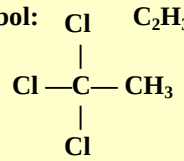
Trichloroethane

Symbol: $C_2H_3Cl_3$



Molecular Weight: 133

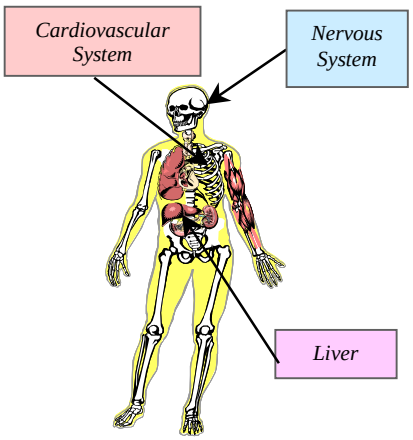
What Is It? Trichloroethane, $C_2H_3Cl_3$, is a non-flammable, colorless liquid with a sweet, chloroform-like odor. This man-made chemical is also known as TCA; 1,1,1-trichloroethane; and methylchloroform. Trichloroethane is slightly soluble in water, and when left exposed to air it evaporates into the atmosphere as a gas where it has a residence time of about six years. At high temperatures, trichloroethane vapors burn to produce toxic phosgene gas and hydrogen chloride. Most people can smell trichloroethane at concentrations of about 120 to 500 parts per million (ppm).

How Is It Used? The production of trichloroethane ended in 1996 in the United States as part of the phase-out of ozone-depleting chemicals. Although use was not prohibited, it has declined since that time as existing stores of trichloroethane were depleted. Previously, trichloroethane was widely used as a solvent in about one-fourth of all industries in the United States. It was used to clean and degrease a variety of equipment, as a precursor in the manufacture of chemicals such as vinylidene chloride, and as a coolant during the drilling and tapping of metals. Trichloroethane was also used in a variety of consumer products, including drain cleaners, cleaning agents, shoe polish, spot removers, wallpaper and carpet glues, food packaging adhesives, photographic films, insecticides, rodenticides, and in many arts and crafts supplies such as printing inks and paints. Additionally, trichloroethane was occasionally used as an aerosol propellant.

What's in the Environment? Trichloroethane is released to the environment by both process emissions and fugitive emissions during its use in industrial and consumer applications, although these emissions have decreased significantly since production ended in 1996. Because of its high volatility, trichloroethane released to surface soil and water evaporates quickly, and most of this organic chemical is present in air. In the atmosphere, trichloroethane is transformed over a six-year process through reactions with hydroxyl radicals. During the transformation process, about 15% migrates into the stratosphere where it is converted into chlorine atoms by lower-wavelength ultraviolet light. These chlorine atoms contribute to the degradation of the ozone layer. When large amounts are released to soil, some can move rapidly down toward groundwater while also evaporating toward the surface. The concentration associated with soil particles has been estimated to be about 80% of that in interstitial water (in pore spaces between soil particles). What does reach groundwater can evaporate and move back up through soil as a gas into the air; its predicted half-life in groundwater is 200 to 300 days. Organisms naturally present in both soil and groundwater can break down trichloroethane.

Typical concentrations of trichloroethane in air range between 0.1 and 0.9 parts per billion (ppb) outdoors and 0.3 and 4.4 ppb indoors, although concentrations as high as 290 ppb have been measured in air in new and recently renovated buildings. The higher concentrations found in indoor air are likely due to the use of trichloroethane in consumer products, which will continue to decline over time. Up to 0.01 ppm trichloroethane has been detected in rivers and lakes. Concentrations measured in drinking water range from 0.01 to 3.5 ppb, and levels in municipal water systems have ranged from 0.8 to 142 ppb. Concentrations in groundwater typically range between 0 and 18 ppb, although highly contaminated wells have been found to contain up to 3 grams of trichloroethane per liter of water (g/L). Soil can be contaminated with trichloroethane through accidental spills, leaching of contaminated water from landfills or treatment and storage lagoons, application of insecticides and rodenticides, wet deposition, and percolation of contaminated rainwater. Trichloroethane has been detected in soil at levels up to 120 ppm. This organic compound has also been found in raw, processed, and prepared food products, with average concentrations ranging from 0.0039 ppb (ice from a commercial machine) to 16,000 ppb (allspice). Trichloroethane does not accumulate in plants or animals.

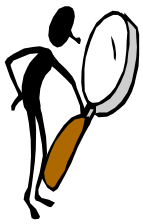
What Happens to It in the Body? Inhalation is the primary route of exposure to trichloroethane. It is rapidly absorbed in the lungs following inhalation and in the gastrointestinal tract following ingestion. Although trichloroethane is also absorbed through the skin, this route is typically less important because trichloroethane evaporates rapidly. The highest concentrations of trichloroethane in the body are found in fat, liver, kidney and brain. Trichloroethane is rapidly eliminated from the body through the lungs and urine. About 90% of the amount taken in leaves the body unchanged in exhaled air, irrespective of the route of exposure (that is, whether it was inhaled, ingested, or taken in through the skin). The remainder is metabolized and excreted either in the urine as trichloroethanol and trichloroacetic acid or exhaled from the lungs as carbon dioxide.



Primary organs affected when trichloroethane is inhaled or ingested.

What Are the Primary Health Effects? Trichloroethane is relatively less toxic than most chlorinated solvents, which accounts in part for its extensive use before its effects on the ozone layer were recognized. At elevated concentrations, trichloroethane can cause central nervous system depression (slowing functions), irregular heartbeat, loss of balance and coordination, and fluid buildup in the lung. In animals, exposure to lower concentrations can damage the nervous system and liver. Trichloroethane is one of the many solvents that have been intentionally inhaled to alter mood or consciousness, and it has been associated with the "sudden sniffing death" syndrome. Although some studies suggest that trichloroethane is weakly mutagenic, these effects may be associated with a contaminant present in the trichloroethane and not the chemical itself. The Environmental Protection Agency (EPA) has stated that adequate information is not available to evaluate the carcinogenicity of trichloroethane.

What Is the Risk? The EPA develops a toxicity value called a reference dose (RfD) to estimate the risk of non-cancer health effects as a result of inhaling or ingesting a chemical. An RfD is an estimate of the highest dose than can be taken in every day without causing an adverse health effect. Although the EPA had previously established an oral RfD for trichloroethane, the agency withdrew the RfD pending further review.

What Are the Current Limits for Environmental Releases and Human Exposure? To help track facility releases to the environment, the Superfund amendments that address emergency planning and community right-to-know require immediate reporting of a release or spill of 1,000 pounds (454 kilograms) or more of trichloroethane. Normal releases must also be reported annually and entered into a nationwide Toxic Release Inventory. For drinking water, the EPA has established a protective level (maximum contaminant level) of 0.2 milligram per liter (mg/L). For air in the workplace, the Occupational Safety and Health Administration (OSHA) has established a limit of 350 ppm in air for an 8-hour workday over a 40-hour week.

Where Can I Find More Information? More information on trichloroethane can be found in the primary information source for this overview: the Toxicological Profile for 1,1,1-Trichloroethane prepared by the Agency for Toxic Substance and Disease Registry (ATSDR) and available at http://www.atsdr.cdc.gov/toxpro2.html. Several other sources of information are available on the Internet, including the ATSDR ToxFAQS (http://www.atsdr.cdc.gov/toxfaq.html), EPA's Integrated Risk Information System Database (http://www.epa.gov/iris/subst/index.html), and the Hazardous Substances Data Bank (http://www.toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).