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Chlorobenzene

Health and Environmental Effects

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DISCLAIMER

This report represents a survey of the potential health and environmental hazards from exposure to the subject chemical. The information contained in the report is drawn chiefly from secondary sources and available reference documents. Because of the limitations of such sources, this short profile may not reflect all available information including all the adverse health and environmental impacts presented by the subject chemical. This document has undergone scrutiny to ensure its technical accuracy.

CHLOROBENZENE

Summary

There is little data on the quantities of chlorobenzene in air, water and food, although this compound has been identified in these media. Chronic exposure to chlorobenzene appears to cause a variety of pathologies under different experimental regimens; however, the liver and kidney appear to be affected in a number of species. There have been no studies conducted to evaluate the mutagenic, teratogenic, or carcinogenic potential of chlorobenzene.

Four species of freshwater fish have 96-hour LC_{50} values ranging from 24,000 to 51,620 µg/l. Hardness does not significantly affect the values. In saltwater, a fish and shrimp had reported 96-hour LC_{50} values of 10,500 µg/l and 6,400 µg/l, respectively. No chronic data involving chlorobenzene are available. Algae, both fresh and saltwater, are considerably less sensitive to chlorobenzene toxicity than fish and invertebrates.

I. INTRODUCTION

This profile is based on the Ambient Water Quality Criteria Document for Chlorinated Benzenes (U.S. EPA, 1979).

Chlorobenzene, most often referred to as monochlorobenzene (MCB; C_6H_5Cl; molecular weight 112.56), is a colorless liquid with a pleasant aroma. Monochlorobenzene has a melting point of -45.6°C, a boiling point of 131-132°C, a water solubility of 488 mg/l at 25°C, and a density of 1.107 g/ml. Monochlorobenzene has been used as a synthetic intermediate in the production of phenol, DDT, and aniline. It is also used as a solvent in the manufacture of adhesives, paints, polishes, waxes, diisocyanates, pharmaceuticals and natural rubber (U.S. EPA, 1979).

Data on current production derived from U.S. International Trade Commission reports show that between 1969 and 1975, the U.S. annual production of monochlorobenzene decreased by 50 percent, from approximately 600 million pounds to approximately 300 million pounds (U.S. EPA, 1977).

II. EXPOSURE

A. Water

Based on the vapor pressure, water solubility, and molecular weight of chlorobenzene, Mackay and Leinonen (1975) estimated the half-life of evaporation from water to be 5.8 hours. Monochlorobenzene has been detected in ground water, "uncontaminated" upland water, and in waters contaminated either by industrial, municipal or agricultural waste. The concentrations ranged from 0.1 to 27 µg/l, with raw waters having the lowest concentration and municipal waste the highest (U.S. EPA, 1975, 1977). These estimates should be considered as gross estimates of exposure, due to the volatile nature of monochlorobenzene.

B. Food

The U.S. EPA (1979) has estimated the weighted average bioconcentration factor of monochlorobenzene to be 13 for the edible portions of fish and shellfish consumed by Americans. This estimate was based on octanol/-water partition coefficients.

C. Inhalation

Data have not been found in the available literature which deal with exposure to chlorobenzene outside of the industrial working environment.

III. PHARMACOKINETICS

A. Absorption

There is little question, based on human effects and mammalian toxicity studies, that chlorobenzene is absorbed through the lungs and from the gastrointestinal tract (U.S. EPA, 1977).

B. Distribution

Because chlorobenzene is highly lipophilic and hydrophobic, it would be expected that it would be distributed throughout total body water space, with body lipid providing a deposition site (U.S. EPA, 1979).

C. Metabolism

Chlorobenzene is metabolised via an NADPH-cytochrome P-448 dependent microsomal enzyme system. The first product, and rate limiting step, is a epoxidation; this is followed by formation of diphenolic and monophenolic compounds (U.S. EPA, 1979). Various conjugates of these phenolic derivatives are the primary excretory products (Lu, et al. 1974). Evidence indicates that the metabolism of monochlorobenzene results in the formation of toxic intermediates (Kohli, et al. 1976). Brodie, et al. (1971) induced microsomal enzymes with phenobarbital and showed a potentiationin in the toxicity of monochlorobenzene. However, the use of 3-methylcho-

lanthrene to induce microsomal enzymes provided protection for rats (Oesch, et al. 1973). The metabolism of chlorobenzene may also lead to the formation of carcinogenic active intermediates (Kohli, et al. 1976).

