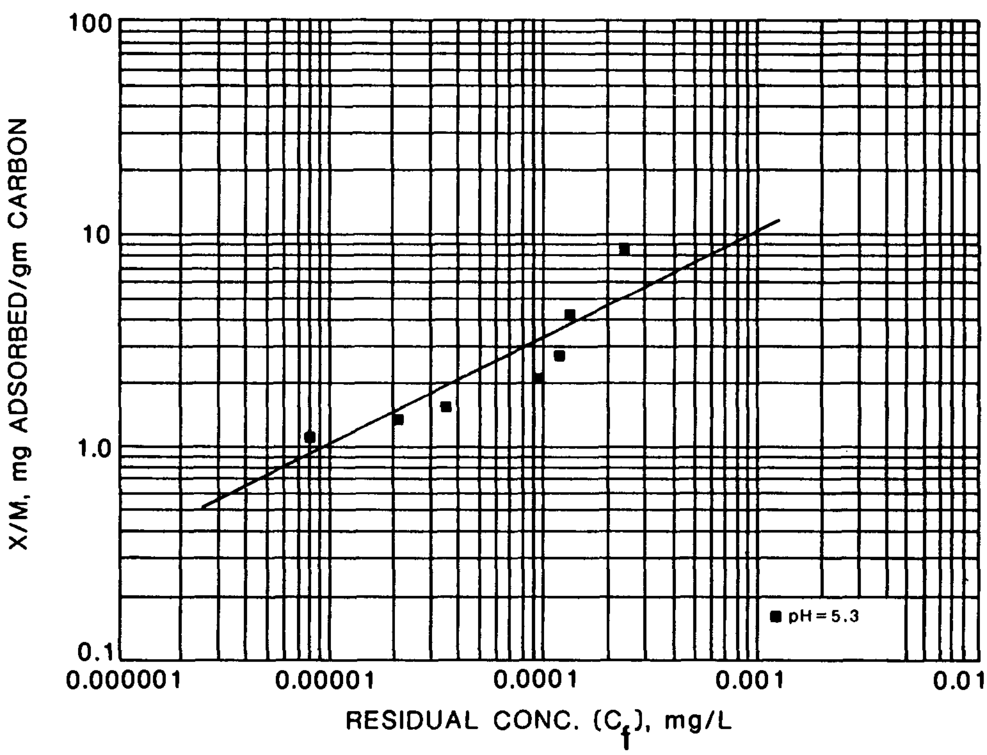
FREUNDLICH PARAMETERS	pH		
	5.3		
K	322		
1/n	0.50		
Corr. Coef. r	0.89		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, Cf mg/L

Co. mg/L	0.1	0.01	0.001
1.0	8.8	31	98
0.1		2.8	9.7
0.01			0.9

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF 4,4'DDT

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	45	0			
Foundries	53	16	<5.0	20	<5.9
Metal Finishing (a) (d)	4	3	ND	10	4.0
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d) (e)	75	0	ND	1.0	0.1
Ore Mining and Dressing (a)	33	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 4,4'DDT

Industry	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
			Minimum	Maximum	Mean
Coal Mining (a)	47	1		2.2	
Foundries	53	16	<5.0	20	<6.2
Nonferrous Metals Manufacturing (b) (c) (d)	55	0	ND	0.4	0.065
Ore Mining and Dressing (a)	28	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR 4,4'DDT

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption -granular	1		NM	BDL	III.3.1.1
Coagulation and Flocculation	1		76*	BDL	III.3.1.5
Filtration	1		NM	BDL	III.3.1.9

BDL, below detection limit; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to DDT and metabolites.

Freshwater Aquatic Life

DDT

For DDT and its metabolites the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0010 μg/L as a 24-hour average and the concentration should not exceed 1.1 μg/L at any time.

TDE

The available data for TDE indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 0.6 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of TDE to sensitive freshwater aquatic life.

DDE

The available data for DDE indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 1,050 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of DDE to sensitive freshwater aquatic life.

Saltwater Aquatic Life

DDT

For DDT and its metabolites the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0010 μg/L as a 24-hour average and the concentration should not exceed 0.13 μg/L at any time.

TDE

The available data for TDE indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 3.6 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of TDE to sensitive saltwater aquatic life.

DDE

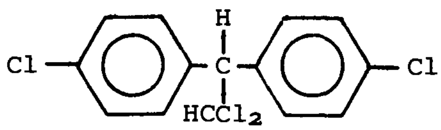
The available data for DDE indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 14 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of DDE to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of DDT through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 0.24 ng/L, 0.024 ng/L, and 0.0024 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 0.24 ng/L, 0.024 ng/L, and 0.0024 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment of an "acceptable" risk level.

Compound: 4,4'-DDD

Formula:



Alternate Names: 1,1-Dichloro-2,2-bis(p-chlorophenyl) ethane

CAS #: 72-54-8

Physical, Chemical, and Biological Properties [1-2, 1-4, 1-28]:

molecular weight: 320.0
melting point, °C: 112
boiling point (760 torr), °C: Not available
vapor pressure (30°C), torr: 10.2×10^{-7}
solubility in water (25°C), mg/L: 0.02-0.09
log octanol/water partition coefficient: 5.99
Henry's law constant (25°C): 2.16×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.11-5

Probable Fate [1-2]:

photolysis: Not important

oxidation: Not important

hydrolysis: Not important

volatilization: May be an important process

sorption: Is an important process

biological processes: Biotransformation and bioaccumulation are important processes; resistant to biodegradation

other reactions/interactions: Unknown

Carbon Adsorption Data, 4,4'DDD (1-8, 1-16):

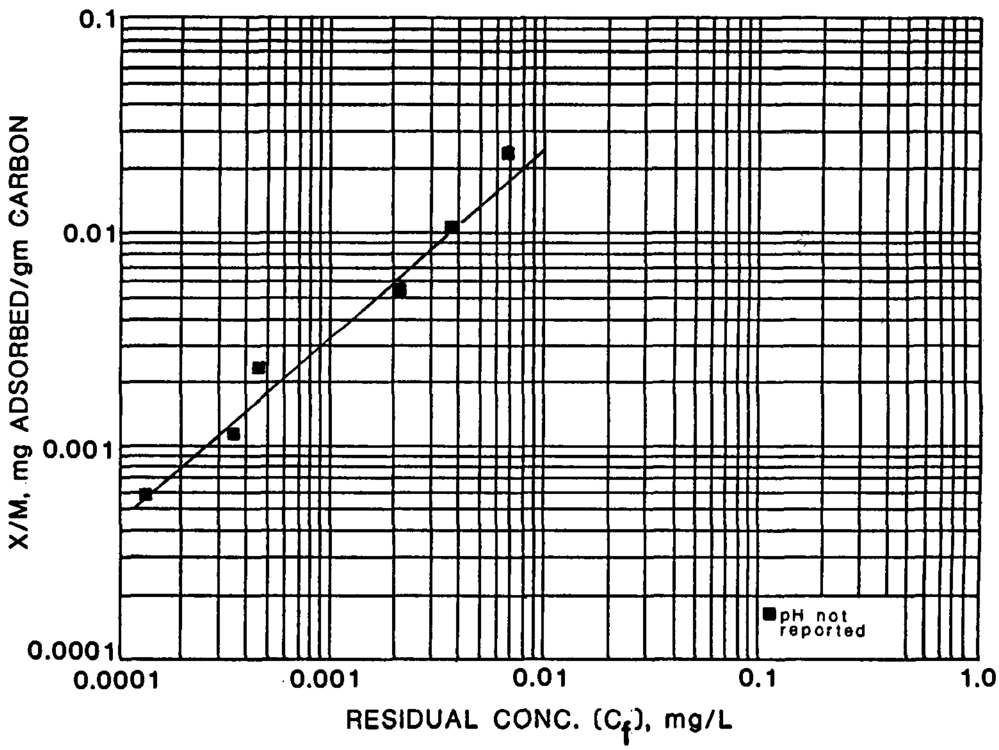
ADSORBABILITY

FREUNDLICH PARAMETERS	pH		
	Not reported		
K	1.7		
1/n	0.89		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	4,100		
0.1			
0.01			



ANALYTICAL METHOD: Not specified

INDUSTRIAL OCCURRENCE OF 4,4'DDD

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	45	1		2.2	
Foundries	53	5	<5.0	<5.0	<5.0
Metal Finishing (a) (f)	3	3	1.0	10	5.0
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (d) (f) (g)	39	0	ND	4.0	1.0
Ore Mining and Dressing (a)	33	1		6.7	
Petroleum Refining (a)	17	1		<5.0	
Steam Electric Power Plants (d)	11	1		<0.01	
Textile Mills (a) (e)	50	1		5.0	

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Verification data plus surveillance and analysis program data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 4,4'DDD

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	1		2.2	
Foundries	53	5	<5.0	<5.0	<5.0
Nonferrous Metals Manufacturing (c) (d) (e)	40	0	ND	0.2	0.1
Ore Mining and Dressing (a)	28	0			
Petroleum Refining (a)	17	0			
Steam Electric Power Plants (b)	11	0			

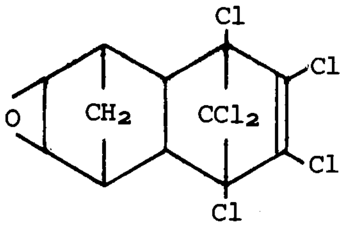
ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Verification data plus surveillance and Analysis program data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: Endrin

Formula:



Alternate Names: 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,endo-5,8-dimethanonaphthalene

CAS #: 72-20-8

Physical, Chemical, and Biological Properties [1-1, 1-2, 1-23, 1-28]:

molecular weight: 380.9
melting point, °C: 235 decomposes
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: 2×10^{-7}
solubility in water (25°C), mg/L: 0.26
log octanol/water partition coefficient: 5.6 (calculated)
Henry's law constant (25°C): 0.5×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.13-5

Probable Fate [1-2]:

photolysis: Photoisomerization occurs, may be important

oxidation: Probably not important

hydrolysis: Hydrolysis of epoxide, too slow to be important

volatilization: Data not available but volatility is likely

sorption: Data not available but sorption is likely

biological processes: Bioaccumulation is an important process; resistant to biodegradation

other reactions/interactions: Unknown

Carbon Adsorption Data, Endrin (1-8):

ADSORBABILITY

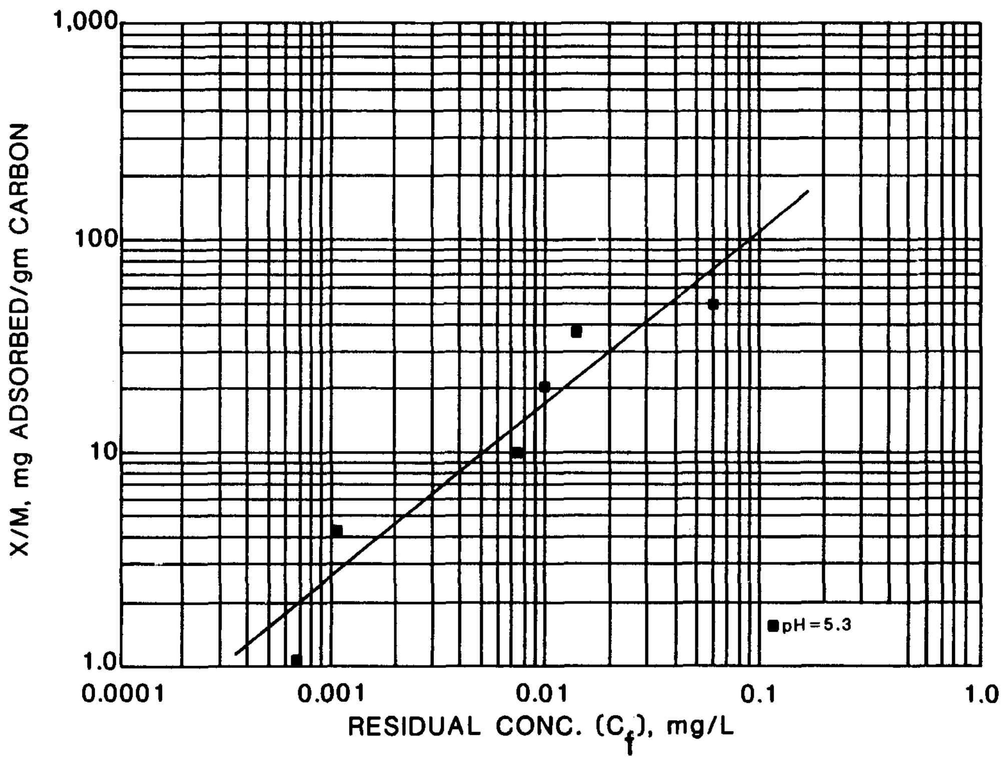
FREUNDLICH PARAMETERS	pH		
	5.3		
K	666		
1/n	0.80		
Corr. Coef. r	0.95		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_0. mg/L	0.1	0.01	0.001
1.0	8.5	60	380
0.1		5.4	37
0.01			3.4

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF ENDRIN

Industry	Raw wastewater Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Foundries	53	6	<5.0	<5.0	<5.0
Metal Finishing (a) (d)	2	2	7.0	10	8.0
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d) (e)	77	0	ND	5.4	0.3
Ore Mining and Dressing (a)	33	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ENDRIN

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Foundries	53	1		<5.0	
Nonferrous Metals Manufacturing (b) (c) (d)	47	0	ND	0.4	0.1
Ore Mining and Dressing (a)	28	1		5.0	

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

RESERVED

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to endrin.

