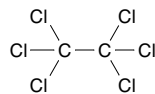


Hexachloroethane

CAS No. 67-72-1

Reasonably anticipated to be a human carcinogen

First listed in the *Seventh Annual Report on Carcinogens* (1994)



Carcinogenicity

Hexachloroethane is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals

Oral exposure to hexachloroethane caused tumors in two rodent species and at several different tissue sites. Administration of hexachloroethane by stomach tube caused liver cancer (hepatocellular carcinoma) in mice of both sexes and benign and malignant kidney tumors (renal-tubular adenoma and carcinoma) in male rats (NCI 1978, IARC 1979, NTP 1989). The incidence of benign adrenal-gland tumors (pheochromocytoma) also was marginally increased in male rats.

Cancer Studies in Humans

No epidemiological studies were identified that evaluated the relationship between human cancer and exposure specifically to hexachloroethane. Since hexachloroethane was listed in the *Seventh Annual Report on Carcinogens*, one additional epidemiological study has been identified. In a cohort study of workers at aluminum foundries and smelters in Sweden, no association was observed between cancer incidence and exposure to hexachloroethane (IARC 1999).

Properties

Hexachloroethane is a chlorinated alkane that exists at room temperature as a colorless crystalline solid with a camphor-like odor. It is practically insoluble in water, soluble in ethanol, benzene, chloroform, and oils, and very soluble in diethyl ether and tetrachloroethylene (Akron 2009, HSDB 2009). Hexachloroethane is stable under normal temperatures and pressures and is considered nonflammable; however, it is incompatible or reactive with alkalis and with metals such as zinc, cadmium, aluminum, hot iron, and mercury (NIOSH 2005). Physical and chemical properties of hexachloroethane are listed in the following table.

Property	Information
Molecular weight	236.7 ^a
Specific gravity	2.09 at 20°C/4°C ^a
Melting point	185°C (closed capillary) ^a
Boiling point	186°C at 777 mm Hg (sublimes) ^a
Log K_{ow}	4.14 ^a
Water solubility	50 mg/L at 25°C ^b
Vapor pressure	0.21 mm Hg at 20°C ^a
Vapor density relative to air	8.16 ^a

Sources: ^aHSDB 2009, ^bChemIDplus 2009.

Use

The applications of hexachloroethane have been extensive; however, industrial uses are diminishing. Hexachloroethane is used primarily in military smoke munitions (e.g., smoke pots, grenades, cartridges, and projectiles used to generate “smoke” or “fog”) and in pyrotechnics. The estimated average annual use of hexachloroethane from 1966 to

1977 at a major facility manufacturing smoke and pyrotechnic devices was 192,802 lb. In the 1970s, about half of the hexachloroethane distributed was used to manufacture military smoke-producing and pyrotechnic devices, 30% to 40% to manufacture degassing pellets to remove air bubbles from molten ore at aluminum foundries, and 10% to 20% as an antihelminthic to control liver flukes in sheep and cattle. The U.S. Food and Drug Administration withdrew approval for the use of hexachloroethane as an antihelminthic in 1971, and it probably is no longer used for this purpose (ATSDR 1997). Its use for degassing aluminum also has been almost completely phased out in the United States (EPA 1999). Other uses in metallurgy include refining alloys, removing impurities from molten metals, recovering metals from ores or smelting products, and as a degassing agent for magnesium; however, the European Union began phasing out the use of hexachloroethane in nonferrous metals in 1998 (EC 1998).

A number of other past uses of hexachloroethane have been identified, but many of these likely have been discontinued or involve the use of only limited quantities. Hexachloroethane is used as a laboratory chemical and as an ingredient in various fungicidal and insecticidal formulations, extreme-pressure lubricants, and plastics (ATSDR 1997, IARC 1999, HSDB 2009). Other past uses include as a moth repellent and in the chemical industry as a polymer additive, a plasticizer for cellulose esters, an accelerator, a vulcanizing agent, a process solvent in rubber manufacturing, a retardant in fermentation processes, and a component of submarine paints, and in the production of some types of synthetic diamonds. It has also been used as a component of fire-extinguishing fluids, an additive in combustible liquids (ignition suppressant), and an inhibitor of the explosiveness of methane and the combustion of ammonium perchlorate (IARC 1979, 1999, HSDB 2009).

