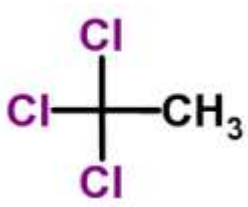
1,1,1-Trichloroethane (Methyl chloroform)

Updated: November 2018

CAS number 71-55-6

The chemical formula of 1,1,1-Trichloroethane is



It is a colorless, volatile, nonflammable liquid with a sweet, chloroform-like odor. Odor generally provides adequate warning of hazardous concentrations.

The odor threshold for 1,1,1-trichloroethane is 44 ppm, which is about one-eighth of the OSHA PEL. Odor is an adequate warning of hazardous concentrations. The vapor is heavier than air and can collect to toxic levels in poorly ventilated or low-lying spaces.

Usage and exposure

1,1,1-Trichloroethane is a synthetic chemical that was first developed as a safer substitute for other chlorinated and flammable solvents. The most common method for industrial production of 1,1,1-trichloroethane is the reaction of hydrochloric acid with vinyl chloride to obtain 1,1-dichloroethane, followed by either thermal or photochemical chlorination. In industry, it has been widely used as a solvent and as a cold cleaning and vapor degreasing agent.

Other applications include its use in pesticides, textile processing, cutting fluids, aerosols, lubricants, cutting oil formulations, drain cleaners, shoe polishes, spot cleaners, printing inks and stain repellents [IARC].

It was used in many household products, including aerosol sprays, spot cleaners, glues, and lubricants. While it is no longer used for such products, it is likely that some of these may still be found in homes, garages, workshops, and hazardous waste sites [CDC].

It has been intentionally abused for its CNS-intoxicating effects.

At one time, it was used as an anesthetic agent.

Because 1,1,1-trichloroethane damages the ozone layer, production in the United States was phased out in 1996, but supplies as a raw material will be available until the year 2002 [CDC].

Occupational exposure to methyl chloroform can occur during the use of metal degreasing agents, paints, glues, and cleaning products. Individuals are more likely to be exposed to methyl chloroform indoors rather than outdoors because of its widespread use in home and office products.

Exposure may also occur by the sniffing of glue or typewriter correction fluid. Methyl chloroform has been detected in surface and groundwater; individuals may be exposed through the consumption of contaminated drinking water [EPA].

1,1,1-Trichloroethane is likely to enter the environment from air emissions or in wastewater from its production and use in vapor degreasing, metal cleaning and other applications. It can also enter the environment in leachates and volatile emissions from landfills. It has been detected at low levels in wastewater, groundwater, drinking-water, ambient water, ambient air, and urban air samples [IARC].

It is regulated by the Montreal Protocol as an ozone-depleting substance and its use is being rapidly phased out (The Montreal Protocol).

Routs of exposure

Inhalation: Inhalation is the most important route of exposure, and 1,1,1-trichloroethane is readily absorbed from the lungs.

Ingestion: Gastrointestinal absorption is rapid and can cause systemic effects similar to those seen with inhalation exposure.

Eye: Transient chemical conjunctivitis can result from exposure to high levels of vapor or direct contact with liquid 1,1,1-trichloroethane.

Skin: The liquid is mildly irritating to the skin. Because absorption across intact skin is slow, systemic toxicity is unlikely unless liquid on the skin is prevented from evaporating by heavy clothing or other impermeable covering.

Target organs

Eye, skin, respiratory system ,cardiovascular system, central nervous system, gastrointestinal system.

Metabolism

1,1,1-Trichloroethane is rapidly taken up by humans after inhalation exposure. Experimental data collected in human subjects indicate that absorption of 1,1,1-trichloroethane is nearly complete following a single breath exposure. The absorption of 1,1,1-trichloroethane by the skin in humans has been shown to be dependent on the duration of exposure and the area of skin exposed. Absorption through the respiratory tract is expected to predominate during whole-body exposure to vapors. After cessation of inhalation exposure,

1,1,1-Trichloroethane is rapidly eliminated from the blood; 60–80% is eliminated within two hours after exposure and more than 95–99% within 50 hours. Less than 10% of the absorbed dose is metabolized; a large fraction is excreted unchanged in exhaled air, regardless of the route of exposure. The major metabolites of 1,1,1-trichloroethane are water-soluble trichloroethanol and its glucuronide conjugate, trichloroacetic acid and carbon dioxide. The kinetics of elimination of 1,1,1-trichloroethane from blood into exhaled air are exponential. Elimination half-times for the initial, intermediate and terminal phases have been estimated at 1–9 hours, 6–20 hours and > 26 hours. Half-times for elimination from blood have been estimated to be 10–27 hours for trichloroethanol and 70–85 hours for trichloroacetic acid. Daily occupational exposure to 1,1,1-trichloroethane has been shown to result in a progressive increase in levels of urinary metabolites. Levels decline over the weekend, after exposure ceases [IARC].

