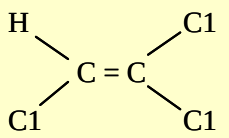
Trichloroethylene

What Is It? Trichloroethylene, C_2HCl_3, is a man-made, colorless liquid with a sweet odor that most people can detect at levels of about 100 parts per million (ppm). Also known as trichloroethene and often called TCE, this compound is moderately soluble in water. Trichloroethylene evaporates readily and has an atmospheric half-life of about a week. It is converted to phosgene gas and hydrogen chloride.

Symbol: C_2HCl_3



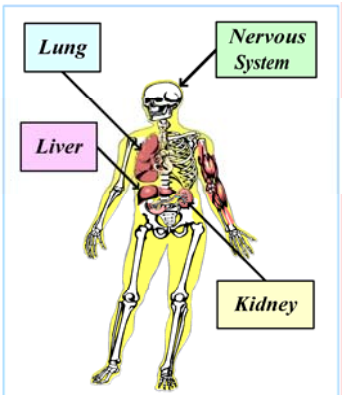
Molecular Weight: 131

How Is It Used? Trichloroethylene is an industrial solvent used primarily in metal cleaning and degreasing operations, including to remove grease from metal parts used to make automobiles. It is also used to make other chemicals such as polyvinyl chloride, and in varnishes, adhesives, paints, and lacquers. Trichloroethylene is present in many household products, such as spot removers, carpet cleaning fluids, typewriter correction fluids, and paint removers. It was once used as a dry-cleaning solvent, fumigant, and general anesthetic, but those uses have been discontinued. Before 1977, it was used to remove caffeine from coffee beans. An estimated 200 million pounds of trichloroethylene are used each year in the United States.

What's in the Environment? Trichloroethylene is mainly present in air and water, with metal degreasing representing a major release source for air. Although rapidly broken down in the atmosphere, primarily via reactions with hydroxyl radicals to produce phosgene, dichloroacetyl chloride, and formyl chloride, TCE is used in such large amounts that those levels continue to be replenished. Found throughout the world, the average concentration in U.S. air ranges from about 30 to 460 parts per trillion (ppt), with higher levels in urban and industrial areas.

Trichloroethylene evaporates easily from surface water, but it can remain in the subsurface, including groundwater, for a long time. In soil and groundwater, it can be broken down by bacteria to produce vinylidene chloride (a suspected human carcinogen) and vinyl chloride (a known human carcinogen). The concentration of trichloroethylene associated with the soil particles has been estimated to be about 60% of that in interstitial water (in pore spaces between soil particles). From a study by the U.S. Environmental Protection Agency (EPA), up to a third of drinking water sources in this country contain trichloroethylene. The median concentration in waters from groundwater sources is around 0.3 parts per billion (ppb). Trichloroethylene has also been found at very low levels in various prepared foods. It does not accumulate to significant levels in plants, animals, or fish.

What Happens to It in the Body? Trichloroethylene can enter the body by breathing air, drinking water, or eating food containing this chemical, and it can also be absorbed through the skin. When trichloroethylene is inhaled, up to 75% can be retained in the body. A substantial fraction is also retained following ingestion. Some trichloroethylene is stored in fatty tissue, while the rest remains in the blood to circulate throughout the body, and it is rapidly metabolized to dichloroacetic acid, trichloroacetic acid, trichloroethanol, and other chemicals. Most of these metabolites leave the body in the urine.



Organs and systems affected when TCE is taken in through food, water, or air.

What Are the Primary Health Effects? Exposure to trichloroethylene can potentially affect a number of organs and systems, including the nervous system, liver, kidney, blood, cardiovascular system, immune system, and reproductive system. Skin contact with trichloroethylene can cause rashes, while inhalation or ingestion of high concentrations for a short time primarily

affects the central nervous system. Inhalation or ingestion of very high concentrations can lead to loss of consciousness and death. At somewhat lower concentrations, people can become sleepy or dizzy or get headaches. Except in severe cases, the effects disappear after the exposure stops. Exposure to relatively low levels of trichloroethylene in air or water for a long period of time (years) can damage the liver and kidney, with more severe effects in people with impaired liver or kidney function, such as alcoholics.

Abnormal skeletal development and other effects have been observed in the offspring of exposed animals; however, it is not known if similar effects can occur in humans. Trichloroethylene has been shown to cause cancer in animals, but we do not know if it causes cancer in humans. The International Agency for Research on Cancer has determined that trichloroethylene is not classifiable as to human carcinogenicity. The EPA is currently reviewing its carcinogenicity, and in a 2001 draft health assessment, characterized trichloroethylene as "highly likely to produce cancer in humans" based on the 1999 proposed (and now accepted) cancer guidelines and as a probable human carcinogen, based on the former 1986 cancer guidelines.

What Is the Risk? The EPA has developed toxicity values to estimate the risk of getting cancer or other adverse health effects as a result of inhaling or ingesting trichloroethylene. These toxicity values were developed by studying test animals given relatively high doses over their lifetimes, then adjusting and normalizing those results to a milligram per kilogram per day (mg/kg-day) basis for humans and by studying humans exposed in occupational settings. However, at this time, EPA has withdrawn all previously published toxicity values as further scientific data have become available and are being evaluated.

The toxicity value for estimating the risk of getting cancer is called a slope factor (SF) for ingestion exposure (also sometimes used for inhalation exposure). An SF is an estimate of the chance that a person exposed to a chemical will get cancer from taking in 1 milligram per kilogram of body weight per day (mg/kg-day), for a lifetime. The EPA identified draft oral SFs ranging from 0.02 to 0.4 per mg/kg-day in the 2001 draft health assessment. The toxicity value used to evaluate the non-cancer effect is called a reference dose (RfD) for ingestion exposure, and a reference concentration (RfC) for inhalation exposure. An RfD is an estimate of the highest dose that can be taken in every day without causing an adverse non-cancer effect. The RfC is the highest concentration in air that can be breathed everyday without causing non-cancer health effects. The oral RfD withdrawn from IRIS was 0.006 mg/kg-day. A draft RfD of 0.0003 mg/kg-day and an inhalation RfC of 0.04 milligram per cubic meter (mg/m^3) were later derived in EPA's 2001 draft health assessment.

What Are Current Limits for Environmental Releases and Human Exposures? To help track facility releases to the environment, the Superfund amendments that address emergency planning and community right-to-know require the immediate reporting of releases of 100 pounds (45.4 kg) or more of trichloroethylene that occur within a 24-hour period, and also require normal releases to be reported annually and entered into a nationwide Toxics Release Inventory. For drinking water supplies, the EPA has established a maximum contaminant level of 5 ppb for TCE with a goal of zero. For air in the workplace, the Occupational Safety and Health Administration has identified a limit of 100 ppm for an 8-hour work day over a 40-hour work week.

Where Can I Find More Information? More information on trichloroethylene can be found in the primary information source used to prepare this overview, the Toxicological Profile for Trichloroethylene, prepared by the Agency for Toxic Substances and Disease Registry and available at http://www.atsdr.cdc.gov/toxpro2.html. Other web-based sources of information include the ATSDRs ToxFAQs (http://www.atsdr.cdc.gov/toxfaq.html), the EPA's Integrated Risk Information System (http://www.epa.gov/iris/subst/index.html), and the National Library of Medicine Hazardous Substances Data Bank (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).