Production

Production of hexachloroethane in the United States for commercial distribution began in 1921 and ended in 1967 (IARC 1979, ATSDR 1997). Currently, hexachloroethane is produced as a by-product of industrial chlorination of two-carbon hydrocarbons. It may be used in-house or recycled in feedstock to produce tetrachloroethylene or carbon tetrachloride. In 2009, hexachloroethane was produced by four manufacturers, all in India (SRI 2009) and was available from 35 suppliers, including 20 U.S. suppliers (ChemSources 2009). U.S. imports of hexachloroethane increased from 1.6 million pounds in 1976 to over 2 million pounds in 1977, 2.5 million pounds in 1985, and 4.5 million pounds in 1986 (ATSDR 1997). U.S. imports in the category of hexachloroethane and tetrachloroethane combined have shown an erratic pattern but have tended to decline in recent years, from 689,000 kg (1.5 million pounds) in 1989 to 139,000 kg (306,000 lb) in 2008 (USITC 2009). U.S. exports of hexachloroethane are not expected (ATSDR 1997). Exports in the category of hexachloroethane and tetrachloroethane combined reached a high of 11 million kilograms (25 million pounds) in 2005 and declined rapidly to 167,000 kg (368,000 lb) in 2008 (USITC 2009). Reports filed under the U.S. Environmental Protection Agency’s Toxic Substances Control Act Inventory Update Rule indicated that U.S. production plus imports of hexachloroethane totaled 10 million to 50 million pounds in 1986 and 1994, 1 million to 10 million pounds in 1990, 500,000 lb to 1 million pounds in 1998, and 10,000 to 500,000 lb in 2002 (EPA 2004). In 2006, the reported quantity was 1 million to 10 million pounds (EPA 2009).

Exposure

The routes of potential human exposure to hexachloroethane are inhalation, dermal contact, and ingestion (ATSDR 1997, NCI 1978). The general population can be exposed to hexachloroethane in the

environment at relatively low levels, primarily from ambient air but possibly also from drinking water (ATSDR 1997). According to EPA's Toxics Release Inventory, environmental releases of hexachloroethane from 1988 to 2007 ranged from a high of about 360,000 lb in 1994 to a low of 1,015 lb in 2004. These data, however, do not include releases at military facilities, which are exempt from reporting (TRI 2009). Although data on releases at military facilities are limited, a major military training facility in Fort Irwin, California, was reported to have released up to 6,683 kg (14,700 lb) of hexachloroethane from smoke devices from 1982 to 1984 (ATSDR 1997). In addition to releases to air from military uses, hexachloroethane may be released through combustion and incineration of chlorinated wastes, from hazardous waste sites, and in small amounts during chlorination of sewage effluent prior to discharge and during chlorination of raw water during drinking-water treatment.

Hexachloroethane is relatively persistent in the environment and has been detected in the atmosphere and in drinking water at low levels. When released to air, hexachloroethane is stable and is not expected to react with hydroxyl radicals or ozone (ATSDR 1997, HSDB 2009). Typical background atmospheric levels in the Northern Hemisphere ranged from 5 to 7 ppt (48 to 68 ng/m³). When released to surface water or soil, hexachloroethane is most likely to volatilize or to be adsorbed to soil or sediments; thus, it will have moderate to low mobility in soil. It has been detected in drinking-water wells near a toxic waste dump in Tennessee (median concentration = 0.26 µg/L). Hexachloroethane has also been detected at low levels in surface water, biota, ambient soil, sediments, and commercial food products (ATSDR 1997). Between 1977 and 1979, it was detected in 4 of 14 raw water samples from drinking-water supply sources. In 1975, it was measured in finished drinking water at a concentration of 4.4 µg/L (HSDB 2009). In the early 1980s, it was detected in only 1 of 882 ambient surface water samples and in none of 116 fish samples (based on data in EPA's STORET database). However, fish collected in Ohio in 1980 and 1981 contained hexachloroethane at a concentration of 0.1 mg/kg, and fish from Lake Michigan were reported to contain hexachloroethane, although concentrations were not reported (HSDB 2009). Some bioconcentration in fish has been reported; however, biomagnification through the food chain is unlikely, because hexachloroethane is rapidly metabolized by fish (ATSDR 1997).