Freshwater Aquatic Life

For endrin the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0023 μg/L as a 24-hour average and the concentration should not exceed 0.18 μg/L at any time.

Saltwater Aquatic Life

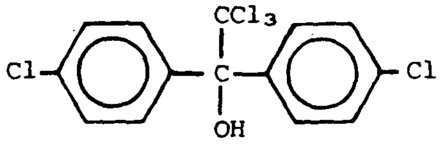
For endrin the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0023 μg/L as a 24-hour average and the concentration should not exceed 0.037 μg/L at any time.

Human Health

The ambient water quality criterion for endrin is recommended to be identical to the existing drinking water standard which is 1.0 μg/L. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Compound: Kelthane

Formula:



Alternate Names: Kelthanethanol;
Dicofol;
2,2,2-Trichloro-1,1-di-(4-chlorophenyl) ethanol

CAS #: 115-32-2

Physical, Chemical, and Biological Properties [1-18, 1-23]:

molecular weight: 370.5
melting point, °C: 77-78
boiling point (760 torr), °C: 77-78
vapor pressure (25°C), torr: Not available
solubility in water: Almost totally insoluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

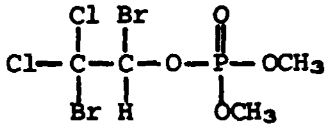
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Naled

Formula:



Alternate Names: Bromex; Orthodibrom;
Phosphoric acid;
1,2-dibromo-2,2-Dichloroethyl dimethyl ester

CAS #: 300-76-5

Physical, Chemical, and Biological Properties [1-18]:

molecular weight: 380.8
melting point, °C: 26
boiling point (0.5 torr), °C: 110
vapor pressure (20°C), torr: 2×10^{-4}
solubility in water: Almost totally insoluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

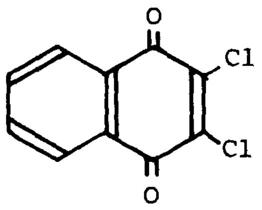
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Dichlone

Formula:



Alternate Names: Phygon; US Rubber 604; 2,3-Dichloro-1,4-naphthoquinone; Sanquinon

CAS #: 117-80-6

Physical, Chemical, and Biological Properties [1-18]:

molecular weight: 227.0
melting point, °C: 195
boiling point (2 torr), °C: 275
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: Insoluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

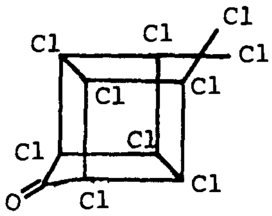
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Kepone

Formula:



Alternate Names: 1,1a,3,3a,4,5,5,5a,5b,6-Decachloroctahydro-1,3,4-metheno-2H-cyclobuta(cd)pentalen-2-one; Merex; Decachloroketone

CAS #: 143-50-0

Physical, Chemical, and Biological Properties [1-1, 1-23]:

molecular weight: 490.6
melting point, °C: Not available
boiling point (760 torr), °C: Sublimes at 350
vapor pressure (25°C), torr: Not available
solubility in water (100°C), mg/L: 4,000
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

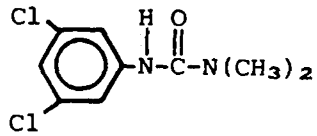
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Diuron

Formula:



Alternate Names: 3-(3,4-Dichlorophenyl)-1,1-dimethylurea

CAS #: 330-54-1

Physical, Chemical, and Biological Properties [1-1, 1-21, 1-23]:

molecular weight: 233.1
melting point, °C: 158-159
boiling point (760 torr), °C: Decomposes at 180
vapor pressure (50°C), torr: 0.31×10^{-5}
solubility in water (temp. unknown), mg/L: 42
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

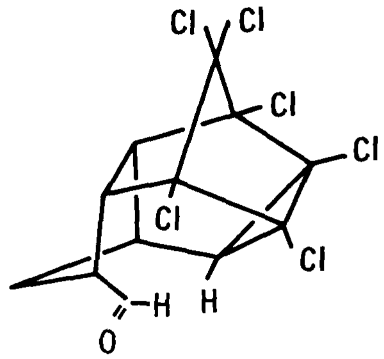
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Endrin aldehyde

Formula:



Alternate Names: 1,2,4-Methenocyclopenta (c,d)pentalene-r-carboxaldehyde,2,2a,3,3,4,7-hexachlorodecahydro

CAS #: 7421-93-4

Physical, Chemical, and Biological Properties [1-2]:

molecular weight: 380.9
melting point, °C: 145-149
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: Not available
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: See page I.13.13-5

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF ENDRIN ALDEHYDE

	Raw wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Coal Mining (a)	45	2	2.2	2.2	2.2
Aluminum Forming	3	1		58	
Foundries	53	13	4.0	20	<6.8
Metal Finishing (a) (d)	9	6	ND	14	6.0
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d) (e)	75	0	ND	0.6	0.15
Ore Mining and Dressing (a)	33	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ENDRIN ALDEHYDE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	0			
Aluminum Forming	16	3	0.3	14	6.1
Foundries	53	5	<5.0	20	<8.0
Nonferrous Metals Manufacturing (b) (c) (d)	55	0	ND	0.6	0.12
Ore Mining and Dressing (a)	28	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ENDRIN ALDEHYDE

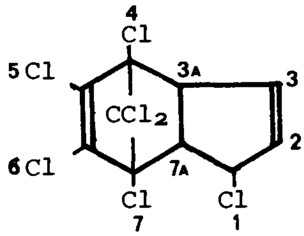
Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Oil Separation		1	>99	ND	III.3.1.14
Ultrafiltration		1	NM	BDL	III.3.1.21

BDL, below detection limit; ND, not detected; NM, not meaningful.

RESERVED

<u>Compound</u>: Heptachlor

<u>Formula</u>:



<u>Alternate Names</u>: 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene

<u>CAS #</u>: 76-44-8

<u>Physical, Chemical, and Biological Properties</u> [1-1, 1-2, 1-15, 1-21, 1-23]:

molecular weight: 373.3
melting point, °C: 95-96
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: 3×10^{-4}
solubility in water (25°C), mg/L: 0.056-0.18
log octanol/water partition coefficient: 4.40
Henry's law constant (25°C): 1.48×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.20-5

<u>Probable Fate</u> [1-2]:

photolysis: Photoisomerization occurs, rate undetermined

oxidation: Information not available

hydrolysis: Hydrolyzes rapidly to 1-hydroxychlordane which is stable

volatilization: Data not available but volatility is likely

sorption: Probably an important process, but no reliable data available

biological processes: Will bioaccumulate if not hydrolyzed; resistant to biodegradation

other reactions/interactions: Not important

Carbon Adsorption Data, Heptachlor (1-8):

ADSORBABILITY

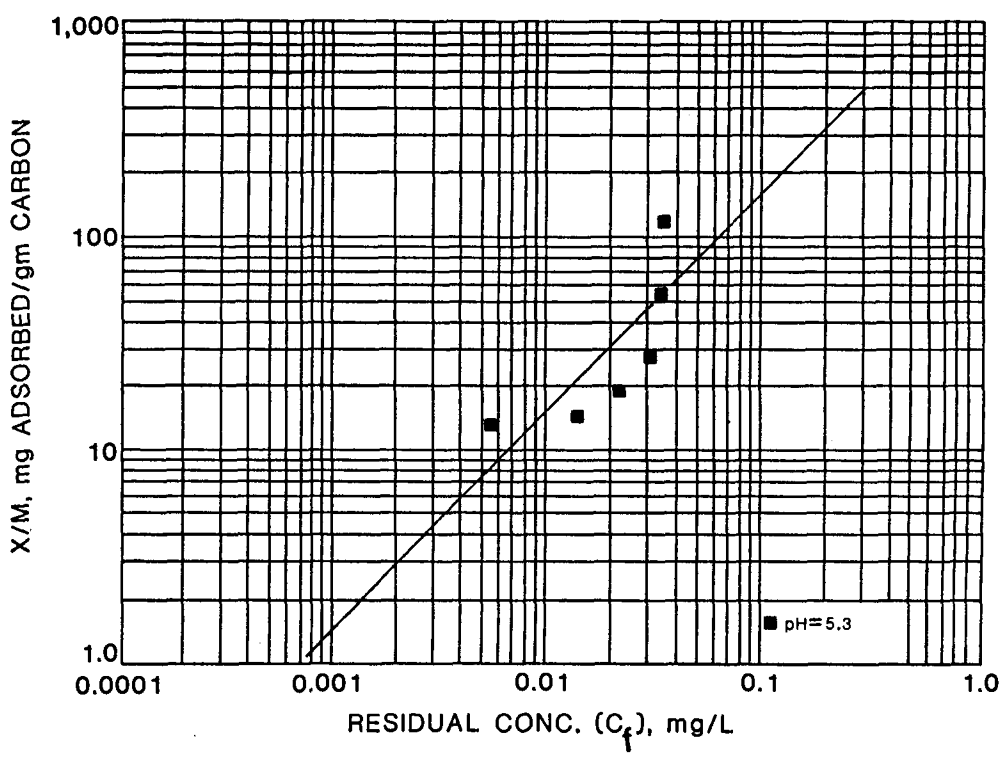
FREUNDLICH PARAMETERS	pH		
	5.3		
K	1,220		
1/n	0.95		
Corr. Coef. r	0.78		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	6.6	64	580
0.1		5.9	57
0.01			5.2

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF HEPTACHLOR

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	45	2	2.2	2.2	2.2
Foundries	53	7	<5.0	20	<7.1
Metal Finishing (b) (f)	3	2	ND	0.3	0.1
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (f) (g)	75	0	ND	0.5	0.1
Ore Mining and Dressing	33	1		7.5	
Petroleum Refining (b)	17	2	<5.0	<5.0	<5.0
Textile Mills (b) (e)	50	3	5.0	6.0	5.0

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF HEPTACHLOR

			Treated wastewater		
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	47	2	2.2	2.2	2.2
Foundries	53	11	<5.0	31	<8.7
Nonferrous Metals Manufacturing (c) (e) (f)	55	0	ND	0.7	0.06
Ore Mining and Dressing (b)	28	2	NA	10	6.6
Petroleum Refining (b)	17	1		<5.0	
Textile Mills (b) (d)	50	1		2.0	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Detections >10 µg/L.
(d) Mean calculated using medians.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR HEPTACHLOR

Treatment process	Number of data points		Range of removal, %	Range of effluent conc., µg/L	Volume III section number
	Pilot scale	Full scale			
Activated Carbon Adsorption -granular	1		NM	BDL	III.3.1.1
Coagulation and Flocculation	1		64*	BDL	III.3.1.5
Filtration		1	NM	BDL	III.3.1.9
Activated Sludge		1	75	1.6	III.3.2.1

BDL, below detection limit; NM, not meaningful; *approximate value.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to heptachlor.

