OxyChem®

Basic Chemicals

Responsible Care® Good Chemistry at Work

Product Stewardship Summary
Perchloroethylene

Summary

Perchloroethylene is a colorless liquid with the chemical formula, C_2Cl_4. Perchloroethylene is used primarily as a chemical intermediate in the production of several fluorinated compounds. Its other major uses are for the cleaning and degreasing of fabricated metals and as a solvent in automotive aerosols.

1. Chemical Identity

Name: Perchloroethylene
Synonyms: Tetrachloroethylene; Perc; PCE
Chemical Abstracts Service (CAS) number: 127-18-4
Chemical Formula: C_2Cl_4
Molecular Weight: 165.82

Perchloroethylene is a colorless, volatile liquid. It has a sweet, chloroform-like odor. It is not flammable. Its vapors are heavier than air and tend to sink to low areas.

2. Production

Perchloroethylene is produced mainly by reacting hydrocarbons such as propane or propylene or chlorinated hydrocarbons such as ethylene dichloride (EDC) with chlorine. The byproduct of each reaction is hydrochloric acid (HCl). Some reactions include:

Propane and chlorine: $2\ C_3H_8 + 14\ Cl_2 \rightarrow 3\ C_2Cl_4 + 16\ HCl$

Propylene and chlorine: $2\ C_3H_6 + 12\ Cl_2 \rightarrow 3\ C_2Cl_4 + 12\ HCl$

EDC and chlorine: $C_2H_4Cl_2 + 3\ Cl_2 \rightarrow C_2Cl_4 + 4\ HCl$

OxyChem is a leading manufacturer of perchloroethylene. Perchloroethylene is manufactured at OxyChem's facilities in Geismar, Louisiana and Wichita, Kansas.

3. Uses

OxyChem does not sell perchloroethylene to household consumers or to dry cleaners. Perchloroethylene is used primarily as a chemical intermediate in the production of several fluorinated compounds that are then used as refrigerants. Its other major uses are for the cleaning and degreasing of fabricated metals and as a solvent in automotive aerosols. It has also been used as a replacement for carbon tetrachloride in the isomerization process in the petroleum refining industry.

4. Physical and Chemical Properties

Perchloroethylene is not flammable and has no measurable flash point. It also has a low vapor pressure, meaning that at room temperature, it does not evaporate as readily as other solvents.

Perchloroethylene does not contribute to the formation of smog (ground-level ozone) or to the depletion of stratospheric ozone. The U.S. EPA has approved the use of perchloroethylene as a replacement for stratospheric ozone depleting solvents.

Perchloroethylene can be stored in vessels made of common materials of construction. Perchloroethylene is stable with common metals other than aluminum.

5. Health Effects

Inhalation
The major symptoms of acute overexposure to perchloroethylene are central nervous system effects typical of anesthesia, which generally disappear when the individual is removed from exposure. Prolonged exposure to concentrations of 200 parts per million (ppm) or more has been associated with dizziness, confusion, headache, nausea, and irritation of the eyes and mucous tissue. At higher exposures (>600 ppm) these symptoms are intensified. Prolonged exposure to extremely high levels (>1,500 ppm) may lead to unconsciousness due to anesthesia and, in extreme cases, death from respiratory depression.

Changes in the liver and kidney of laboratory animals have been observed following prolonged exposure to concentrations of 200 ppm or more. In humans, reversible effects in liver function have been noted in persons exposed to high levels of perchloroethylene vapor for extended periods of time. No effects on the liver or kidney were seen in human volunteers exposed to up to 150 ppm, 7.5 hours per day, 5 days per week for 11 weeks. For occupational exposures, there are reports of mild alterations of liver or kidney function in a few studies, but other studies have found no detectable effect.

Eye Contact
Perchloroethylene may cause eye irritation with tearing, redness, stinging and burning.

Skin Contact
Perchloroethylene may cause skin irritation with redness, itching and burning.

Ingestion
Swallowing perchloroethylene may be harmful. Effects may include nausea, vomiting, abdominal cramps and diarrhea. It can also produce narcotic effects such as dizziness or drowsiness. Perchloroethylene is an aspiration hazard, meaning it can get into the lungs if swallowed, possibly causing causing lung damage or even death.

Cancer Studies
The International Agency for Research on Cancer (IARC) classifies perchloroethylene in Group 2A, as a substance considered “probably carcinogenic to humans.” NTP listed perchloroethylene as “reasonably anticipated” to be a carcinogen based on a finding of “sufficient” evidence of carcinogenicity in experimental animals.

