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Trichloroethylene: Health Information Summary

Trichloroethylene (TCE) is a synthetic liquid chemical with a sweet odor. It was once used as a general anesthetic. Its current main use is as a solvent and degreaser for metal compounds in the metal parts manufacturing, electronics, and automotive industries. It is also found in many consumer products including paints, paint strippers, adhesives, varnishes, and spot removers. TCE may be buried in landfills or dumped on the ground or into sewers when mixed with grease or oil. TCE in soil will readily migrate to groundwater. TCE is one of the most common organic contaminants detected in groundwater. Although TCE in surface soil or surface water readily volatilizes into the air as a gas, it generally remains stable in groundwater for months to years. Under certain conditions in groundwater, TCE eventually degrades to other toxic chlorinated chemicals such as 1,1-dichloroethene and vinyl chloride. The odor threshold for TCE in air is reported as 100 parts per million (ppm); there is no information on its odor threshold in water.

Health Effects

Absorption

Studies indicate that 40 to 70 percent of TCE is absorbed by inhalation exposure, which is the most common TCE exposure route. In an oral exposure study with rats, absorption of about 90 percent was observed. Dermal absorption is also known to occur, but the fraction absorbed has not been measured. The body eliminates most absorbed TCE within two days. The small amount remaining may be stored in fat cells and slowly released over several days to a few weeks.

Short-Term (Acute) Effects

Inhaling or ingesting large amounts of TCE, which is how poisonings occur, results in disturbances of heart rhythm. This observation is supported by results in some animal studies. Breathing TCE at high concentrations, as happens in industrial accidents, has been shown to cause central nervous system symptoms such as headache, sleepiness, dizziness, blurred vision and loss of facial sensation. High acute exposures have resulted in nerve damage lasting several months, causing facial numbness and jaw weakness. High TCE exposure by inhalation in animals has caused toxicity to the lungs.

Long-Term (Chronic) Effects

Chronic inhalation exposure to low levels of TCE in occupational settings has produced CNS effects including memory loss, mood swings, and facial nerve damage. Another study of long-term exposure reported such effects as eye irritation, cough, drowsiness, weakness, dizziness, and heart palpitations.

Abnormalities of the immune system have been detected in a study of humans exposed to TCE-contaminated drinking water. Studies of exposed workers have found increases in autoimmune diseases such as scleroderma, a chronic condition where the skin and internal connective tissues harden and tighten. Animal testing has confirmed that the immune system can be affected by TCE.

Studies of workers exposed to TCE indicate that this chemical can induce damage to the liver and kidney. Animal studies support the human evidence that both liver and kidney effects can result from TCE exposure.

Carcinogenic (cancer causing) Effects

Studies of humans exposed to TCE provide evidence that it increases the risk of kidney cancer, liver cancer, and non-Hodgkin's Lymphoma. A large study of cancer registry data in New Jersey found associations between exposure to TCE in drinking water and elevated rates of leukemia and lymphoma. Another study with TCE exposure from drinking water found an elevated risk of leukemia after pre-natal exposure.

Oral TCE exposure in animal studies has caused increased tumors in the liver and kidneys while inhalation exposure resulted in increased liver and lung tumors. TCE has been categorized as a "human carcinogen" by the U.S. Environmental Protection Agency (EPA).

Reproductive/Developmental Effects

The results of animal testing indicate an increase in total birth defects including those of the heart, eye, skeleton, and hearing impairment from pre-natal TCE exposure. TCE exposure that was both pre-natal and for a short time after birth in animals has increased immune system abnormalities.

Health Standards and Criteria

The EPA has established a Maximum Contaminant Level (MCL) for TCE. MCLs are enforceable drinking water standards determined by balancing the adverse health effects of a particular chemical against the feasibility and costs of treating contaminated water. The MCL for TCE is 5 parts per billion (ppb). The EPA has also established a Maximum Contaminant Level Goal (MCLG) of 0 ppb (ppb also is equal to micrograms per liter or ug/l) for TCE in public drinking water systems. MCLGs are health-based non-enforceable guidelines and are traditionally set at zero for potential human carcinogens.

Because TCE is a human carcinogen, there may be some degree of carcinogenic risk even below the MCL. Drinking water containing 5 ppb TCE is associated with an increased lifetime risk of cancer of one in one hundred thousand (1 excess cancer case in 100,000 people exposed). This estimate is based on a daily intake of two liters of water per day for 70 years. However, EPA considers children (up to 16 years of age) exposed to TCE to be at a higher risk of cancer compared to adult exposure. Because most evidence indicates that it is the breakdown products of TCE in the body that are largely responsible for its toxicity, those who are exposed to other chlorinated solvents with similar breakdown products may be at greater risk.

The Occupational Safety and Health Administration (OSHA) enforceable standard, a permissible exposure limit or PEL, for TCE in workplace air is 100 ppm averaged over an eight-hour workday.

Suggested Reading and References

Casarett and Doull's Toxicology: The Basic Science of Poisons, Sixth Edition. Klaassen, C.D., ed. McGraw-Hill Publishing Co., Inc., New York, 2001.

Case Studies in Environmental Medicine: Trichloroethylene (TCE) Toxicity. Agency for Toxic Substances and Disease Registry (ATSDR). Atlanta, GA. November, 2007.

Toxicological Profile for Trichloroethylene (Update). Agency for Toxic Substances and Disease Registry (ATSDR). Atlanta, GA. September, 1997.

Toxicological Review of Trichloroethylene. In Support of Summary Information on the Integrated Risk Information System (IRIS). U.S. Environmental Protection Agency. September 2011.

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