Freshwater Aquatic Life

For heptachlor the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0038 µg/L as a 24-hour average and the concentration should not exceed 0.52 µg/L at any time.

Saltwater Aquatic Life

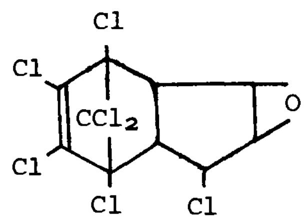
For heptachlor the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0036 µg/L as a 24-hour average and the concentration should not exceed 0.053 µg/L at any time.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of heptachlor through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 2.78 ng/L, 0.28 ng/L, and 0.028 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 2.85 ng/L, 0.29 ng/L, and 0.029 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Heptachlor epoxide

Formula:



Alternate Names: 1,4,5,6,7,8,8-Heptachloro-2,3-epoxy-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene

CAS #: 1024-57-3

Physical, Chemical, and Biological Properties [1-1, 1-2, 1-15]:

molecular weight: 389.3
melting point, °C: 157-160
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: 0.35-0.20
log octanol/water partition coefficient: 3.65
Henry's law constant (25°C): 3.2×10^{-5} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.20-5

Probable Fate [1-2]:

photolysis: Possible dechlorination of C=C double bond

oxidation: Probably not important

hydrolysis: Stable to hydrolysis

volatilization: Information not available but volatility is likely

sorption: Sorption on clay and algae

biological processes: Strong bioaccumulation; biotransformation occurs very slowly, but could be important; resistant to biodegradation

other reactions/interactions: Unknown

Carbon Adsorption Data, Heptachlor epoxide (1-8):

ADSORBABILITY

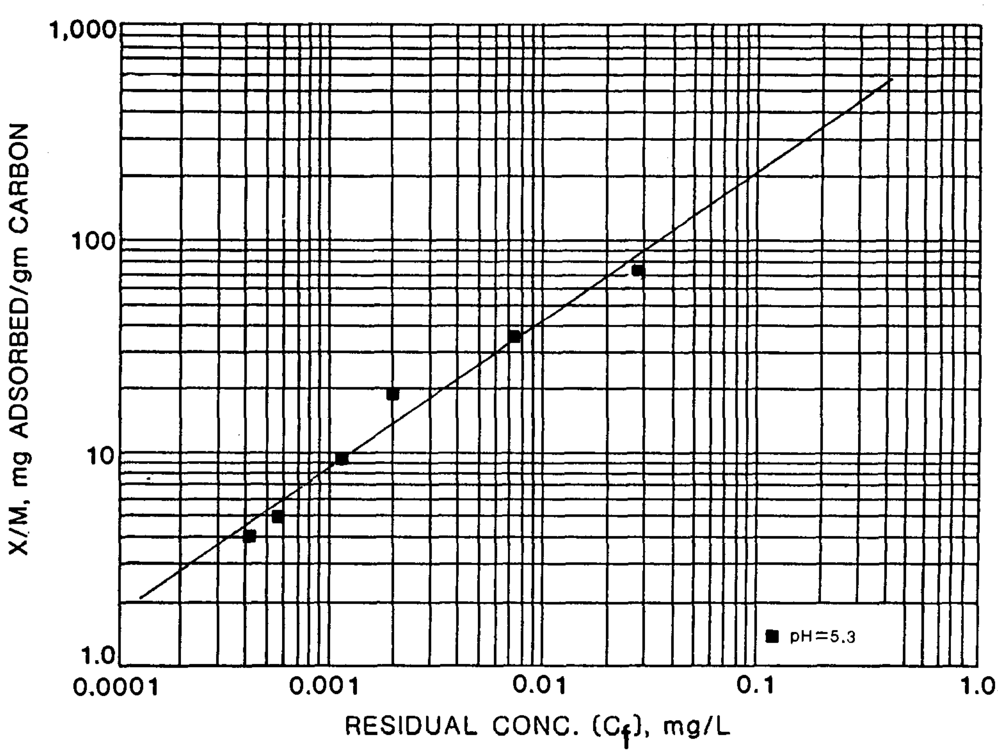
FREUNDLICH PARAMETERS	pH		
	5.3		
K	1,038		
1/n	0.70		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	4.3	24	120
0.1		2.2	12
0.01			1.1

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF HEPTACHLOR EPOXIDE

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	45	3	0.2	2.2	1.6
Electrical/Electronic Components (b)	3	0			
Foundries	53	5	<5.0	<5.0	<5.0
Metal Finishing (a) (f)	1	1		0.01	
Photographic Equipment/Supplies (c)	7	0			
Nonferrous Metals Manufacturing (d) (f) (g)	72	0	ND	0.2	0.055
Ore Mining and Dressing (a)	33	0			
Petroleum Refining (a)	17	1		<5.0	
Textile Mills (a) (e)	50	1		1.0	

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Analytic method not specified.
(c) Screening plus additional data.
(d) Detections >10 µg/L.
(e) Mean calculated using medians.
(f) Minimum, maximum, and mean are based on the number of samples, not detections.
(g) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF HEPTACHLOR EPOXIDE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Coal Mining (a)	47	1		2.2	
Foundries	53	7	<5.0	<5.0	<5.0
Nonferrous Metals Manufacturing (b) (c) (d)	53	0	ND	0.7	0.01
Ore Mining and Dressing (a)	28	0			
Petroleum Refining (a)	17	0			

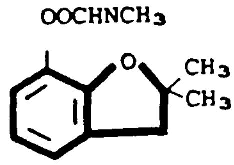
ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: Carbofuran

Formula:



Alternate Names [1-1]: 2,3-Dihydro-2,2-dimethyl-7-benzofuranol methylcarbamate; Methyl carbamic acid; 2,3-Dihydro-2,2-dimethyl-7-benzofuranyl ester

CAS #: 156-36-62

Physical, Chemical, and Biological Properties [1-9, 1-23, 1-28]:

molecular weight: 221.3
melting point, °C: 150-153
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: 2×10^{-5}
solubility in water (25°C), mg/L: 700
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 8.28×10^{-9} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

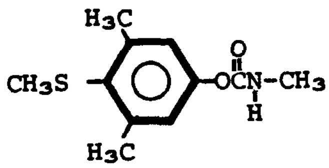
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Mercaptodimethur

Formula:



Alternate Names: Methiocarb;
Mesurol

CAS #: 2032-65-7

Physical, Chemical, and Biological Properties [1-18]:

molecular weight: 225.3
melting point, °C: 117-118
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Negligible
solubility in water (25°C), mg/L: Insoluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

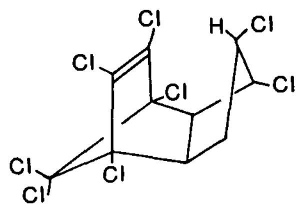
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Chlordane

Formula:



Technical chlordane is a mixture of chlorinated products with as many as 45 components as identified by gas chromatography. Major components are cis and trans isomers of chlordane

Alternate Names: 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane; trans-Chlordane

CAS #: 5103-71-9

Physical, Chemical, and Biological Properties [1-2, 1-15, 1-23]:

molecular weight: 406
melting point, °C: 103-105 (trans)
boiling point (2 torr), °C: 175
vapor pressure (25°C), torr: 1×10^{-5}
solubility in water (25°C), mg/L: 1.85, 0.056
log octanol/water partition coefficient: 2.78
Henry's law constant (25°C): 4.8×10^{-5} atmos. m^3 $mole^{-1}$
biodegradability: N-not significantly degraded
water quality criteria: See page I.13.24-5

Probable Fate [1-2]:

photolysis: Information not available on aqueous systems

oxidation: Information not available

hydrolysis: Compound stable in aqueous systems

volatilization: Volatilization can occur, but slowly

sorption: Specific information not available, however, sorption on particulates is highly likely to occur

biological processes: Bioaccumulation is an important process with concentration factors of 10^2 - 10^4; compound is very resistant to microbial degradation

other reactions/interactions: Not important

Carbon Adsorption Data, Chlordane (1-8):

ADSORBABILITY

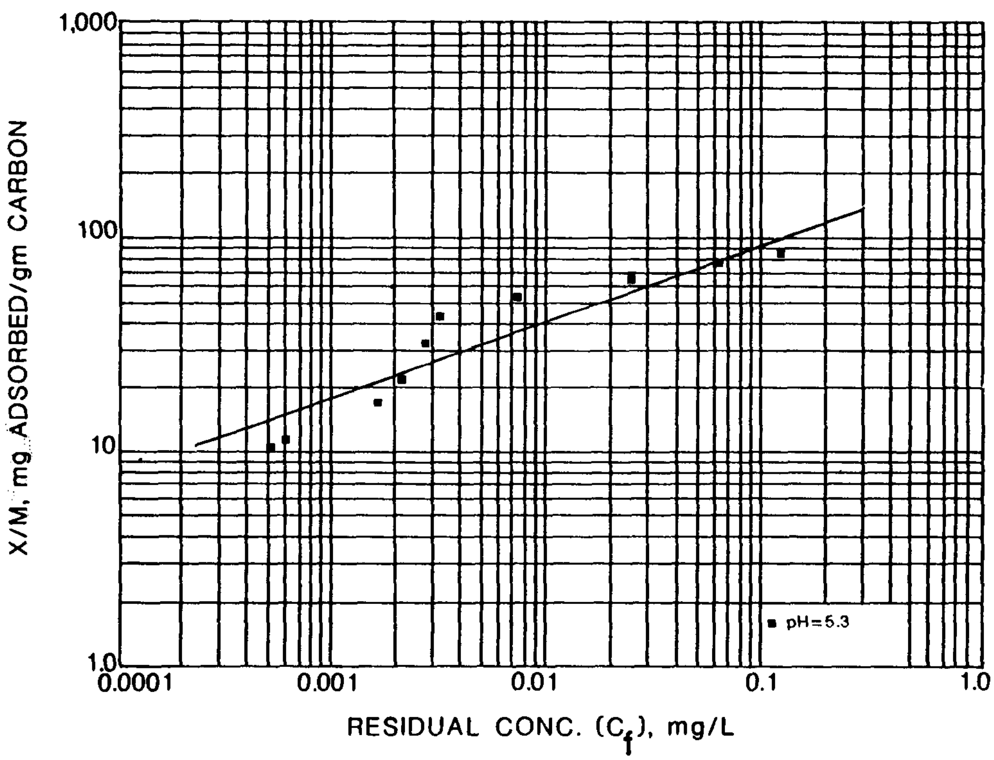
FREUNDLICH PARAMETERS	pH		
	5.3		
K	245		
1/n	0.38		
Corr. Coef. r	0.95		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	8.8	23	56
0.1		2.1	5.6
0.01			0.5

(a) Carbon doses in mg/L at pH 5.3



ANALYTICAL METHOD: Solvent extraction - G.C.