D. Excretion

The predominant route of elimination is through the formation of conjugates of the metabolites of monochlorobenzene and elimination of these conjugates by the urine (U.S. EPA, 1979). The types of conjugates formed vary with species (Williams, et al. 1975). In the rabbit, 27 percent of an administered dose appeared unchanged in the expired air (Williams, 1959).

IV. EFFECTS

Pertinent data could not be located in the available literature on the carcinogenicity, mutagenicity, teratogenicity, or other reproductive effects of chlorobenzene.

A. Chronic Toxicity

Data on the chronic toxicity of chlorobenzene is sparse and somewhat contradictory. "Histopathological changes" have been noted in lungs, liver and kidneys following inhalation of monochlorobenzene (200, 475, and 1,000 ppm) in rats, rabbits and guinea pigs (Irish, 1963). Oral administration of doses of 12.5, 50 and 250 mg/kg/day to rats produced little pathological change, except for growth retardation in males (Knapp, et al. 1971).

B. Other Relevant Information

Chlorobenzene appears to increase the activity of microsomal NADPH-cytochrome P-450 dependent enzyme systems. Induction of microsomal enzyme activity has been shown to enhance the metabolism of a wide variety of drugs, pesticides and other xenobiotics (U.S. EPA, 1979).

V. AQUATIC TOXICITY

A. Acute Toxicity

Pickering and Henderson (1966) reported observed 96-hour LC_{50} values for goldfish, Carassius auratus, guppy, Poecilia reticulatus, and bluegill, Lepomis macrochirus, to be 51,620, 45,530, and 24,000 µg/l, respectively, for chlorobenzene. Two 96-hour LC_{50} values for chlorobenzene and fathead minnows, Pimephales promelas, are 33,930 µg/l in soft water (20 mg/l) and 29,120 µg/l in hard water (360 mg/l), indicating that hardness does not significantly affect the acute toxicity of chlorobenzene (U.S. EPA, 1978). With Daphnia magna, an observed 48-hour EC_{50} value of 86,000 µg/l was reported. In saltwater studies, sheepshead minnow had a reported unadjusted LC_{50} (96-hour) value of 10,500 µg/l, with a 96-hour EC_{50} of 16,400 µg/l for mysid shrimp (U.S. EPA, 1978).

B. Chronic Toxicity

No chronic toxicity studies have been reported on the chronic toxicity of chlorobenzene and any salt or freshwater species.

C. Plant Effects

The freshwater alga Selenastrum capricornutum is considerably less sensitive than fish and Daphnia magna. Based on cell numbers, the species has a reported 96-hour EC_{50} value of 224,000 µg/l. The saltwater alga, Skeletonema costatum, had a 96-hour EC_{50}, based on cell numbers of 341,000 µg/l.

D. Residues

A bioconcentration factor of 44 was obtained assuming an 8 percent lipid content of fish.

VI. EXISTING GUIDELINES AND STANDARDS

Neither the human health nor the aquatic criteria derived by U.S. EPA (1979), which are summarized below, have gone through the process of public review; therefore, there is a possibility that these criteria will be changed.

A. Human

The American Conference of Governmental Industrial Hygienists (ACGIH, 1971) threshold limit value for chlorobenzene is 350 mg/m^3. The acceptable daily intake (ADI) was calculated to be 1.008 mg/day. The U.S. EPA (1979) draft water criterion for chlorobenzene is 20 µg/l, based on threshold concentration for odor and taste.

B. Aquatic

For chlorobenzene, the drafted criterion to protect freshwater aquatic life is 1,500 µg/l as a 24-hour average; the concentration should not exceed 3,500 µg/l at any time. To protect saltwater aquatic life, a draft criterion of 120 µg/l as a 24-hour average with a concentration not exceeding 280 µg/l at any time has been recommended (U.S. EPA, 1979).

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