



## Project Summary

# Determination of Dioxin Levels in Carbon Reactivation Process Effluent Streams

J. E. Howes, Jr., F. L. DeRoos, D. Aichele, D.F. Kohler, M.E. Larson, and B.W. Lykins, Jr.

A preliminary study was made to evaluate the potential formation and persistence of tetrachlorodibenzo-p-dioxins (TCDDs) and tetrachlorodibenzo furans (TCDFs) in effluent streams of the fluidized bed system used at the Cincinnati, Ohio Waterworks for thermal reactivation of granular activated carbon (GAC). The study resulted from concern about possible releases of adsorbed organic compounds or their reaction products into the environment during reactivation of the GAC used for treating municipal drinking water.

Four tests were performed to sample the effluent streams of the reactivator system and the spent carbon feedstock during reactivation of a batch of GAC used to treat Cincinnati municipal drinking water. During one test, the natural gas supply to the reactivation system was sampled for polychlorinated biphenyls (PCBs). The effluent stream and spent carbon feed samples were analyzed to determine (1) 2,3,7,8-TCDD and 2,3,7,8-TCDF concentrations, (2) total TCDD and TCDF concentrations, and (3) the TCDD and TCDF isomeric composition (i.e., the number and, when possible, the identity of isomers in the samples).

*This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

### Introduction

Activated carbon has been used for many years to remove taste and odor

components from drinking water. Recent studies have focused on activated carbon treatment to remove potentially hazardous trace organics from municipal drinking water supplies. In this regard, the Cincinnati Waterworks conducted a study of water treatment with granular activated carbon (GAC). After exhaustion, this carbon was thermally reactivated in a fluidized-bed furnace and reused in the water treatment process. During carbon reactivation, organic compounds could be released into effluent streams that enter the environment. Thus the total evaluation of the net gains achieved by water treatment with GAC included an examination of the potential for causing exposure to the public from the reactivation process effluents.

This program was undertaken to determine whether tetrachlorodibenzo-p-dioxins (TCDDs) and tetrachlorodibenzo furans (TCDFs) were in any effluent streams from the Cincinnati Waterworks reactivator unit during a carbon reactivation cycle. The study also evaluated the possible presence of TCDDs and TCDFs in the spent carbon feedstock and PCBs in the natural gas supply used to fire the carbon reactivator system. The data generated will be used to evaluate any possible environmental and health hazards associated with effluents from reactivation of carbon used in municipal water treatment.

### Procedures

Four tests were performed to measure TCDD and TCDF levels in the effluent streams and the spent carbon feedstock of the Cincinnati Waterworks carbon reactivation system (shown schematically in Figure 1). The tests were conducted