INDUSTRIAL OCCURRENCE OF CHLORDANE

	Raw wastewater				
	Number of	Number of	Detected concentrations, µg/L		
Industry	samples	detections	Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Leather Tanning and Finishing	18	1		<10	
Aluminum Forming	19	12	<0.01	1.9	<0.2
Foundries	53	6	<5.0	38	<10
Metal Finishing (a) (d)	2	2	0.8	13	7.0
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d) (e)	75	0	ND	1.2	0.14
Ore Mining and Dressing (a)	33	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.
(e) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF CHLORDANE

	Treated wastewater				
			Detected concentrations, µg/L		
Industry	Number of samples	Number of detections	Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Foundries	53	12	<5.0	24	<6.6
Nonferrous Metals Manufacturing (b) (c) (d)	57	0	ND	1.6	0.88
Ore Mining and Dressing (a)	28	0			
Petroleum Refining (a)	17	0			

ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Detections >10 µg/L.
(c) Minimum, maximum, and mean are based on the number of samples, not detections.
(d) Mean is not representative of all subcategories due to lack of data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR CHLORDANE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Filtration		1	37	24	III.3.1.9
Activated Sludge	1		NM	BDL	III.3.2.1

BDL, below detection limit; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to chlordane.

Freshwater Aquatic Life

For chlordane the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0043 µg/L as a 24-hour average and the concentration should not exceed 2.4 µg/L at any time.

Saltwater Aquatic Life

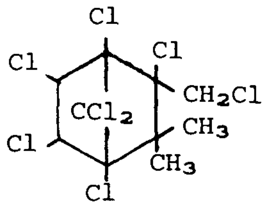
For chlordane the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0040 µg/L as a 24-hour average and the concentration should not exceed 0.09 µg/L at any time.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of chlordane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 4.6 ng/L, 0.46 ng/L, and 0.046 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 4.8 ng/L, 0.48 ng/L, and 0.048 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Toxaphene

Formula:



Alternate Names: Polychlorocamphene

CAS #: 8001-35-2

Physical, Chemical, and Biological Properties [1-2, 1-15, 1-22, 1-24]:

molecular weight: 414 (average for mixture of chlorinated camphenes)
melting point, °C: 70-90
boiling point (760 torr), °C: Decomposes >120
vapor pressure (25°C), torr: 0.2-0.4
solubility in water (25°C), mg/L: 0.5-3.0
log octanol/water partition coefficient: 3.3 ± 0.4
Henry's law constant (25°C): 4.89×10^{-3} atmos. m^3 $mole^{-1}$
biodegradability: Not available
water quality criteria: See page I.13.25-5

Probable Fate [1-2]

photolysis: Not an important process

oxidation: Information not available

hydrolysis: Too slow to be important

volatilization: May be an important process

sorption: Is an important process

biological processes: Bioaccumulation is an important process; biodegraded in anaerobic systems, but not in aerobic systems

other reactions/interactions: Unknown

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF TOXAPHENE

Industry	Raw wastewater Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	46	0			
Foundries	53	1		<5.0	
Photographic Equipment/Supplies (b)	7	0			
Nonferrous Metals Manufacturing (c) (d)	29	0	ND	0.4	NA
Ore Mining and Dressing (a)	32	0			

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.
(c) Detections >10 µg/L.
(d) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF TOXAPHENE

	Treated wastewater				
	Number of samples	Number of detections	Detected concentrations, µg/L		
Industry			Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Foundries	53	0			
Nonferrous Metals Manufacturing	16	0			
Ore Mining and Dressing (a)	27	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

RESERVED

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to toxaphene.

Freshwater Aquatic Life

For toxaphene the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.013 µg/L as a 24-hour average and the concentration should not exceed 1.6 µg/L at any time.

Saltwater Aquatic Life

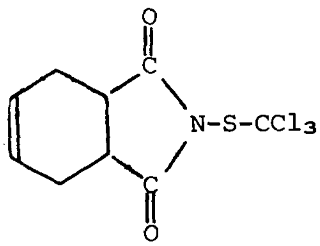
For saltwater aquatic life the concentration of toxaphene should not exceed 0.070 µg/L at any time. No data are available concerning the chronic toxicity of toxaphene to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of toxaphene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. [There is no recognized safe concentration for a human carcinogen]. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. [A risk of 10^{-5}, for example, indicates a probability of one additional case of cancer for every 100,000 people exposed]. The corresponding criteria are 7.1 ng/L, 0.71 ng/L, and 0.07 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 7.3 ng/L, 0.73 ng/L, and 0.07 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Compound: Captan

Formula:



Alternate Names: N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboxylic acid,imide

CAS #: 133-06-2

Physical, Chemical, and Biological Properties [1-18, 1-22, 1-28]:

molecular weight: 300.6
melting point, °C: 158-164
boiling point (760 torr), °C: Decomposes near melting point
vapor pressure (25°C), torr: 6×10^{-5}
solubility in water (25°C), mg/L: <0.5
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): $>4.7 \times 10^{-5}$ atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

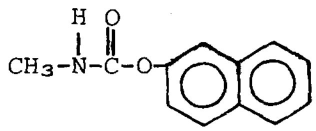
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Carbaryl

Formula:



Alternate Names: 1-Naphthyl methylcarbamate;
Methylcarbamic acid;
1-naphthyl ester; Sevin

CAS #: 63-25-2

Physical, Chemical, and Biological Properties [1-18, 1-28]:

molecular weight: 201.2
melting point, °C: 142
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: <0.005
solubility in water (30°C), mg/L: 40
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): $<3.2 \times 10^{-5}$ atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

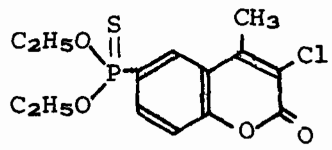
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Coumaphos

Formula:



Alternate Names: O-(3-Chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl),O,O-diethyl phosphorothioate; Co-Ral

CAS #: 56-72-4

Physical, Chemical, and Biological Properties [1-21, 1-23, 1-28]:

molecular weight: 362.8
melting point, °C: 90-92
boiling point (760 torr), °C: Not available
vapor pressure (20°C), torr: 1×10^{-7}
solubility in water (25°C), mg/L: 1.5
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 3.2×10^{-8} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

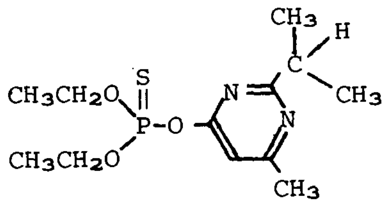
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Diazinon

Formula:



Alternate Names: 0,0-Diethyl-0-(2-isopropyl-6-methyl-4-pyrimidinyl)ester

CAS #: 333-41-5

Physical, Chemical, and Biological Properties [1-25, 1-28]:

molecular weight: 304.4
melting point, °C: Not available
boiling point (2×10^{-3} torr), °C: 83-84
vapor pressure (20°C), torr: 1.4×10^{-4}
solubility in water (20°C), mg/L: 40
log octanol/water partition coefficient: Not available
Henry's law constant (20°C): 1.4×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

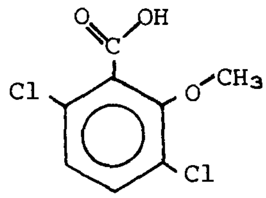
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Dicamba

Formula:



Alternate Names: Banvel;
3,6-Dichloro-o-anisic acid

CAS #: 1918-00-9

Physical, Chemical, and Biological Properties [1-1, 1-21, 1-23]:

molecular weight: 221.0
melting point, °C: 114-116
boiling point (760 torr), °C: Not available
vapor pressure (100°C), torr: 3.75×10^{-3}
solubility in water (25°C), mg/L: 4,500
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

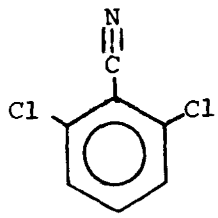
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Dichlobenil

Formula:



Alternate Names: Casoron 113;
2,6-Dichlorobenzonitrile

CAS #: 1194-65-6

Physical, Chemical, and Biological Properties [1-23, 1-28]:

molecular weight: 172
melting point, °C: 139-145
boiling point (760 torr), °C: 270
vapor pressure (20°C), torr: 5.5×10^{-4}
solubility in water (20°C), mg/L: 25
log octanol/water partition coefficient: Not available
Henry's law constant (20°C): 5.0×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

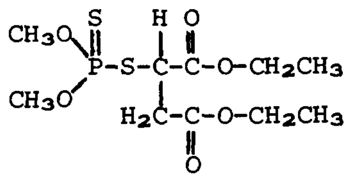
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Malathion

Formula:



Alternate Names: Diethyl mercaptosuccinate;
s-ester with 0,0-dimethyl phosphorodithioate

CAS #: 121-75-5

Physical, Chemical, and Biological Properties [1-21, 1-22]:

molecular weight: 330
melting point, °C: 2.85
boiling point (0.7 torr), °C: 156-157 (slight decomposition)
vapor pressure (20°C), torr: 4×10^{-5}
solubility in water, mg/L: 145
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

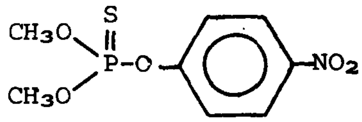
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Methyl parathion

Formula:



Alternate Names: 0,0-Dimethyl-0-ρ-nitrophenyl phosphorothioate

CAS #: 298-00-0

Physical, Chemical, and Biological Properties [1-21, 1-26, 1-28]:

molecular weight: 263.2
melting point, °C: 35-36
boiling point (760 torr), °C: Thermally unstable
vapor pressure (20°C), torr: 0.97×10^{-5}
solubility in water (25°C), mg/L: 55-60
log octanol/water partition coefficient: Not available
Henry's law constant (25°): 5.4×10^{-8} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Methyl parathion (1-8, 1-16):

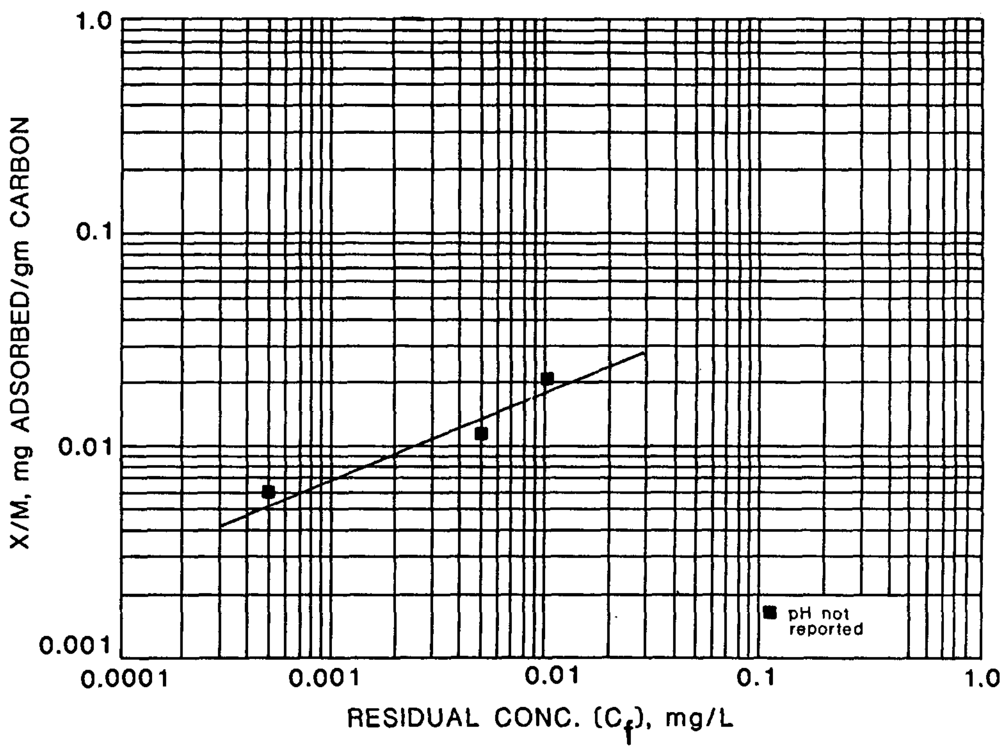
ADSORBABILITY

FREUNDLICH PARAMETERS	pH		
	Not reported		
K	0.11		
1/n	0.38		
Corr. Coef. r	0.99		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

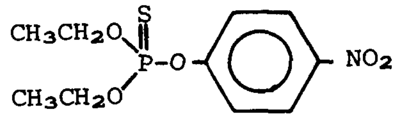
C_o. mg/L	0.1	0.01	0.001
1.0	20,000	52,000	125,360
0.1		4,700	12,400
0.01			1,130



ANALYTICAL METHOD: Not specified.