Organochlorine pollutants, including hexachloroethane, were measured in human follicular fluid, serum, and seminal plasma in couples undergoing *in vitro* fertilization in Canada (Younglai *et al.* 2002). Hexachloroethane was found in over half of the samples of follicular fluid, at a mean concentration of 232 pg/mL.

Occupational exposure to hexachloroethane can occur through inhalation or dermal contact. Military and civilian personnel working with smoke or pyrotechnic devices that contain hexachloroethane could be exposed. Most of the hexachloroethane in a smoke pot or grenade is used up by the smoke-producing reaction, but small amounts (5% or less) remain after the smoke has formed and could result in further exposure. One study reported hexachloroethane concentrations in smoke ranging from 0.64 to 1.26 mg/m³. Plasma concentrations of hexachloroethane in workers exposed to hexachloroethane in loading and packing operations for smoke munitions production rose from 0.08 ± 0.14 µg/L to 7.3 ± 6.0 µg/L after more than five weeks of work in those areas, despite the use of protective equipment, including disposable overalls and compressed-air-fed visors or full-facepiece masks with filters (ATSDR 1997).

Other occupational exposure to hexachloroethane may occur during its manufacture, transportation, or use. Elevated amounts of hexachloroethane in the air can result when it is used in aluminum foundries as a degassing agent. Industries that may have used hexa-

chloroethane include real estate, paper and allied products, lumber and wood products, and amusement and recreation services (NIOSH 1978). Occupations with potential exposure to hexachloroethane include cleaners and charwomen, millwrights, miscellaneous machine operatives, plumbers and pipefitters, and electricians. The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 8,516 workers, including 576 women, potentially were exposed to hexachloroethane in seven industries (Business Services; Machinery, Except Electrical; Chemicals and Allied Products; Primary Metal; Electric and Electronic Equipment; Transportation by Air; and Printing and Publishing) (NIOSH 1990).

Regulations

Department of Transportation (DOT)

Hexachloroethane is considered a hazardous substance, and special requirements have been set for transporting hexachloroethane in tank cars.

Environmental Protection Agency (EPA)

Clean Air Act

National Emissions Standards for Hazardous Air Pollutants: Listed as a hazardous air pollutant.

New Source Performance Standards: Manufacture of hexachloroethane is subject to certain provisions for the control of volatile organic compound emissions.

Clean Water Act

Effluent Guidelines: Listed as a toxic pollutant.

Water Quality Criteria: Based on fish and shellfish and water consumption = 1.4 µg/L; based on fish and shellfish consumption only = 3.3 µg/L.

Comprehensive Environmental Response, Compensation, and Liability Act

Reportable quantity (RQ) = 100 lb.

Emergency Planning and Community Right-To-Know Act

Toxics Release Inventory: Listed substance subject to reporting requirements.

Resource Conservation and Recovery Act

Characteristic Hazardous Waste: Toxicity characteristic leaching procedure (TCLP) threshold = 3.0 mg/L.

Listed Hazardous Waste: Waste codes for which the listing is based wholly or partly on the presence of hexachloroethane = U131, F024, F025, K016, K030, K073.

Listed as a hazardous constituent of waste.

Occupational Safety and Health Administration (OSHA)

While this section accurately identifies OSHA's legally enforceable PELs for this substance in 2010, specific PELs may not reflect the more current studies and may not adequately protect workers. Permissible exposure limit (PEL) = 1 ppm (10 mg/m³).

Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 1 ppm.

National Institute for Occupational Safety and Health (NIOSH)

Recommended exposure limit (REL) = 1 ppm (10 mg/m³).

Immediately dangerous to life and health (IDLH) limit = 300 ppm.

Listed as a potential occupational carcinogen.

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