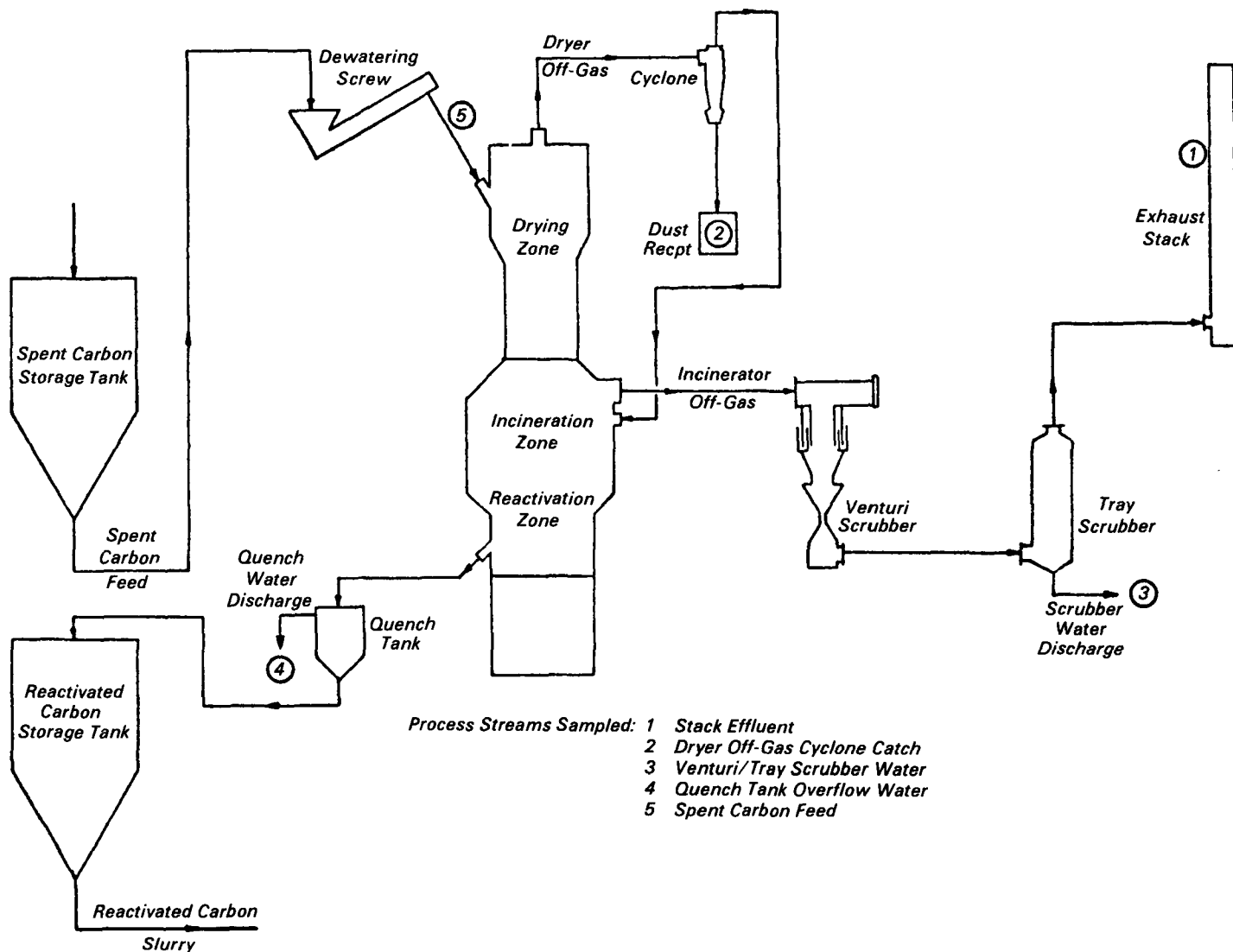


Figure 1. Cincinnati Waterworks carbon reactivation system.

during reactivation of a batch of some 18,000 kg (40,000 lb) of GAC that had been used in a contact bed system for about a year to treat Cincinnati municipal drinking water.

During each test, samples were acquired from the process streams identified in Figure 1. The stack effluent was sampled with an EPA Method 5 train that had been modified by adding a water-cooled condenser and a 22-g XAD-2 trap between the filter and first impinger to collect TCDDs and TCDFs in the vapor phase of the sample stream. Gas temperature at the exit of the XAD-2 trap was maintained at  $<20^{\circ}\text{C}$  ( $<68^{\circ}\text{F}$ ). Grab and composite procedures were used to

collect samples of the dryer off-gas cyclone catch, scrubber water, quench water, and spent carbon feed. During one test, the natural gas was sampled with an XAD-2 trap to determine whether PCBs were present in the supply used to fire the carbon reactivation system.

TCDD and TCDF analyses of the effluent and spent carbon feed samples were performed by (1) Soxhlet or liquid-liquid extraction to remove the analyses from the sample matrix, (2) removal of co-extracted interferences with silica liquid chromatographic columns, and (3) identification and quantitation of the TCDD and TCDF isomers by combined high-resolution gas chromatography/high resolution

mass spectrometry (HRGC/HRMS). PCB analyses were performed by Soxhlet extraction of the XAD-2 trap, concentration of the extract, and determination of the PCBs by combined high-resolution gas chromatography/mass spectrometry (HRGC/MS).

## Results

Effluent streams in which TCDDs were detected were the stack emissions, the dryer off-gas cyclone catch, and the scrubber water. TCDDs were not detected in any quench water or spent carbon feed samples from the four tests. TCDDs were detected in the stack particulate samples from all four tests and in the vapor phase

(XAD-2) sample from one test. The total TCDD concentrations found in the stack emissions (particulate material and gaseous emissions) ranged from 0.06 to 0.3 nanograms per dry, standard cubic meter (ng/dscm), and emission factors ranged from 0.49 to 1.11 ng total TCDDs/kg of spent carbon feed. TCDDs were detected in the dryer off-gas cyclone catch samples from all four tests and in the scrubber liquid samples from two of the four tests. The total TCDD concentrations found in the cyclone catch ranged from 0.20 to 4.14 ng/g. TCDDs at concentrations of 0.12 and 0.21 ng/L were found in the scrubber water from two tests.

Effluent streams in which TCDFs were detected were the stack emission and the dryer off-gas cyclone catch. TCDFs were not detected in any scrubber water, quench water, or spent carbon feed samples from the four tests. TCDFs were detected in stack particulate samples from three tests and in the vapor phase (XAD-2) samples from two tests. The total TCDF concentrations found in the stack emissions (particulate material and gaseous emissions) ranged from 0.08 to 0.51 ng/dscm, and emission factors ranged from 0.28 to 1.88 ng total TCDFs/kg of spent carbon feed. TCDFs were detected in the dryer off-gas cyclone catch from all four tests at concentrations ranging from 0.48 to 3.33 ng total TCDFs/g.

The principal TCDD isomers found in the samples were 1,3,6,8-TCDD, 1,3,7,8-TCDD, 1,3,7,9-TCDD, and 2,3,7,8-TCDD. Some samples contained other unidentified TCDD isomers, but they were present at very low levels relative to the isomers listed above. When present, 2,3,7,8-TCDF was identified; but other TCDF isomers could not be specifically identified because of lack of suitable reference standards.

PCBs at a concentration of 2.6 micrograms per standard cubic meter ( $\mu\text{g}/\text{scm}$ ) were found in the natural gas supply used to fire the reactivation unit during the tests. The principal PCBs detected in the natural gas were tri- and tetrachlorobiphenyls.

Reactivated carbon and spent carbon samples obtained during the test program and a sample of virgin carbon of the type being reactivated were analyzed for total organic halogens (TOX). The TOX levels found in the samples were as follows:

Virgin carbon	.....	None detected
Spent carbon	.....	657 mg/kg
Reactivated carbon	.....	55 mg/kg

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*The complete report, entitled "Determination of Dioxin Levels in Carbon Reactivation Process Effluent Streams," (Order No. PB 84-137 710; Cost: \$14.50, subject to change) will be available only from:*

*National Technical Information Service*

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