Compound: Parathion

Formula:



Alternate Names: 0,0-Diethyl-0-ρ-nitrophenyl phosphorothioate

CAS #: 56-38-2

Physical, Chemical, and Biological Properties [1-4, 1-23, 1-28]:

molecular weight: 291.3
melting point, °C: 6.1
boiling point (760 torr), °C: 375
vapor pressure (20°C), torr: 3.78×10^{-5}
solubility in water (25°C), mg/L: 24
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 6.1×10^{-7} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Parathion (1-8, 1-16):

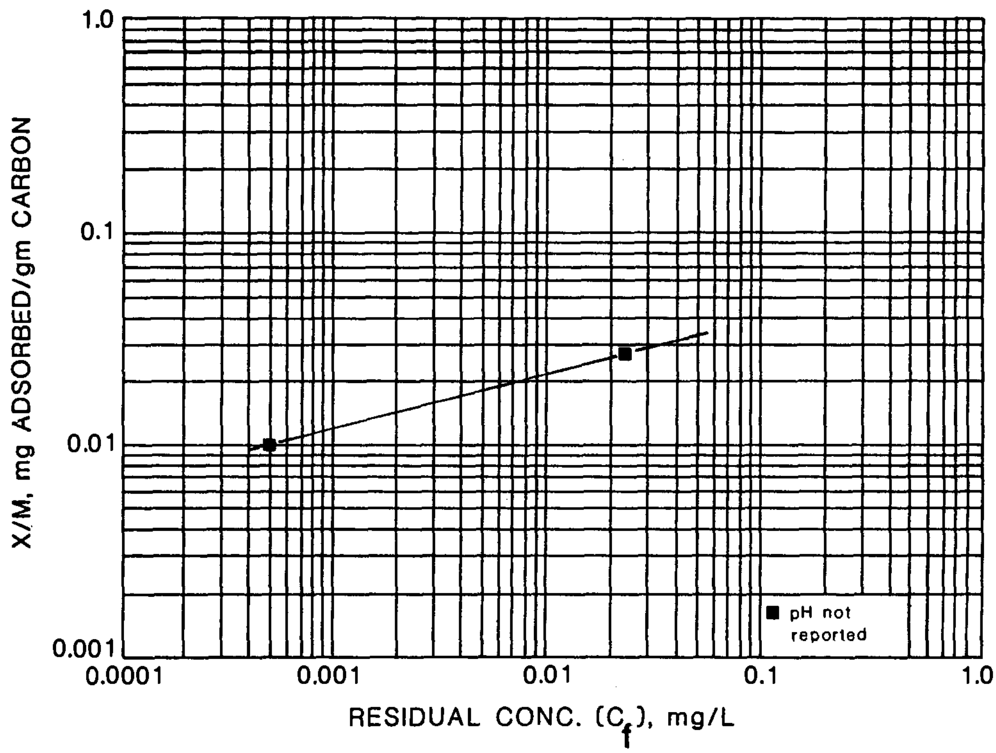
ADSORBABILITY

FREUNDLICH PARAMETERS	pH		
	Not reported		
K	0.08		
1/n	0.27		
Corr. Coef. r	1.0		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

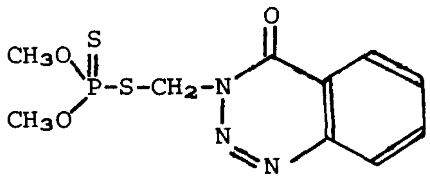
C_o, mg/L	0.1	0.01	0.001
1.0	21,000	43,000	80,600
0.1		3,900	8,000
0.01			730



ANALYTICAL METHOD: Not specified.

Compound: Guthion

Formula:



Alternate Names: Azinphos-methyl;
Benzotriazinedithiophosphoric acid dimethoxy ester

CAS #: 86-50-0

Physical, Chemical, and Biological Properties [1-23, 1-25, 1-28]:

molecular weight: 317.3
melting point, °C: 73-74
boiling point (760 torr), °C: Decomposes at 200
vapor pressure (20°C), torr: $<3.8 \times 10^{-4}$
solubility in water (25°C), mg/L: 33
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): $<3.8 \times 10^{-6}$ atmos. m^3 $mole^{-1}$ (calculated)
biodegradability (25°C): $<3.8 \times 10^{-6}$ atmos. m^3 $mole^{-1}$ (calculated)
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

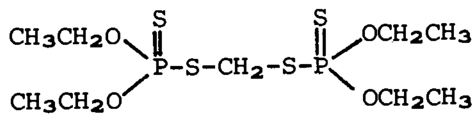
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Ethion

Formula:



Alternate Names: O,O,O',O'-Tetraethyl-S,S'-methylene-bisphosphorodithioate

CAS #: 563-12-2

Physical, Chemical, and Biological Properties [1-25]:

molecular weight: 384.5
melting point, °C: -12 to -13
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: 1.5×10^{-6}
solubility in water: Slightly soluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

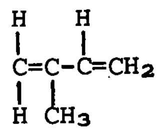
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Isoprene

Formula:



Alternate Names: 2-Methyl-1,3-butadiene

CAS #: 78-79-5

Physical, Chemical, and Biological Properties [1-25]:

molecular weight: 68.13
melting point, °C: ~-120
boiling point (760 torr), °C: 34.1
vapor pressure (15.4°C), torr: 400
solubility in water (25°C), mg/L: Almost totally insoluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

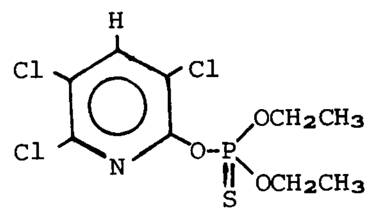
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Chlorpyrifos

Formula:



Alternate Names: Dursban; O,O-Diethyl-O-(3,5,6-trichloro-2-pyridyl)-phosphorothioate; Lorsban; Dowco 179

CAS #: 2921-88-2

Physical, Chemical, and Biological Properties [1-25, 1-28]:

molecular weight: 350.6
melting point, °C: 41-42
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: 1.8×10^{-5}
solubility in water (35°C), mg/L: 2
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 4.1×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

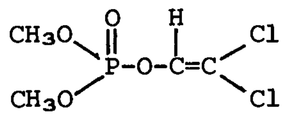
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Dichlorvos

Formula:



Alternate Names: 2,2-Dichlorovinyl-O,O-dimethyl phosphate

CAS #: 62-73-7

Physical, Chemical, and Biological Properties [1-9, 1-23, 1-28]:

molecular weight: 221
melting point, °C: Not available
boling point (20 torr), °C: 140
vapor pressure (20°C), torr: 1.2×10^{-2}
solubility in water (20°C), mg/L: 10,000
log octanol/water partition coefficient: Not available
Henry's law constant (20°C): 3.4×10^{-7} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

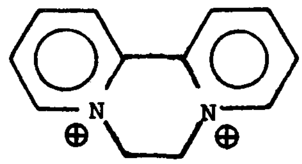
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Diquat

Formula:



Alternate Names: Usually exists as diquat dibromide

CAS #: 85-00-7 (Diquat dibromide)

Physical, Chemical, and Biological Properties of Diquat Dibromide [1-25]:

molecular weight: 344.1
melting point, °C: 335-340
boiling point (760 torr), °C: Decomposes 335-340
vapor pressure (25°C), torr: Not available
solubility in water (20°C), mg/L: 700,000
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

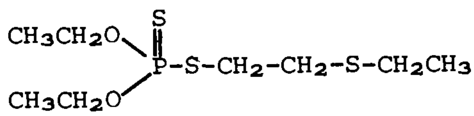
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Disulfoton

Formula:



Alternate Names: O,O-Diethyl-S-[2-(ethylthio)ethyl] phosphorodithioate

CAS #: 298-04-4

Physical, Chemical, and Biological Properties [1-25, 1-28]:

molecular weight: 274.4
melting point, °C: >-25
boiling point (1.5 torr), °C: 132-133
vapor pressure (20°C), torr: 1.8×10^{-4}
solubility in water (23°C), mg/L: 25
log octanol/water partition coefficient: Not available
Henry's law constant (20°C): 2.5×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate : Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

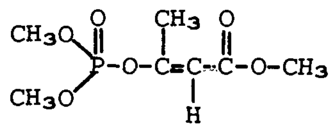
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Mevinphos

Formula:



Alternate Names: Phosdrin;
2-Methoxycarbonyl-1-methylvinyl dimethyl phosphate

CAS #: 7786-34-7

Physical, Chemical, and Biological Properties [1-25]:

molecular weight: 224.2
melting point, °C: Not available
boiling point (1 torr), °C: 106-108
vapor pressure (21°C), torr: 2.9×10^{-3}
solubility in water (25°C), mg/L: Miscible
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

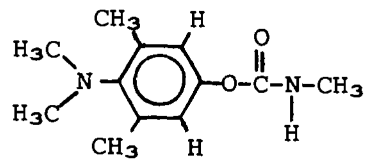
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Mexacarbate

Formula:



Alternate Names: Zectran;
4-Dimethylamino-3,5-xylyl-N-methylcarbamate

CAS #: 315-18-4

Physical, Chemical, and Biological Properties [1-23, 1-25]:

molecular weight: 222.3
melting point, °C: 85
boiling point (760 torr), °C: Not available
vapor pressure (139°C), torr: <0.1
solubility in water (25°C), mg/L: 100
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate : Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

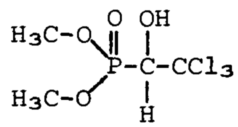
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Trichlorfon

Formula:



Alternate Names: Dylox;
Dimethyl(2,2,2-trichloro-1-hydroxyethyl) phosphonate

CAS #: 52-68-6

Physical, Chemical, and Biological Properties [1-21, 1-23, 1-28]:

molecular weight: 257
melting point, °C: 81-82
boiling point (0.1 torr), °C: 100
vapor pressure (25°C), torr: 7.8×10^{-6}
solubility in water (25°C), mg/L: 154,000
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 1.71×10^{-11} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

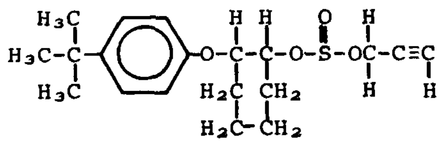
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Propargite

Formula:



Alternate Names: Omite;
2-(ρ-tert-Butylphenoxy) cyclohexyl-2-proponyl sulfite

CAS #: 2312-35-8

Physical, Chemical, and Biological Properties [1-23]:

molecular weight: 350
melting point, °C: Not available
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: Insoluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Carbon disulfide

Formula: S=C=S

Alternate Names: Dithiocarbonic anhydride

CAS #: 75-15-0

Physical, Chemical, and Biological Properties [1-25, 1-28]:

molecular weight: 76.14
melting point, °C: -111
boiling point (760 torr), °C: 46.3
vapor pressure (25°C), torr: 360
solubility in water (20°C), mg/L: 2,940
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 1.33×10^{-2} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

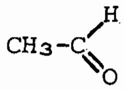
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Acetaldehyde

Formula:



