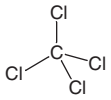
Carbon Tetrachloride
CAS No. 56-23-5

Reasonably anticipated to be a human carcinogen
First Listed in the *Second Annual Report on Carcinogens* (1981)



Carcinogenicity

Carbon tetrachloride (CCl_4) is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity in experimental animals (IARC 1972, 1979, 1982, 1987, 1999). When administered by gavage, carbon tetrachloride increased the incidences of hepatomas and hepatocellular carcinomas in mice of both sexes. By the same route of administration, the compound increased the incidence of neoplastic nodules of the liver in rats of both sexes. When administered by subcutaneous injection, carbon tetrachloride induced hepatocellular carcinomas in male rats and mammary adenocarcinomas and fibroadenomas in female rats. When administered by inhalation, carbon tetrachloride induced liver carcinomas in rats. When administered intrarectally, the compound induced nodular hyperplasia of the liver in male mice.

No adequate data were available from human studies to evaluate the carcinogenicity of carbon tetrachloride in humans (IARC 1979, 1982, 1987, 1999). Three case reports described liver tumors associated with cirrhosis in humans exposed to carbon tetrachloride. A mortality study of laundry and dry cleaning workers exposed to a variety of solvents suggested an excess of respiratory cancers, liver tumors, and leukemia.

Properties

Carbon tetrachloride is a colorless, highly volatile liquid with a strong ethereal odor similar to chloroform. It mixes sparingly with water. When heated to decomposition, it emits highly toxic fumes of phosgene. Carbon tetrachloride is available in the United States in technical and chemically pure grades (IARC 1972, 1979, 1999, HSDB 2000).

Use

Carbon tetrachloride is used primarily as a chemical intermediate in the production of the refrigerants Freon 11 and 12. Freon 11 and 12 are also used as solvents, in plastic and resin production, as foam blowing agents, and previously as aerosol propellants. Carbon tetrachloride has also been used as a general solvent in industrial degreasing operations and as an industrial solvent for cable and semiconductor manufacture (NCI 1985, IARC 1999). Its use as a grain fumigant was banned by EPA in 1985. Carbon tetrachloride is not permitted in products intended for home use (HSDB 2000).

Production

The 1997 Directory of Chemical Producers identified one company producing a total of 110 million lb of carbon tetrachloride at two different sites (SRI 1997). In 1991 and 1990, 315 and 413 million lb were produced, respectively (USITC 1993, 1991). The USITC identified four U.S. producers of carbon tetrachloride in 1989, but no production figures were provided (USITC 1990). In 1988, the United States produced over 761 million lb of carbon tetrachloride; this quantity was an increase over the 1987 total of 672 million lb (USITC 1988, 1989). In 1986, 625 million lb of carbon tetrachloride were produced by five domestic companies (CEN 1987). Total U.S. production capacity was 923 million lb in 1985, although total U.S. production was only 646 million lb (CMR 1986). Production in 1984 and 1983 was 713 million lb and 573 million lb, respectively. Production in the United States decreased an average of 3% per year from 1976, when 857 million lb were produced, to 1986 (CEN 1987). Production of carbon tetrachloride on a large scale in the United States began in 1907 (IARC 1979). The 1998 Chemical Buyers Directory listed six suppliers of the compound, while Chemcyclopedia 98 listed three (Tilton 1997, Rodnan 1997).

U.S. imports of carbon tetrachloride have tended to increase and exports have tended to decrease over the years (ATSDR 1994). Carbon tetrachloride imports exceeded 111 million lb in 1987 (USDOC Imports 1988). Imports increased to over 57 million lb in 1985 from 7 million lb in 1983. Exports decreased from 86 million lb in 1980 to 36 million lb in 1985 (CMR 1986). USITA (2001) noted that, in 2000, the United States exported approximately 32 billion lb worldwide of carbon tetrachloride. No imports were reported.

Exposure

The primary routes of potential human exposure to carbon tetrachloride are inhalation, ingestion, and dermal contact. The greatest risk of occupational exposure to carbon tetrachloride most likely occurred during fumigation processes before this use was banned in 1985 (NCI 1985). NIOSH estimated that workers exposed to carbon tetrachloride are primarily those at blast furnaces and steel mills, in the air transportation industry, and in motor vehicle and telephone and telegraph equipment manufacturing. Approximately 4,500 workers were potentially exposed during production processes and 52,000 during industrial use of the chemical. OSHA estimated that 3.4 million workers may possibly be exposed to carbon tetrachloride directly or indirectly. Exposure to carbon tetrachloride may occur in dry cleaning establishments, where ambient air concentrations have been determined to average between 20 and 70 ppm. Average exposures of 206 and 338 ppm with excursions of 1,252 and 7,100 ppm have been reported during dry cleaning machine operations (NCI 1985). Occupational exposure is also possible during its use in the manufacture of Freon 11 and 12. Exposure during fluorocarbon production is most likely to be experienced by tank farm and process operators, who may be exposed to emissions arising from storage tank vents or resulting from transfer of the chemical or process equipment leaks or spills (NCI 1985). The National Occupational Hazard Survey, conducted by NIOSH from 1972 to 1974, estimated that 160,000 workers were exposed to carbon tetrachloride in the workplace, including 25,000 workers exposed during grain fumigation (NIOSH 1976). The National Occupational Exposure Survey (1981-1983) estimated that 77,315 workers including 12,605 women, potentially were exposed to carbon tetrachloride (NIOSH 1984).