Health hazards

Acute effects

The fatalities have been associated with exposure to 1,1,1-trichloroethane, mostly due to deliberate inhalation or to accidental occupational exposure. Death was due to suffocation, the lungs showing acute edema and congestion. Exposure to 1,1,1- trichloroethane impairs psychophysiological functions [IARC].

CNS

1,1,1-Trichloroethane causes concentration-related CNS depression. Symptoms can include euphoria, headache, dizziness, malaise, hallucinations or distorted perceptions, behavioral changes, ataxia, seizures, sedation, coma, cerebral edema, and death. CNS effects resolve quickly when the victim is removed from further exposure.

A one hour exposure to 1,000 ppm can cause dizziness and loss of coordination. Central nervous system (CNS) depression generally begins at 5,000 ppm. Levels of 10,000 ppm or higher can cause sedation, hypotension, cardiac dysrhythmia, coma, and death.

Cardiovascular

Inhalation of high concentrations can cause hypotension and dysrhythmia. 1,1,1-Trichloroethane sensitizes the heart to epinephrine. Physical exertion, stress, or other stimuli resulting in epinephrine release can trigger dysrhythmia and result in sudden death [CDC].

Sudden deaths in situations indicative of acute overexposure have been attributed to cardiac arrhythmias as a result of cardiac sensitization [LaDou J].

Gastrointestinal

Nausea, vomiting, and diarrhea can occur following ingestion or inhalation of a high dose (3,000-10,000 ppm) of 1,1,1-trichloroethane. Ingestion can produce a burning sensation in the mouth, throat, and esophagus.

Hepatic

Although there are no reports of toxicity at low concentrations, hepatic lipidosis, macronodular cirrhosis, and transient hepatitis have been reported following high-level inhalation exposures [CDC].

1,1,1-Trichloroethane is only weakly hepatotoxic, with minor injury reported following massive overexposure [LaDou J].

Dermal

Direct skin exposure to liquid 1,1,1-trichloroethane can cause a burning sensation, erythema, and blistering.

Ocular

Exposure to 1,1,1-trichloroethane vapor (>500 ppm for 1 hour) and direct contact with the liquid can cause irritation or transient conjunctivitis [CDC, EPA,TOXNET].

Chronic effects

Chronic exposure can cause lethargy, impaired memory, and impaired balance.

Chronic skin exposure can cause irritant contact dermatitis [CDC, EPA,TOXNET].

Hepatic

Although there are no reports of toxicity at low concentrations, hepatic lipidosis, macronodular cirrhosis, and transient hepatitis have been reported following high-level inhalation exposures [CDC].

1,1,1-Trichloroethane is only weakly hepatotoxic, with minor injury reported following massive overexposure [LaDou J].

Carcinogenicity

1,1,1-Trichloroethane has been assessed for carcinogenic effects; the International Agency for Research on Cancer (IARC) has assigned 1,1,1-trichloroethane to Group 3 (not classifiable as to carcinogenicity in humans) [IARC].

The Environmental Protection Agency [EPA] has assigned it to Group D (not classifiable as to carcinogenicity in humans) based on inadequate evidence of cancer for humans and experimental animals [EPA].

Reproductive and Developmental Effects

1,1,1-Trichloroethane is not included in Reproductive and Developmental Toxicants. Adverse reproductive or developmental effects in humans have not been reported and animal studies do not suggest that 1,1,1-trichloroethane is a reproductive or developmental toxicant although it crosses the placenta and is excreted in breast milk [CDC].

No data for reproductive and developmental effects were available to the Working Group [IARC].

References

- Overall Evaluations of Carcinogenicity: An Updating of IARC Monographs Supplement 7; pp:365-366; 881-900. IARC Monographs Supplement 7 (1987).
- The Montreal Protocol on Substances That Deplete the Ozone Layer https://www.state.gov/e/oes/eqt/chemicalpollution/83007.htm
- Medical Management Guidelines for 1,1,1-Trichloroethane https://www.atsdr.cdc.gov/MMG/MMG.asp?id=427&tid=76
- LaDou J.: Current Occupational and Environmental Medicine, 5th ed., McGraw Hill Education, 2014. p 553.
- Methyl chloroform (1,1,1-Trichloroethane) 71-55-6 . https://www.epa.gov/sites/production/files/2016-09/documents/methyl-chloroform.pdf
- 1,1,1-Trichloroethane. NSDB. Toxnet. Toxicology Data network. https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+157