Alternate Names: Ethanal;
Ethyl aldehyde

CAS #: 75-07-0

Physical, Chemical, and Biological Properties [1-6, 1-25, 1-28]:

molecular weight: 44.05
melting point, °C: -124
boiling point (760 torr), °C: 21
vapor pressure (20°C), torr: 740
solubility in water (25°C), mg/L: Miscible
log octanol/water partition coefficient: Not available
Henry's law constant (15°C): 3.24×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: 93% acetaldehyde removal (measured as BOD) obtained in 5-day static activated sludge test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

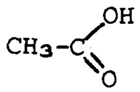
Carbon Adsorption Data: Not available

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ACETALDEHYDE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., μg/L	Volume III section number
Solvent Extraction	5		15 - 97	4,000 - 1.1 × 10E6	III.3.1.20

Compound: Acetic acid

Formula:



Alternate Names: Ethanoic acid;
Methane carboxylic acid;
Vinegar acid

CAS #: 64-19-7

Physical, Chemical, and Biological Properties [1-6, 1-28]:

molecular weight: 60.05
melting point, °C: 16.7
boiling point (760 torr), °C: 118
vapor pressure (20°C), torr: 11.4
solubility in water (20°C), mg/L: Miscible
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 1.08×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: 50% theoretical oxidation of 500 ppm acetic acid by phenol acclimated sludge after 12 hr aeration
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Acetic Acid (1-8, 1-16):

ADSORBABILITY

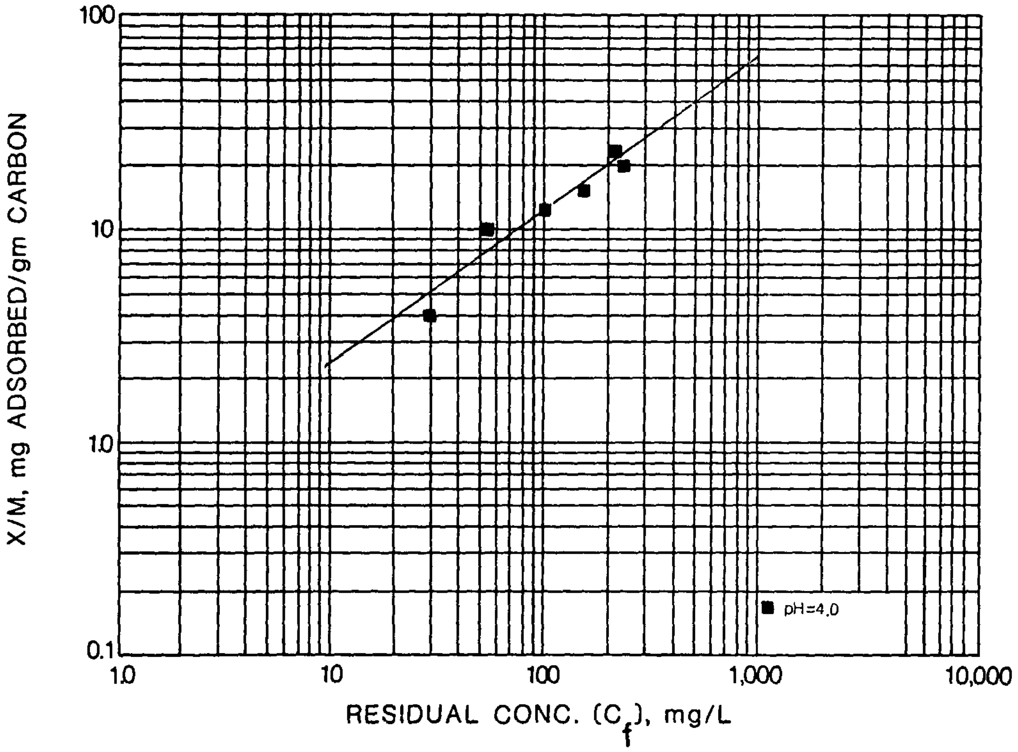
FREUNDLICH PARAMETERS	pH		
	4.0		
K	0.44		
1/n	0.72		
Corr. Coef. r	0.96		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o, mg/L	0.1	0.01	0.001
1.0	11,000	62,000	328,000
0.1		5,600	32,500
0.01			3,000

(a) Carbon doses in mg/L at pH 4.0



ANALYTICAL METHOD: Not specified.

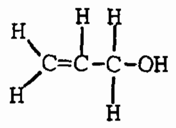
POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ACETIC ACID

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Solvent Extraction	7		8 - 91	1.1 x 10E5 - 14 x 10E6	III.3.1.20

RESERVED

Compound: Allyl alcohol

Formula:



Alternate Names: 2-Propen-1-ol

CAS #: 107-18-6

Physical, Chemical, and Biological Properties [1-6, 1-25, 1-28]:

molecular weight: 58.08
melting point, °C: -50
boiling point (760 torr), °C: 96-97
vapor pressure (25°C), torr: 23.8
solubility in water, mg/L: Miscible
log octanol/water partition coefficient: Not available
Henry's law constant (15°C): 1.0×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: 57% allyl alcohol removal (measured in BOD removal) obtained in 10-day static activated sludge test for initial allyl alcohol concentrations of 1,000 mg/L
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

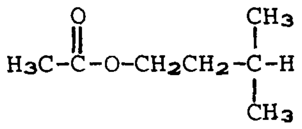
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Amyl acetate

Formula:



Alternate Names: Isoamyl acetate;
Acetic acid 3-methylbutyl ester

CAS #: 123-92-2

Physical, Chemical, and Biological Properties [1-25, 1-28]:

molecular weight: 130.1
melting point, °C: -78.5
boiling point (760 torr), °C: 142
vapor pressure (25°C), torr: 6
solubility in water (25°C), mg/L: 2,500
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 4.1×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: n-Butyl acetate

Formula:

$$H_3C-\overset{O}{\overset{\|}{C}}-O-CH_2CH_2CH_2CH_3$$

Alternate Names: Acetic acid butyl ester; Butyl ethanoate

CAS #: 123-86-4

Physical, Chemical, and Biological Properties [1-6, 1-9, 1-25, 1-28]:

molecular weight: 116.2
melting point, °C: -77.9
boiling point (760 torr), °C: 125-126
vapor pressure (25°C), torr: 15
solubility in water (25°C), mg/L: 8,300
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 4.68×10^{-4} atmos m^3 $mole^{-1}$ (calculated)
biodegradability: 7% of theoretical oxygen demand removed in 5-day BOD test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Butyric acid

Formula:

$$CH_3-CH_2-CH_2-C(=O)OH$$

Alternate Names: Butanoic acid;
Ethylacetic acid;
Propylformic acid

CAS #: 107-92-6

Physical, Chemical, and Biological Properties [1-6, 1-25]:

molecular weight: 88.12
melting point, °C: -7.9
boiling point (760 torr), °C: 164
vapor pressure (20°C), torr: 0.84
solubility in water (25°C), mg/L: Miscible
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 25% of theoretical oxygen demand removed in 12 hr static activated sludge test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

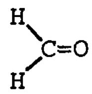
biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Formaldehyde

Formula: 

Alternate Names: Methanal;
Formalin;
Oxomethane

CAS #: 50-00-0

Physical, Chemical, and Biological Properties [1-6]:

molecular weight: 30.0
melting point, °C: -118 to -92
boiling point (760 torr), °C: -21 to -19
vapor pressure (-88°C), torr: 10
solubility in water (25°C), mg/L: Not available
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 60% of theoretical oxygen demand removed in 5-day BOD test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

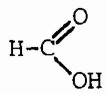
Carbon Adsorption Data: Not available

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR FORMALDEHYDE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Rotating Biological Contactor	2		61 - 83	25,000 - 37,000	III.3.2.4

Compound: Formic acid

Formula:



Alternate Names: Methanoic acid;
Hydrogen carboxylic acid;
Formylic acid

CAS #: 64-18-6

Physical, Chemical, and Biological Properties [1-6, 1-25]:

molecular weight: 46.03
melting point, °C: 8.4
boiling point (760 torr), °C: 101
vapor pressure (24°C), torr: 40
solubility in water (25°C), mg/L: Miscible
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 70% of theoretical oxygen demand removed in 24 hr static activated sludge test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

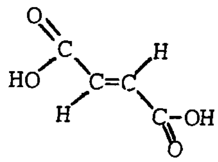
POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR FORMIC ACID

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Solvent Extraction	5		55 - >99	ND - 8.6 × 10E5	III.3.1.20

ND, not detected.

Compound: Fumaric acid

Formula:



Alternate Names: Trans-1,2-ethylenedicarboxylic acid;
Trans-butenedioic acid;
Allomaleic acid

CAS #: 110-17-8

Physical, Chemical, and Biological Properties [1-6, 1-25]:

molecular weight: 116.1
melting point, °C: 300 to 302 (sealed tube)
boiling point (1.7 torr), °C: Sublimes at 165
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: 7,000
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 1.7% of theoretical oxygen demand removed after 24 hr static activated sludge test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

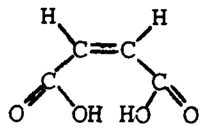
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Maleic acid

Formula:



Alternate Names: Cis-1,2-ethylenedicarboxylic acid;
Toxilic acid;
Cis-butenedioic acid

CAS #: 110-16-7

Physical, Chemical, and Biological Properties [1-6, 1-25]:

molecular weight: 116.1
melting point, °C: 130.5
boiling point (760 torr), °C: Decomposes at 135
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: Freely soluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 4.5% of theoretical oxygen demand removed after 12 hr static activated sludge test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

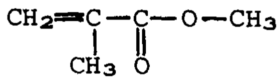
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Methyl methacrylate

Formula:



Alternate Names: 2-Methyl-propenoic acid; methyl ester

CAS #: 80-62-6

Physical, Chemical, and Biological Properties [1-4, 1-6]:

molecular weight: 100.1
melting point, °C: -48
boiling point (760 torr), °C: 100-101
vapor pressure (25°C), torr: 37
solubility in water (25°C), mg/L: Slightly soluble
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 47% theoretical oxidation of 10 mg/L methyl methacrylate observed in 10-day static activated sludge test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

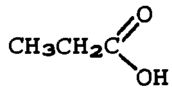
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Propionic acid

Formula:



Alternate Names: Propanoic acid;
Methylacetic acid

CAS #: 79-09-4

Physical, Chemical, and Biological Properties [1-4, 1-6]:

molecular weight: 74.08
melting point, °C: -20.8
boiling point (760 torr), °C: 141
vapor pressure (25°C), torr: 3.5
solubility in water (25°C), mg/L: Miscible
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 40% of theoretical oxygen demand removed after 24 hr static activated sludge test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR PROPIONIC ACID

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Solvent Extraction	1		71	23,000	III.3.1.20

Compound: Vinyl acetate

Formula:

$$CH_3\overset{\overset{O}{\|}}{C}-C-CH=CH_2$$

Alternate Names: Acetic acid;
ethenyl ester;
1-Acetoxyethylene

CAS #: 108-05-4

Physical, Chemical, and Biological Properties [1-6, 1-25, 1-28]:

molecular weight: 86.10
melting point, °C: -93.2
boiling point (760 torr), °C: 72.2-72.3
vapor pressure (21°C), torr: 100
solubility in water (20°C), mg/L: 20,000
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 5.94×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: 42% theoretical oxidation of 10 mg/L vinyl acetate observed in 10-day static activated sludge test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Adipic acid

Formula:

$$HO-\overset{\overset{O}{\|}}{C}-(CH_2)_4-\overset{\overset{O}{\|}}{C}-OH$$

Alternate Names: 1,6-Hexanedioic acid;
1,4-Butanedicarboxylic acid

CAS #: 124-04-9

Physical, Chemical, and Biological Properties [1-25, 1-28]:

molecular weight: 146.1
melting point, °C: 153
boiling point (760 torr), °C: 338
vapor pressure (159°C), torr: 1
solubility in water (25°C), mg/L: 14,400
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 5.4×10^{-11} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data, Adipic acid (1-8):