Eight studies of the carcinogenic potential of perchloroethylene in laboratory animals have been conducted. Three of the studies showed a significant increase in liver tumors in mice, and two studies found an increase in leukemia among rats. An EPA Science Advisory Board reviewed the increase of

leukemia among rats exposed to perchloroethylene. There is a high spontaneous background rate of leukemia in the particular rat strain used in the study. The Board determined that the study does not provide a basis for associating perchloroethylene exposure with leukemia in humans. The Board also indicated that the increase in the mouse liver tumors may be due to a mechanism that is tumorigenic only in rodents.

Several epidemiology studies have investigated cancer mortality among drycleaning workers and show no consistent link between perchloroethylene exposure and cancer. In the worker studies, the tumor types observed in experimental animals were not observed to occur with increased frequency in the worker groups studied.

Workers studied were typically exposed to a variety of solvents in addition to perchloroethylene. There are three studies where perchloroethylene was the predominant solvent. One study was completed on a group of workers entering a Missouri drycleaners union after 1960. The second study was conducted by the National Institute for Occupational Safety and Health (NIOSH), and it included a subgroup of 625 workers employed in shops where perchloroethylene was believed to be the primary or only solvent. The largest and most recent study looked at cancer mortality among more than 7,000 workers in the Nordic countries where perchloroethylene was the predominant drycleaning solvent during the period of interest.

Slightly elevated rates of bladder cancer were observed in some of the worker studies, but not in the groups of workers exposed only to perchloroethylene. An increase in esophageal cancer was observed in the Missouri drycleaners union study, but not in the other studies. In the Missouri drycleaners union study, the incidence of esophageal cancer did increase with duration or level of exposure. In the NIOSH study, a significant increase in esophageal cancer was observed in the entire cohort and in workers with exposure to other solvents, but not in the perchloroethylene-only subgroup. The Nordic study did not find an increase in esophageal cancer among drycleaning workers.

Reproductive Studies

A number of studies have been conducted on the reproductive effects of perchloroethylene. The results of these studies in a variety of species indicate that perchloroethylene is not likely to cause significant developmental defects. On the basis of the available data, EPA has concluded that there is no evidence suggesting that the fetus is uniquely susceptible to the effects of perchloroethylene.

6. Environmental Effects

If released to soil, perchloroethylene is expected to have moderate mobility. Perchloroethylene has often been detected in groundwater. Volatilization from moist soil surfaces into the air is expected to be an important process. Perchloroethylene may volatilize from dry soil surfaces based upon its vapor pressure. Volatilization half-lives in the range of 1.2-5.4 hours were measured for perchloroethylene from a sandy loam soil surface and volatilization half-lives of 1.9-5.2 hours were measured from an organic topsoil. Biodegradation is expected to occur slowly in soils under both aerobic and anaerobic conditions.

If released into water, perchloroethylene is not expected to adsorb to suspended solids and sediment in water. The biodegradation half-lives of perchloroethylene in aerobic and anaerobic waters were reported as 180 and 98 days, respectively. Volatilization from water surfaces into the air is expected to be an important process. Estimated volatilization half-lives for a model river and model lake are 1 hour and 5 days, respectively.

If released to air, its vapor pressure of 18.5 mm mercury at 25 °C indicates that perchloroethylene will remain a vapor in the ambient atmosphere. Vapor-phase perchloroethylene will be degraded in the

atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 96 days. Direct photolysis is not expected to be an important degradation process since perchloroethylene only absorbs light weakly in the environmental UV spectrum.

Perchloroethylene is moderately toxic to aquatic life on an acute basis. In laboratory studies the concentrations that were lethal to 50% of the fishes exposed ranged from 5 to 46 milligrams per liter. Measured bioconcentration factors of 26-77 in fish suggest bioconcentration in aquatic organisms is low to moderate.

7. Exposure

The most likely ways exposures could occur are:

- Worker exposure – Exposure could occur in the manufacturing facility or in industrial facilities that use perchloroethylene. Exposures could occur by inhalation of vapors. Perchloroethylene is used in closed systems in manufacturing processes to minimize exposures. In addition, good industrial hygiene practices and personal protective equipment minimize the risk of exposure.
- Consumer exposure – OxyChem does not sell perchloroethylene for use directly in consumer products or to dry cleaners.
- Releases – If a spill occurs, emergency personnel should wear protective equipment to minimize exposures.

