Technical Factsheet on: DIOXIN (2,3,7,8-TCDD)

List of Contaminants

As part of the Drinking Water and Health pages, this fact sheet is part of a larger publication:
National Primary Drinking Water Regulations

Drinking Water Standards
MCLG: zero mg/L
MCL: 3x10-8 mg/L
HAL(child): 1 day: 1x10-6 mg/L; 10-day: 1x10-7 mg/L

Health Effects Summary

Acute: EPA has found dioxin to potentially cause the following health effects from acute exposures at levels above the MCL: liver damage, weight loss, atrophy of thymus gland and immunosuppression.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day, a one-day exposure of 1x10-6 mg/L or a ten-day exposure to 1x10-7 mg/L.

Chronic: Dioxin has the potential to cause the following health effects from long-term exposures at levels above the MCL: variety of reproductive effects, from reduced fertility to birth defects.

Cancer: There is some evidence that dioxin may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Dioxin is not produced or used commercially in the US. It is a contaminant formed in the production of 2,4,5-trichlorophenol and of a few chlorinated herbicides such as silvex. It may also be formed during combustion of a variety of chlorinated organic compounds.

Dioxin has been tested for use in flameproofing polyesters and as an insecticide, but these uses were never exploited commercially.

Release Patterns

2,3,7,8-TCDD is released to the environment in stack emissions from the incineration of municipal refuse and certain chemical wastes, in exhaust from automobiles powered by leaded gasoline, in emissions from wood burning in the presence of chlorine, in accidental fires involving transformers containing PCBs and chlorinated benzenes, and from the improper disposal of certain chlorinated chemical wastes. TCDD has been released to the environment as a low level impurity in various pesticides (such as 2,4,5-T and derivatives) which were manufactured from 2,4,5-trichlorophenol.

Dioxin is not a listed chemical in the Toxics Release Inventory. Data on its incidental releases are not available.

Environmental Fate

Dioxin is one of the most toxic and environmentally stable tricyclic aromatic compounds of its structural class.

Due to its very low water solubility, most of the 2,3,7,8-TCDD occurring in water is expected to be associated with sediments or suspended material. Aquatic sediments may be an important, and ultimate, environmental sink for all global releases of TCDD. Two processes which may be able to remove TCDD from water are photolysis and volatilization.

The photolysis half-life at the water's surface has been estimated to range from 21 hr in summer to 118 hr in winter; however, these rates will increase significantly as water depth increases. Many bottom sediments may therefore not be susceptible to significant photodegradation.

The volatilization half-life from the water column of an environmental pond has been estimated to be 46 days; however, when the effects of adsorption to sediment are considered, the volatilization model predicts an overall volatilization removal half-life of over 50 years.

Various biological screening studies have demonstrated that TCDD is generally resistant to biodegradation. The persistence half-life of TCDD in lakes has been estimated to be in excess of 1.5 yr.

If released to soil, TCDD is not expected to leach. As a rule, the amount of TCDD detected more than 8 cm below the surface has been approximately 1/10 or less than that detected down to 8 cm. Being only slightly soluble in water, its migration in soil may have occurred along with soil colloids and particles to which it may have been bound. Soil cores collected from roadsides in Times Beach, MO in 1985 which had been sprayed with waste oils containing TCDD in the early 1970s indicated that most of the TCDD had remained in the upper 15 cm. A mean log Koc of 7.39 was determined for ten contaminated soils from NJ and MO. Tests conducted by the USDA determined that vertical movement of 2,3,7,8-TCDD did not occur in a wide range of soil types.

Being only slightly soluble in water, its migration in soil may have occurred along with soil colloids and particles to which it may have been bound. Photodegradation on terrestrial surfaces may be an important transformation process. Volatilization from soil surfaces during warm conditions may be a major removal mechanism. The persistence half-life of TCDD on soil surfaces may vary from less than 1 yr to 3 yrs, but half-lives in soil interiors may be as long as 12 years. Screening studies have shown that TCDD is generally resistant to biodegradation.

If released to the atmosphere, vapor-phase TCDD may be degraded by reaction with hydroxyl radicals and direct photolysis. Particulate-phase TCDD may be physically removed from air by wet and dry deposition.

Bioconcentration in aquatic organisms has been demonstrated. Mean bioconcentration factors (BCF) of 29,200 (dry wt) and 5,840 (wet wt) were measured for fathead minnows over a 28 day exposure; the elimination half-life after exposure was found to be 14.5 days. Log BCFs of approximately 3.2 to 3.9 were determined for rainbow trout and fathead minnow in laboratory flow-through studies during 4-5 exposures. The following log BCFs have been reported for various aquatic organisms: snails, fish (Gambusia), daphnia 4.3-4.4; duckweed, algae, catfish, 3.6-3.95.

The major route of exposure to the general population results from incineration processes and exhausts from leaded gasoline engines.

Chemical/ Physical Properties

CAS Number: 1746-01-6

Color/ Form/Odor: White crystalline needles

M.P.: 305-306 C B.P.: N/A

Vapor Pressure: 7.4x10-4 mm Hg, 25 C

Density/Spec. Grav.: N/A

Octanol/Water Partition (Kow): Log Kow = 6.8

Solubility: 19.3 ng/L of water at 25 C; Insoluble in water

Soil sorption coefficient: Koc-N/A; very low mobility in soil

Odor/Taste Thresholds: N/A

Bioconcentration Factor: 3.2 to 3.9 in fish; expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 1.62x10-5 atm-cu m/mole;

Trade Names/Synonyms: 2,3,7,8-Tetrachlorodibenzo-1,4-dioxin; Dioxin; Tetradioxin;

Other Regulatory Information

Monitoring For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years
Repeat Frequency- If no detections during initial round:
2 quarterly per year if serving >3300 persons;
1 sample per 3 years for smaller systems
Triggers - Return to Initial Freq. if detect at > 5 ng/L

Analysis:

Reference Source	Method Numbers
EPA 821-B-94-005	1613

Treatment- Best Available Technologies:
Granular Activated Charcoal

For Additional Information:

EPA can provide further regulatory and other general information:
EPA Safe Drinking Water Hotline - 800/426-4791

Other sources of toxicological and environmental fate data include:
Toxic Substance Control Act Information Line - 202/554-1404
Toxics Release Inventory, National Library of Medicine - 301/496-6531
Agency for Toxic Substances and Disease Registry - 404/639-6000