ADSORBABILITY

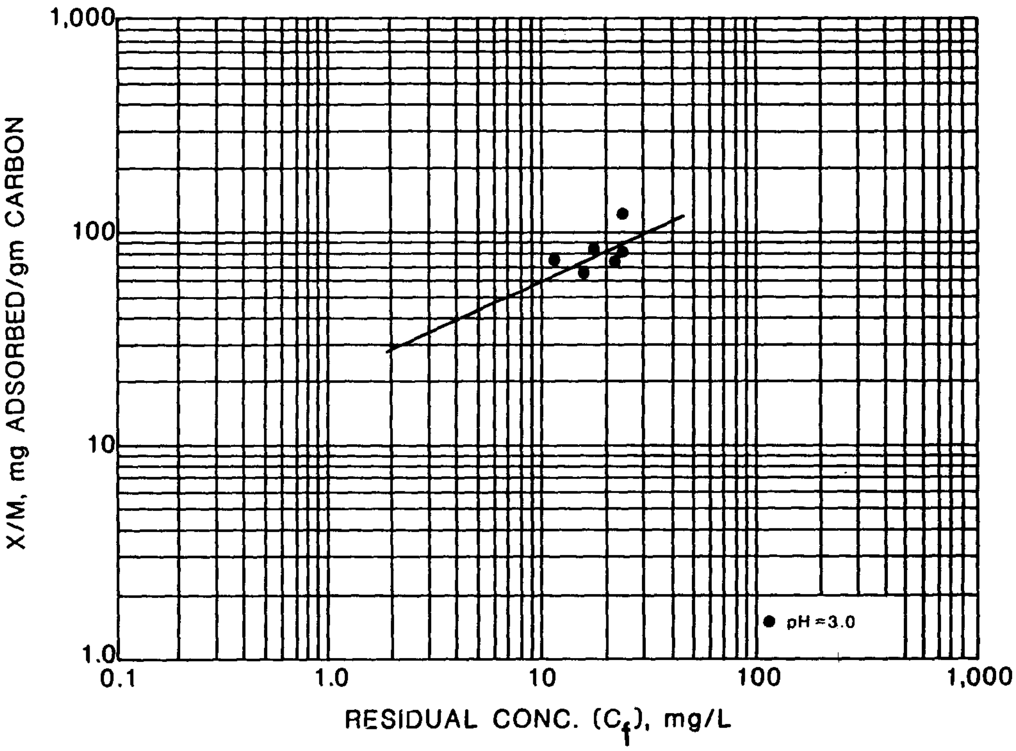
FREUNDLICH PARAMETERS	pH		
	3.0		
K	20		
1/n	0.47		
Corr. Coef. r	0.60		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	130	430	1,300
0.1		39	130
0.01			12

(a) Carbon doses in mg/L at pH 3.0



ANALYTICAL METHOD: Organic Carbon

Compound: Crotonaldehyde

Formula: $CH_3CH{=}CHC(H){=}O$

Alternate Names: 2-Butenal

CAS #: 123-73-9

Physical, Chemical, and Biological Properties [1-4, 1-6, 1-9, 1-28]:

molecular weight: 70.09
melting point, °C: -74
boiling point (760 torr), °C: 104-105
vapor pressure (25°C), torr: Not available
solubility in water (20°C), mg/L: 180,000
log octanol/water partition coefficient: Not available
Henry's law constant (20°C): 1.4×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: 37% of theoretical oxygen demand removed in 5-day BOD test
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Acrolein

Formula:

$$H_2C{=}CH{-}\underset{\substack{\| \\ O}}{C}{-}H$$

Alternate Names: Aqualin; Acrylaldehyde;
2-Propenal; Allylaldehyde

CAS #: 107-02-8

Physical, Chemical, and Biological Properties [1-6, 1-14, 1-28]:

molecular weight: 56.1
melting point, °C: -87.7
boiling point (760 torr), °C: 52.5
vapor pressure (20°C), torr: 220
solubility in water (temp. unknown), mg/L: 400,000
log octanol/water partition coefficient: -0.090
Henry's law constant (15°C): 7.7×10^{-5} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.14.16-5

Probable Fate:

photolysis: Probable photooxidation in atmosphere

oxidation: Can occur slowly

hydrolysis: Not an important process

volatilization: Principal transport mechanism

sorption: Not an important process

biological processes: Biotransformation occurs readily; biodegradation not important in the environment; may degrade in acclimated sewage systems

other reactions/interactions: Unknown

Carbon Adsorption Data, Acrolein (1-8):

ADSORBABILITY

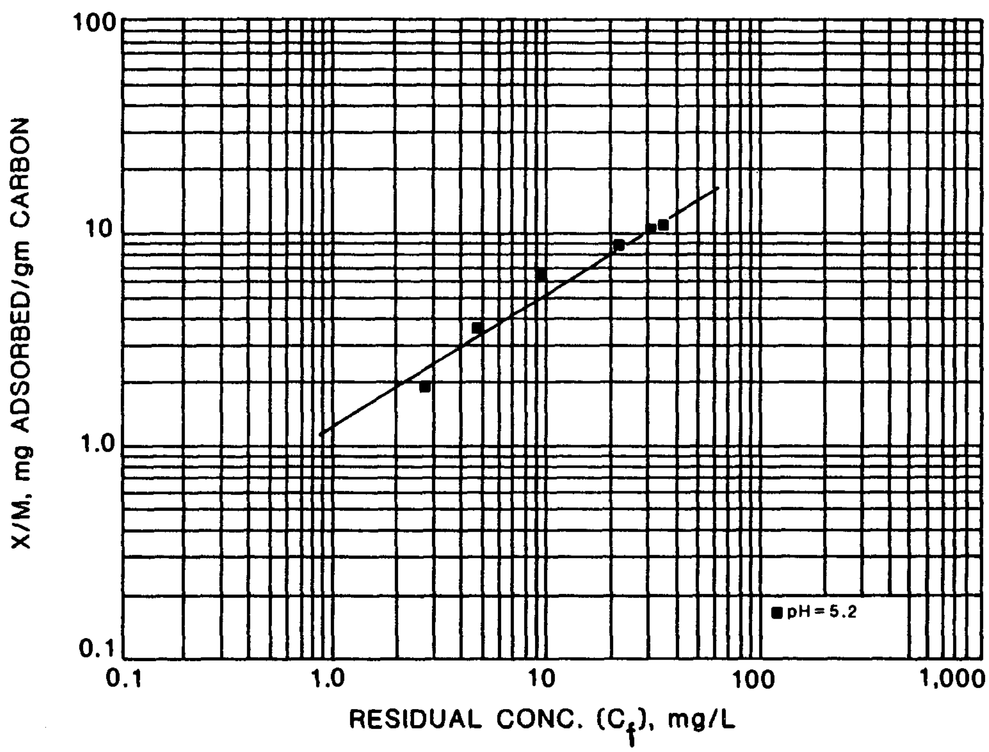
FREUNDLICH PARAMETERS	pH		
	5.2		
K	1.2		
1/n	0.65		
Corr. Coef. r	0.98		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	3,500	17,000	76,800
0.1		1,500	7,600
0.01			690

(a) Carbon doses in mg/L at pH 5.2



ANALYTICAL METHOD: Total Carbon

Date: 10/8/82

INDUSTRIAL OCCURRENCE OF ACROLEIN

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	47	0			
Foundries	53	0			
Photographic Equipment/Supplies (c)	7	0			
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	6	NA	NA	NA	310
Textile Mills (b) (d)	66	1		200	

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Screening plus additional data.
(d) Mean calculated using medians.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF ACROLEIN

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	1		360	
Coal Mining (b)	51	0			
Foundries	53	0			
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	3	NA	NA	NA	1.7
Textile Mills (b) (c)	62	1		87	

NA, not available. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Mean calculated using medians

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ACROLEIN

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Filtration		1	>99	ND	III.3.1.9
Flotation		1	NM	360	III.3.1.10

ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a)(1) of the Clean Water Act. These summaries apply to acrolein.

Freshwater Aquatic Life

The available data for acrolein indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 68 and 21 μg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for acrolein indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 55 μg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of acrolein to sensitive saltwater aquatic life.

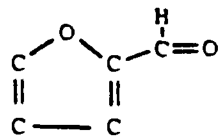
Human Health

For the protection of human health from the toxic properties of acrolein ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 320 μg/L.

For the protection of human health from the toxic properties of acrolein ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 780 μg/L.

Compound: Furfural

Formula:



Alternate Names: Furfurole; 2-Furancarbonyl; 2-Furaldehyde; Fural; Furfuraldehyde; Furole

CAS #: 98-01-1

Physical, Chemical, and Biological Properties [1-4, 1-6, 1-12, 1-27]:

molecular weight: 96.09
melting point, °C: -38.7
boiling point (760 torr), °C: 162
vapor pressure (25°C), torr: ~1.65
solubility in water (temp. unknown), mg/L: 91,000
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 96% furfural removal (measured as COD removal) obtained at 20°C in activated sludge at a rate of 37 mg COD/g dry inoculum/hr
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Propylene oxide

Formula: CH_3CH-CH_2
O

Alternate Names: 1,2-Epoxy-propane;
Methyloxiron

CAS #: 75-56-9

Physical, Chemical, and Biological Properties [1-4, 1-6, 1-27, 1-28]:

molecular weight: 58.08
melting point, °C: -104
boiling point (760 torr), °C: 34.3
vapor pressure (25°C), torr: ~530
solubility in water, mg/L: 650,000 at 30°C; 405,000 at 20°C
log octanol/water partition coefficient: Not available
Henry's law constant (15°C): 1.28×10^{-4} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: 75% propylene oxide removal (measured as BOD removal) obtained in 5-day static activated sludge test on a 333 mg/L solution
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Methyl mercaptan

Formula:

```
    H
    |
  H-C-S-H
    |
    H
```

Alternate Names: Methanethiol; Mercaptomethane;
Methyl sulfhydrate; Thiomethyl alcohol

CAS #: 74-93-1

Physical, Chemical, and Biological Properties [1-25, 1-28]:

molecular weight: 48.10
melting point, °C: -123
boiling point (760 torr), °C: 5.95
vapor pressure (25°C), torr: 1,500
solubility in water (20°C), mg/L: 23,330
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 3.85 x 10^{-3} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

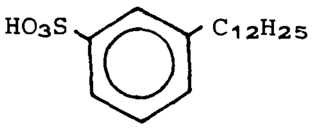
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Dodecyl benzenesulfonic acid

Formula:



Alternate Names: Benzenesulfonic acid;
dodecyl ester;
Dodecylbenzenesulfonate

CAS #: 1886-81-3

Physical, Chemical, and Biological Properties [1-1, 1-12]:

molecular weight: 326.5
melting point, °C: Not available
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (25°C), mg/L: Not available
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: 99% removal (measured as COD removal) obtained at 20°C in activated sludge at a rate of 11 mg COD/g dry inoculum/hr
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

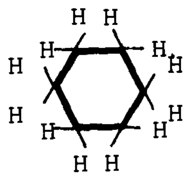
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Cyclohexane

Formula:



Alternate Names: Hexahydrobenzene;
Hexamethylene;
Hexanaphthene

CAS #: 110-82-7

Physical, Chemical, and Biological Properties [1-6, 1-28]:

molecular weight: 84.16
melting point, °C: 6.3
boiling point (760 torr), °C: 81
vapor pressure (20°C), torr: 77
solubility in water (20°C), mg/L: 55
log octanol/water partition coefficient: Not available
Henry's law constant (25°C): 0.16 atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

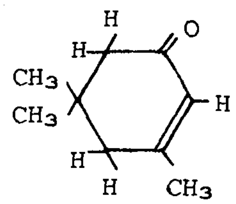
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: Isophorone