8. Recommended Risk Management Measures

Prior to using perchloroethylene, carefully read and comprehend the Material Safety Data Sheet. The following are some recommended risk management measures:

- Work areas where perchloroethylene is used should be well ventilated to limit solvent vapors to below exposure limits.
- To avoid overexposure to perchloroethylene vapors, monitor the vapor concentration in the work place. If vapors are above exposure limits, install additional engineering controls (such as localized ventilation) to reduce perchloroethylene vapor concentrations to safe operating levels.
- To prevent eye contact, protective eye wear (such as splash goggles, a full face shield, or safety glasses with side shields) must be worn.
- To prevent skin contact, wear protective clothing (including gloves) when working with perchloroethylene.
- Proper labeling, handling and storage of perchloroethylene will reduce the likelihood of accidental exposure.
- Avoid environmental contamination by keeping perchloroethylene out of water supplies, sewers and soil. Do not discharge it into drains surface water or groundwater.
- Equipment used for perchloroethylene storage or processing should be constructed of the proper materials. Do not use aluminum as a material of construction.
- Personnel involved with perchloroethylene manufacturing operations should be properly trained.

9. Product Stewardship Programs

OxyChem provides bulletins to help perchloroethylene customers handle the product safely. OxyChem is also a member of the Halogenated Solvents Industry Association (HSIA). Through the HSIA, OxyChem is sponsoring studies of perchloroethylene under EPA's Voluntary Children's Chemical Evaluation Program.

10. Regulatory Compliance Information

The following is a summary of regulations and guidelines that may pertain to perchloroethylene (additional regulations and guidelines may apply):

U.S. Environmental Protection Agency:

- Clean Air Act: Perchloroethylene is included on the Clean Air Act, Section 112(b) list of Hazardous Air Pollutants.
- Clean Air Act: A New Source Performance Standard has been developed for perchloroethylene under Clean Air Act, Section 111.
- Clean Water Act: Perchloroethylene is included on the Clean Water Act, Section 126 list of Priority Pollutants.
- Clean Water Act: Effluent limitation guidelines have been developed for perchloroethylene under Section 304B of the Clean Water Act.
- Comprehensive Environmental Response, Compensation, and Liability Act: Releases of perchloroethylene in excess of the Reportable Quantity of 100 pounds must be reported.
- Emergency Planning and Community Right-to-know Act: Perchloroethylene is a listed substance that is subject to reporting requirements under Section 313 of the act. These reports are often called Toxic Release Inventory (TRI) Reports.
- Resource Conservation and Recovery Act: Listed Hazardous Waste Codes in which listing is based wholly or partly on perchloroethylene include U210, F002, and D039.

Occupational Safety and Health Administration - Permissible Exposure Limits:

- 8 hour time weighted average: 100 ppm
- Ceiling: 200 ppm
- Peak (5 minutes in any 3 hour period): 300 ppm

American Conference of Governmental Industrial Hygienists - Threshold Limit Values

- 8 hour time weighted average: 25 ppm
- Short Term (15 minute average): 100 ppm

National Institute for Occupational Safety and Health – Recommended Exposure Levels:

- Immediately Dangerous to Life and Health concentration: 150 ppm

11. Sources for Additional Information

ATSDR, Toxicological Profile for Tetrachloroethylene, September 1997.

U.S. Environmental Protection Agency, Draft Toxicological Review of Tetrachloroethylene (Perchloroethylene) (CAS No. 127-18-4), June 2008.

HSDB, Hazardous Substances Databank Number: 124, Last Revision Date: 20050823.

Halogenated Solvents industry Association, Perchloroethylene White Paper, November 2008. http://www.hsia.org/white_papers/paper.shtml

IARC (1995), IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Vol. 63, Dry Cleaning, Some Chlorinated Hydrocarbons and Other Industrial Chemicals, pp. 159-221.

IUCLID Dataset, Tetrachloroethylene, Substance ID: 127-18-4, February 18, 2000.

NIOSH, Tetrachloroethylene, IDLH Documentation, August 16, 1996.

Report on Carcinogens, Eleventh Edition; U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program.

OxyChem Material Safety Data Sheet web site: http://msds.oxy.com/

Reprotox, Reprotox Record Number: 1239, Last Revision Date: November 1, 2007.

RTECS, RTECS Number: KX3850000, Review Date: 200902.

12. Contact Information: For additional information, call 1-800-752-5151 or 1-972-404-3700.

13. Preparation Date: December 2, 2009

This Product Stewardship Summary is intended to give general information about the product discussed above. It is not intended to provide an in-depth discussion of all health and safety information about the product or to replace any required regulatory communications.