

2,3,7,8-Tetrachlorodibenzo-p-Dioxin (2,3,7,8-TCDD)

1746-01-6

Hazard Summary

2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is formed as an unintentional by-product of incomplete combustion. It may be released to the environment during the combustion of fossil fuels and wood, and during the incineration of municipal and industrial wastes. It causes chloracne in humans, a severe acne-like condition. It is known to be a developmental toxicant in animals, causing skeletal deformities, kidney defects, and weakened immune responses in the offspring of animals exposed to 2,3,7,8-TCDD during pregnancy. Human studies have shown an association between 2,3,7,8-TCDD and soft-tissue sarcomas, lymphomas, and stomach carcinomas. EPA has classified 2,3,7,8-TCDD as a probable human carcinogen (Group B2).

Please Note: The main source of information for this fact sheet is the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for Chlorinated Dibenzop-Dioxins.(1)

Uses

- 2,3,7,8-TCDD is not intentionally produced by industry. It can be inadvertently produced in very small amounts as an impurity during the incineration of municipal and industrial wastes and during the manufacture of certain chemicals. (1)
- The only present use for 2,3,7,8-TCDD is in chemical research. (1)

Sources and Potential Exposure

- 2,3,7,8-TCDD may be formed during the chlorine bleaching process used by pulp and paper mills, and as a by-product from the manufacture of certain chlorinated organic chemicals, such as chlorinated phenols. (1)
- 2,3,7,8-TCDD is primarily released to the environment during the combustion of fossil fuels (including motor vehicles) and wood, and during incineration processes. (1)
- Very low levels of 2,3,7,8-TCDD are found throughout the environment, including air, food, and soil. (1)
- Most of the exposure of the general population to 2,3,7,8-TCDD is from food, mainly meat, dairy products, and fish. (1)

Assessing Personal Exposure

- Body fat, blood, and breast milk may be analyzed for 2,3,7,8-TCDD. (1)

Health Hazard Information

Acute Effects:

- The major acute (short-term) effect from exposure of humans to high levels of 2,3,7,8-TCDD in air is chloracne, a severe acne-like condition that can develop within months of first exposure. (1,2)
- Acute animal tests in dogs, monkeys, and guinea pigs have shown 2,3,7,8-TCDD to have extreme toxicity from oral exposure. (1)

Chronic Effects (Noncancer):

- Chloracne is also the major effect seen from chronic (long-term) exposure to 2,3,7,8-TCDD in humans. (1)
- Animal studies have reported hair loss, loss of body weight, and a weakened immune system from oral exposure to 2,3,7,8-TCDD. (1)
- EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for 2,3,7,8-TCDD.
- ATSDR has calculated a chronic oral minimal risk level (MRL) of 1×10^{-9} milligrams per kilogram body weight per day (mg/kg/d) based on neurological effects in monkeys. The MRL is an estimate of daily exposure to a dose of a chemical that is likely to be without appreciable risk of adverse noncancerous effects over a specified duration of exposure. Exposure to a level above the MRL does not mean that adverse effects will occur. The MRL is used by public health professionals as a screening tool. (1)

Reproductive/Developmental Effects:

- The results of available reproductive and developmental studies in humans are inconclusive. (1)
- Animal studies have reported developmental effects, such as skeletal deformities, kidney defects, and weakened immune responses in the offspring of animals exposed to 2,3,7,8-TCDD during pregnancy. (1)
- Reproductive effects, including altered levels of sex hormones, reduced production of sperm, and increased rates of miscarriages, have been seen in animals exposed to 2,3,7,8-TCDD. (1)

Cancer Risk:

- Human studies, primarily of workers occupationally exposed to 2,3,7,8-TCDD by inhalation, have found an association between 2,3,7,8-TCDD and lung cancer, soft-tissue sarcomas, lymphomas, and stomach carcinomas, although for malignant lymphomas, the increase in risk is not consistent. (1)
- No information is available on the carcinogenic effects of 2,3,7,8-TCDD in animals following inhalation exposure. (1)
- Animal studies have reported tumors of the liver, lung, tongue, thyroid, and nasal turbinates from oral exposure to 2,3,7,8-TCDD. (1)
- EPA has classified 2,3,7,8-TCDD as a Group B2; probable human carcinogen. (2,3)
- EPA has calculated an inhalation cancer slope factor of 1.5×10^5 (mg/kg/d)⁻¹ and an inhalation unit risk estimate of 3.3×10^{-5} (pg/m³)⁻¹ for 2,3,7,8-TCDD. (2,3)
- EPA has calculated an oral cancer slope factor of 1.5×10^5 (mg/kg/d)⁻¹ and an oral unit risk factor of 4.5 (μg/L)⁻¹ for 2,3,7,8-TCDD. (2,3)

Physical Properties

- 2,3,7,8-TCDD is a colorless solid with no distinguishable odor. (1)
- The chemical formula for 2,3,7,8-TCDD is C₁₂H₄Cl₄O₂, and the molecular weight is 322 g/mol. (1)
- The vapor pressure for 2,3,7,8-TCDD is 7.4×10^{-10} at 25 °C, and it has an octanol/water partition coefficient (log K_{ow}) of 6.8–7.58. (1)

Note: There are very few health numbers or regulatory/advisory numbers for 2,3,7,8-TCDD; thus, a graph has not been prepared for this compound. The health information cited in this fact sheet was obtained in December 1999.

Conversion Factors (only for the gaseous form):

To convert concentrations in air (at 25°C) from ppm to mg/m³: $\text{mg/m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$. For 2,3,7,8-TCDD: $1 \text{ ppm} = 13.2 \text{ mg/m}^3$.

Summary created in April 1992, updated January 2000

References

1. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Chlorinated Dibenzo-p-Dioxins. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1998.
2. U.S. Environmental Protection Agency. Health Effects Assessment Summary Tables. FY 1997 Update. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1997.
3. U.S. Environmental Protection Agency. Health Assessment Document for Polychlorinated Dibenzo-p-Dioxin. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. EPA 600/8-84-014F. 1985.