Formula:



Alternate Names: Trimethylcyclohexenone;
Isooctaphenone;
3,5,5-Trimethyl-2-cyclohexene-1-one

CAS #: 78-59-1

Physical, Chemical, and Biological Properties [1-6, 1-28]:

molecular weight: 138.2
melting point, °C: -8
boiling point (760 torr), °C: 215
vapor pressure (20°C), torr: 0.38
solubility in water (temp. unknown), mg/L: 12,000
log octanol/water partition coefficient: 1.7
Henry's law constant (25°C): 5.8×10^{-6} atmos. m^3 $mole^{-1}$ (calculated)
biodegradability: D-significant degradation, rapid adaptation
water quality criteria: See page I.15.4-5

Probable Fate:

photolysis: Information not available, but photolysis is likely to occur

oxidation: Information not available

hydrolysis: Information not available, but probably is stable

volatilization: Information not available, but volatility is unlikely

sorption: High aqueous solubility precludes sorption

biological processes: Bioaccumulation is unlikely; may degrade in acclimated sewage systems

other reactions/interactions:

Carbon Adsorption Data, Isophorone (1-8):

ADSORBABILITY

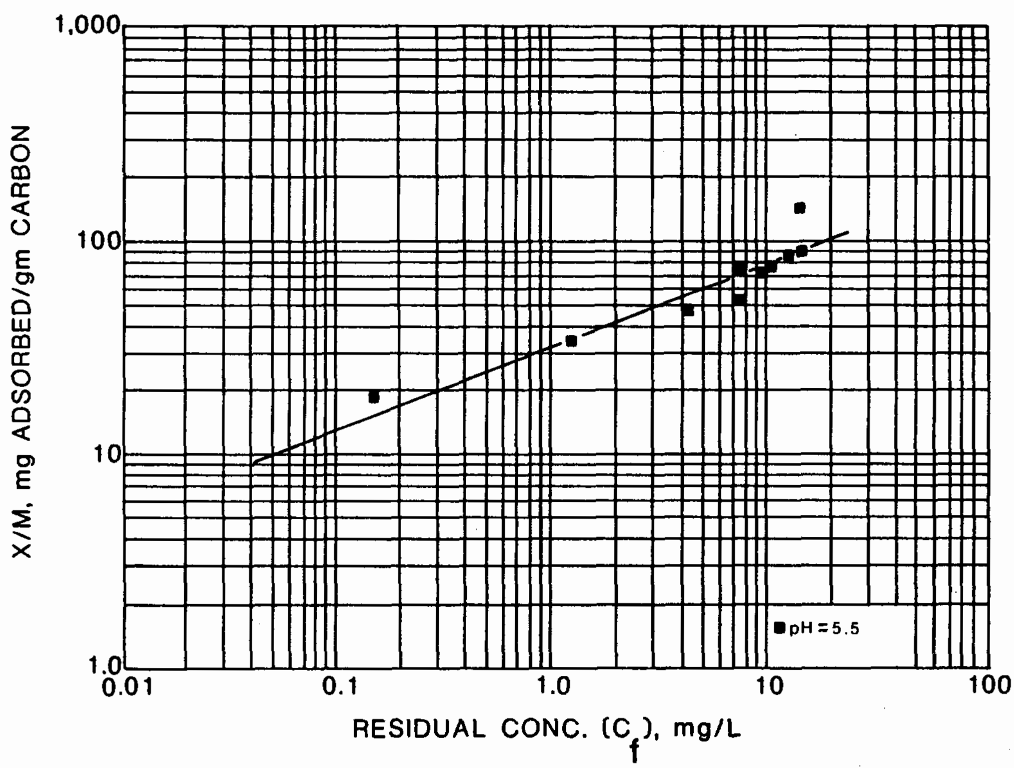
FREUNDLICH PARAMETERS	pH		
	5.5		
K	32		
1/n	0.39		
Corr. Coef. r	0.93		

CALCULATED CARBON REQUIREMENTS TO ACHIEVE INDICATED CHANGE IN CONCENTRATION (a)

SINGLE STAGE POWDERED CARBON, C_f mg/L

C_o. mg/L	0.1	0.01	0.001
1.0	70	190	460
0.1		17	46
0.01			4.2

(a) Carbon doses in mg/L at pH 5.5



ANALYTICAL METHOD: Total Carbon

INDUSTRIAL OCCURRENCE OF ISOPHORONE

Industry	Raw wastewater: Number of samples	Number of detections	Detected concentrations, μg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	1		190	
Coal Mining (b)	49	1		310	
Iron and Steel Manufacturing (a)	5	2	<2.0	55	<28
Leather Tanning and Finishing	18	0			
Aluminum Forming	21	3	<3.0	39	<19
Coil Coating	78	3	18	520	200
Electrical/Electronic Components (c)	1	0			
Foundries	53	2	<10	<10	<10
Metal Finishing (b) (g)	12	8	ND	310	87
Photographic Equipment/Supplies (d)	7	1		1.0	
Explosives Manufacturing	1	0			
Nonferrous Metals Manufacturing (e) (g)	58	2	ND	29	1.2
Ore Mining and Dressing (b)	33	0			
Organic Chemicals and Plastics and Synthetic Resins	2	NA	NA	NA	0.01
Paint and Ink Formulation (c)	27	2	22,000	22,000	22,000
Petroleum Refining (b)	21	2	2,500	3,600	3,000
Pulp and Paperboard Mills	3	3	8.0	15	11
Textile Mills (b) (f)	66	1		110	

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Screening plus additional data.
(e) Detections >10 μg/L.
(f) Mean calculated using medians.
(g) Minimum, maximum, and mean are based on the number of samples, not detections.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Porcelain Enameling.

INDUSTRIAL OCCURRENCE OF ISOPHORONE

Industry	Treated wastewater: Number of samples	Number of detections	Detected concentrations, µg/L: Minimum	Maximum	Mean
Auto and Other Laundries (a)	1	0			
Coal Mining (b)	53	0			
Iron and Steel Manufacturing (a)	5	1		170	
Aluminum Forming	1	0			
Coil Coating (f)	16	4	0.0	560	140
Foundries	53	7	3.0	28	<12
Nonferrous Metals Manufacturing (d) (e)	42	0	ND	6.0	3.0
Ore Mining and Dressing (b)	28	0			
Organic Chemicals and Plastics and Synthetic Resins	2	NA	NA	NA	5.0
Paint and Ink Formulation (c)	19	4	13	100	46
Petroleum Refining (b)	21	0			
Pulp and Paperboard Mills	3	0			

NA, not available; ND, not detected. See Section I.1 Introduction for additional information.

(a) Screening data.
(b) Screening and verification data.
(c) Analytic method not specified.
(d) Detections >10 µg/L.
(e) Minimum, maximum, and mean are based on the number of samples, not detections.
(f) Reference reports 0.0 µg/L for detections less than detection limit 10 µg/L.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Porcelain Enameling.

POLLUTANT REMOVABILITY/TREATABILITY WASTEWATER TREATMENT ALTERNATIVE FOR ISOPHORONE

Treatment process	Number of data points: Pilot scale	Number of data points: Full scale	Range of removal, %	Range of effluent conc., µg/L	Volume III section number
Chemical Precipitation with Sedimentation					III.3.1.3
-combined precipitants		1	NM	100	
-lime		2	7	ND - 560	
Flotation		1	>99	ND	III.3.1.10
Sedimentation		5	35 - >99	ND - 110	III.3.1.18
Activated Sludge	1		NM	BDL	III.3.2.1

BDL, below detection limit; ND, not detected; NM, not meaningful.

SUMMARY OF WATER QUALITY CRITERIA [1-56]

The following water quality criteria have been developed by USEPA pursuant to section 304 (a) (1) of the Clean Water Act. These summaries apply to isophorone.

Freshwater Aquatic Life

The available data for isophorone indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 117,000 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of isophorone to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for isophorone indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 12,900 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of isophorone to sensitive saltwater aquatic life.

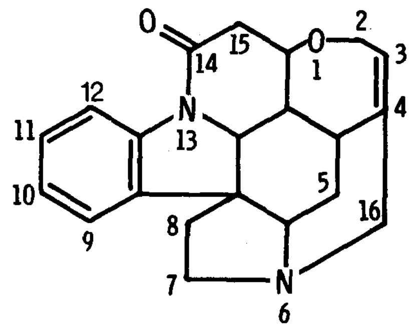
Human Health

For the protection of human health from the toxic properties of isophorone ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 5.2 mg/L.

For the protection of human health from the toxic properties of isophorone ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 520 mg/L.

Compound: Strychnine

Formula:



Alternate Names: Strychnidin-10-one

CAS #: 57-24-9

Physical, Chemical, and Biological Properties [1-3, 1-9]:

molecular weight: 334.4
melting point, °C: 268-290
boiling point (5 torr), °C: 270
vapor pressure (25°C), torr: Not available
solubility in water (temp. unknown), mg/L: 156
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

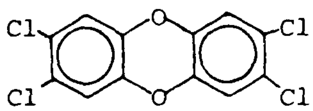
other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

Compound: 2,3,7,8-Tetrachlorodibenzo-p-dioxin

Formula:



Alternate Names: TCDD

CAS #: 1746-01-6

Physical, Chemical, and Biological Properties [1-1, 1-2]:

molecular weight: 322
melting point, °C: 303-305
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (temp. unknown), mg/L: 0.0002
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: No specific data, but TCDD is extremely toxic and very resistant to all forms of degradation

photolysis: Will be an important process if reactive substrates are available

oxidation: Not an important process

hydrolysis: Does not occur

volatilization: Not important

sorption: Important process

biological processes: Bioaccumulation probably an important process

other reactions/interactions: Unknown

Carbon Adsorption Data: Not available

RESERVED

INDUSTRIAL OCCURRENCE OF 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

Industry	Number of samples	Number of detections	Raw wastewater: Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	49	0			
Foundries	53	0			
Photographic Equipment/Supplies (b)	7	0			
Ore Mining and Dressing (a)	33	0			

See Section I.1 Introduction for additional information.

(a) Screening and verification data.
(b) Screening plus additional data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Battery Manufacturing, Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

INDUSTRIAL OCCURRENCE OF 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

	Treated wastewater				
Industry	Number of samples	Number of detections	Detected concentrations, µg/L Minimum	Maximum	Mean
Coal Mining (a)	53	0			
Foundries	53	0			
Ore Mining and Dressing (a)	28	0			

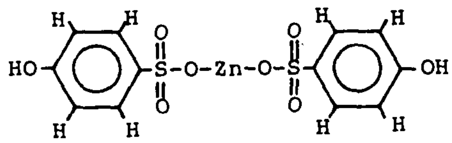
See Section 1.1 Introduction for additional information.

(a) Screening and verification data.

Information represents data from the USEPA verification program except as noted. The pollutant was not detected during the screening program and therefore was not sampled in the verification program for the following industries: Coil Coating, Porcelain Enameling, Pulp and Paperboard Mills.

Compound: Zinc phenol sulfonate

Formula:



Alternate Names: Zinc salt of 4-Hydroxy-benzenesulfonic acid

CAS #: 127-82-2

Physical, Chemical, and Biological Properties [1-9]:

molecular weight: 411.7
melting point, °C: Not available
boiling point (760 torr), °C: Not available
vapor pressure (25°C), torr: Not available
solubility in water (temp. unknown), mg/L: 625,000
log octanol/water partition coefficient: Not available
Henry's law constant: Not available
biodegradability: Not available
water quality criteria: Not included

Probable Fate: Not available

photolysis:

oxidation:

hydrolysis:

volatilization:

sorption:

biological processes:

other reactions/interactions:

Carbon Adsorption Data: Not available

RESERVED

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I.17 CROSS REFERENCE OF COMPOUND NAMES

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