EPA's Toxic Chemical Release Inventory (TRI) listed 95 industrial facilities that produced, processed, or otherwise used carbon tetrachloride in 1988 (TRI88 1990). Chem Sources (2001) reported 31 suppliers of carbon tetrachloride in the United States. These facilities reported releases of carbon tetrachloride to the environment, which were estimated to total 3.9 million lb. These releases indicate that a large proportion of the general population is possibly exposed to the chemical. EPA estimated that 8 million people living within 12.5 miles of manufacturing sites are possibly exposed to average levels of 0.5 $\mu g/m^3$, with peaks of 1,580 $\mu g/m^3$. According to the report of 1992, releases of the compound to air were significantly reduced in 1990, with an estimated total of 1,671,092 lb. The amount discharged to water was 36,201 lb, and the amount released to soil was a little over 1,000 lb (ATSDR 1994). During 1999, TRI99 (2001) reported total on-site releases to be 268,140 lb.

Carbon tetrachloride is formed in the troposphere by solar-induced photochemical reactions of chlorinated alkenes (IARC 1979). Carbon tetrachloride is readily volatile at ambient temperature and is a stable chemical that is degraded very slowly; therefore, there has been a gradual

accumulation of carbon tetrachloride in the environment. It is broken down by chemical reactions in air, but this occurs so slowly that estimates of its atmospheric lifetime are between 30 and 100 years, with 50 years generally regarded as the probable value. In 1988, an average concentration of carbon tetrachloride in air in the United States was reported to be 0.168 ppb, and other studies have observed a steady increase of global atmospheric levels of the chemical at an annual rate of approximately 1.3%. Surveys by the federal government have found that approximately 99% of all groundwater supplies and 95% of all surface water supplies contain less than 0.5 µg/L of carbon tetrachloride. The general population is most likely exposed to carbon tetrachloride through air and drinking water. Assuming inhalation of 20 m^3/day by a 70-kg adult and 40% absorption of carbon tetrachloride across the lung, typical levels of carbon tetrachloride in ambient air (about 1 µg/m^3) yield daily exposure levels of approximately 0.1 µg/kg. Somewhat higher exposures could occur near point sources of carbon tetrachloride. For water, consumption of 2 L/day by a 70-kg adult at a typical carbon tetrachloride concentration of 0.5 µg/L yields a typical intake by this route of approximately 0.01 µg/kg per day (ATSDR 1994).

Exposure from contaminated foods is possible, but it is not likely to be of much significance, since most levels are below analytical detection limits. Carbon tetrachloride may possibly have been ingested as a contaminant of foods that were treated with the chemical prior to its banning as a grain fumigant. When carbon tetrachloride was used as a fumigant on stored grain, residue concentrations of the chemical ranged from 1 to 100 mg/kg. Exposure to carbon tetrachloride may also occur by dermal contact with tap water (e.g., while bathing) (ATSDR 1994).

Regulations

CPSC

Carbon tetrachloride and mixtures containing it (with the exception of chemicals containing unavoidable residues of carbon tetrachloride that don't result in atmospheric concentrations of carbon tetrachloride greater than 10 ppm) are banned

DOT

Carbon tetrachloride is considered a hazardous material and special requirements have been set for marking, labeling, and transporting this material

EPA

Clean Air Act

- NESHAP: Listed as a Hazardous Air Pollutant (HAP)
- NSPS: Manufacture of substance is subject to certain provisions for the control of Volatile Organic Compound (VOC) emissions
- Urban Air Toxics Strategy: Identified as one of 33 HAPs that present the greatest threat to public health in urban areas

Clean Water Act

- Effluent Guidelines: Listed as a Toxic Pollutant
- Water Quality Criteria: Based on fish/shellfish and water consumption = 0.23 µg/L; based on fish/shellfish consumption only = 1.6 µg/L

Comprehensive Environmental Response, Compensation, and Liability Act

- Reportable Quantity (RQ) = 10 lb

Emergency Planning and Community Right-to-Know Act

- Toxics Release Inventory: Listed substance subject to reporting requirements

Federal Insecticide, Fungicide, and Rodenticide Act

- All registrations have been cancelled

Resource Conservation and Recovery Act

- Characteristic Toxic Hazardous Waste: TCLP Threshold = 0.5 mg/L
- Listed Hazardous Waste: Waste codes in which listing is based wholly or partly on substance - U211, F001, F024, F025, K016, K019, K020, K021, K073, K116, K150, K151, K157
- Listed as a Hazardous Constituent of Waste

Safe Drinking Water Act

- Maximum Contaminant Level (MCL) = 0.005 mg/L

FDA

Maximum permissible level in bottled water = 0.005 mg/L

All medical devices containing or manufactured with carbon tetrachloride must contain a warning statement that the compound may destroy ozone in the atmosphere

OSHA

Acceptable Peak Exposure = 200 ppm (maximum duration = 5 minutes in any 4 hours)
Ceiling Concentration = 25 ppm
Permissible Exposure Limit (PEL) = 10 ppm

Guidelines

ACGIH

Threshold Limit Value - Short Term Exposure Limit (TLV-STEL) = 10 ppm
Threshold Limit Value - Time-Weighted Average Limit (TLV-TWA) = 5 ppm

NIOSH

Short-term Exposure Limit (STEL) = 2 ppm (12.6 mg/m^3) (60 minute exposure)
Immediately Dangerous to Life and Health (IDLH) = 200 ppm
Listed as a potential occupational carcinogen

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