

Chemical companies produce many tank cars full of industrial solvents every year. One of the most important classes of solvents is that of chlorinated hydrocarbons. Chlorinated derivatives of methane (CH_4), ethane (CH_3CH_3), and ethylene (CH_2CH_2) have proven especially useful. Chlorocarbons are used as anesthetics and fire retardants, among other uses. Chlorocarbons are particularly useful as solvents.

Three applications account for most of the production of these solvents:

- extraction of vegetable oils from plants
- dry cleaning of fabrics
- degreasing newly-manufactured metal parts

We will look at the five most important and profitable chlorocarbon solvents, and then summarize their properties at the end of the passage.

All of these liquids are good solvents for nonpolar organic compounds, such as oils, fats, and waxes. Most are nonpolar solvents, which is why they are able to dissolve nonpolar organic compounds. Even the chlorocarbon that is a polar solvent dissolves nonpolar organics.

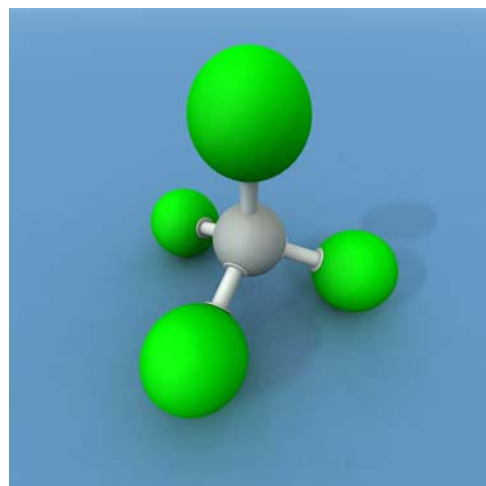
A disadvantage of using these compounds is that some of them are toxic to humans. The levels of toxicity cover a wide range from “Call 911!” to “Go out and breathe some fresh air. You’ll probably be OK.” All of these compounds suppress activity of the central nervous system. Some cause cancer and may even cause liver and kidney damage. Humans are not the only targets of chlorocarbons, as some affect the environment by contributing to ozone depletion.

Carbon tetrachloride (CCl_4), or carbon tet, is a derivative of methane. The liquid is non-flammable. Carbon tet has a density of 1.6 g/cm^3 , which is much greater than that of water. Carbon tet was once used as a dry cleaning solvent, but it has been replaced by other solvents, mostly because of its known ability to cause liver toxicity.

1,1,1-Trichloroethane (CCl_3CH_3), also known as methyl chloroform, is the least toxic of the solvents under discussion. The molecule is usually considered polar, owing to the partial negative charge on the chlorine end, and the partial positive charge on the hydrogen end, of the molecule. This makes it useful for certain solvent applications. At one time, it was widely used to clean metal parts. Now that it has been discovered to



Industrial solvents are often transported by rail.



In this model of carbon tetrachloride, the green spheres are chlorine, and the white sphere is carbon.

have ozone-depleting properties, methyl chloroform is tightly regulated, and only available in small quantities.

1,1,2-Trichloroethane (CHCl₂CH₂Cl) is a good solvent for fats, oils, and waxes. The compound's toxicity is moderate, but if it gets too hot, it can react to produce another very toxic compound, phosgene (COCl₂).

Trichloroethylene (CCl₂CHCl), also called trichlor, is used extensively as a de-greaser for metal parts. The problem is that it reacts with aluminum to produce aluminum chloride (AlCl₃) and hydrogen gas (H₂). Not only is hydrogen explosive, the reaction corrodes parts made of aluminum. It was discovered by chemists at Dow Chemical Company that adding 1,4-dioxane (C₄H₈O₂) to the solvent inhibits the corrosive reaction. Trichlor was also used as a dry cleaning solvent until it was replaced by tetrachloroethylene. Trichlor is also used in the extraction of vegetable oils from plants, including the process that decaffeinate coffee. Other nicknames for the compound are TCE, trike, and tricky.

Tetrachloroethylene (CCl₂CCl₂) is a class 2A carcinogen, which is the “probably causes cancer” category, as opposed to the more serious “definitely causes cancer” category. It is so widely used in the dry cleaning industry that it is often referred to as “dry cleaning fluid.”

Those are the five main chlorocarbon solvents. If you are exposed to any of them, they will make you dizzy or worse. Some of them also cause pollution problems. On the other hand, they smell somewhat pleasant, they are not highly flammable, and they are great solvents.

Name	Molecular Formula	Structural Formula	Uses	Problems
Carbon tetrachloride	CCl ₄	<pre> Cl Cl - C - Cl Cl </pre>	Formerly used as a dry cleaning solvent	Most toxic of all
1,1,1-Trichloroethane	CCl ₃ CH ₃	<pre> Cl H Cl - C - C - H Cl Cl </pre>	Formerly used to clean metal parts	Ozone-depleting compound
1,1,2-Trichloroethane	CHCl ₂ CH ₂ Cl	<pre> H H Cl - C - C - H Cl H </pre>	Solvent for fats, oils, and waxes	Can react when heated to produce toxic material
Trichloroethylene	CCl ₂ CHCl ₂	<pre> Cl Cl \ / C = C / \ Cl H </pre>	Cleaning metal parts and extracting oils from plants Formerly used in dry cleaning	Corrosive to some metals without added inhibitor
Tetrachloroethylene	CCl ₂ CCl ₂	<pre> Cl Cl \ / C = C / \ Cl Cl </pre>	Dry cleaning solvent of choice	Could be carcinogenic

Chlorocarbon solvents are used in many different applications.