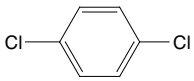
1,4-Dichlorobenzene

CAS No. 106-46-7

Reasonably anticipated to be a human carcinogen

First listed in the *Fifth Annual Report on Carcinogens* (1989)

Also known as *p*-dichlorobenzene



Carcinogenicity

1,4-Dichlorobenzene 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 1,4-dichlorobenzene caused tumors at several different tissue sites in mice and rats. Administration of 1,4-dichlorobenzene by stomach tube caused benign and malignant liver tumors (hepatocellular adenoma and carcinoma) in mice of both sexes and kidney cancer (tubular-cell adenocarcinoma) and mononuclear-cell leukemia in male rats. It also increased the combined incidence of benign and malignant adrenal-gland tumors (pheochromocytoma) in male mice (IARC 1987, NTP 1987).

Since 1,4-dichlorobenzene was listed in the *Fifth Annual Report on Carcinogens,* an additional study in mice has been identified. Inhalation exposure to 1,4-dichlorobenzene caused liver cancer (hepatocellular carcinoma and hepatoblastoma or histiocytic sarcoma) in mice of both sexes (Aiso *et al.* 2005).

Cancer Studies in Humans

The data available from epidemiological studies are inadequate to evaluate the relationship between human cancer and exposure specifically to 1,4-dichlorobenzene. One cohort study reported five cases of leukemia associated with exposure to dichlorobenzenes (IARC 1974, 1982). The International Agency for Research on Cancer reviewed the evidence for the carcinogenicity of dichlorobenzenes in 1999, but reported no additional studies of human exposure to 1,4-dichlorobenzene (IARC 1999).

Properties

1,4-Dichlorobenzene is a chlorinated aromatic compound with a distinctive aromatic odor that is very strong at high concentrations. It is a white or colorless crystal at room temperature (Akron 2009, HSDB 2009). 1,4-Dichlorobenzene is practically insoluble in water; soluble in chloroform, carbon disulfide, benzene, and ether; and very soluble in ethanol and acetone. 1,4-Dichlorobenzene is noncorrosive, volatile, and combustible, and it is flammable when exposed to heat, flame, or oxidizers. When it is heated to decomposition, toxic gases and vapors (such as hydrochloric acid and carbon monoxide) are released (HSDB 2009). It is stable at room temperature under normal handling and storage in closed containers (Akron 2009). Physical and chemical properties of 1,4-dichlorobenzene are listed in the following table.

Property	Information
Molecular weight	147.0
Density	1.2475 g/mL at 20°C/4°C
Melting point	52.7°C
Boiling point	174°C at 760 mm Hg
Log K_{ow}	3.44
Water solubility	0.076 g/L at 25°C
Vapor pressure	1.7 mm Hg at 25°C
Vapor density relative to air	5.08

Source: HSDB 2009.

Use

1,4-Dichlorobenzene has been used primarily as a space deodorant in products such as room deodorizers and toilet deodorant blocks and as a fumigant for moth control (accounting for about 35% to 55% of the 1,4-dichlorobenzene produced) (ATSDR 1998). In 2007, it was used primarily as an intermediate in the production of polyphenylene sulfide, a plastic used in the electrical and electronics industries (52%), in the production of 1,2,4-trichlorobenzene room deodorant (22%), and for moth control (15%) (CMR 2004). Other uses of 1,4-dichlorobenzene include use as a germicide or disinfectant; a soil fumigant; an insecticide for fruit borers and ants; a chemical intermediate in the production of various dyes, pharmaceuticals, and resin-bonded abrasives; an agent to control mold and mildew growth on tobacco seeds, leather, and some fabrics; and an extreme-pressure lubricant (HSDB 2009).

Production

1,4-Dichlorobenzene was first produced commercially in the United States in 1915 (IARC 1982). In 2005, U.S. production capacity for 1,4-dichlorobenzene was reported to be 79 million pounds (CMR 2004). Demand is expected to grow by about 5% in the future because of growth in the production of polyphenylene sulfide resin, an engineering plastic that is used mainly for its insulating and dielectric properties. In 2009, 1,4-dichlorobenzene was produced by 32 manufacturers worldwide, including 1 each in the United States and Canada, 2 each in Mexico and East Asia, 4 in Europe, 9 in India, and 13 in China (SRI 2009), and it was available from 63 suppliers, including 22 U.S. suppliers (ChemSources 2009). U.S. imports of 1,4-dichlorobenzene reached a low of slightly less than 900,000 kg (2 million pounds) in 1990, increasing to almost 22 million kilograms (50 million pounds) in 2007. U.S. exports of 1,4-dichlorobenzene declined from a high of over 12 million kilograms (27 million pounds) in 2000 to slightly more than 0.5 million kilograms (1.2 million pounds) in 2005 (USITC 2009). According to reports filed under the U.S. Environmental Protection Agency's Toxic Substances Control Act Inventory Update Rule, U.S. production plus imports of 1,4-dichlorobenzene totaled 10 million to 50 million pounds in 1986 and 50 million to 100 million pounds between 1990 and 2002, decreasing to 10 million to 50 million pounds in 2006 (EPA 2004, 2009).

Exposure

The primary route of human exposure to 1,4-dichlorobenzene is inhalation; other potential routes are ingestion and dermal contact (ATSDR 2006). The major potential sources of consumer exposure are its uses as a deodorizer and a moth-control agent. For this reason, indoor air concentrations exceed outdoor concentrations by at least an order of magnitude. Concentrations of 1,4-dichlorobenzene in urban areas and in the vicinity of hazardous waste sites generally average less than 25.2 μg/m^3, but indoor air concentrations may be one to three orders of magnitude higher where it is used as a space deodorizer or moth repellent. 1,4-Dichlorobenzene has been detected in

meat and eggs from exposed animals and in fish from contaminated waters (IARC 1982). In the U.S. Food and Drug Administration's Total Diet Study, the concentrations measured in food and water were generally low, and exposure was less than that from air (ATSDR 2006). 1,4-Dichlorobenzene was detected 102 times in 33 different food items, at concentrations ranging from 0.002 to 0.29 ppm (in popcorn popped in oil) (FDA 2006). It has also been identified in samples of pig back fat at a concentration of 502 ng/g (Rius *et al.* 2005). Concentrations of 1,4-dichlorobenzene measured in fresh vegetables in the United Kingdom ranged from 0.027 µg/kg of fresh weight in potatoes to 0.464 µg/kg in peas (Wang and Jones 1994).

In 1988, EPA's Toxics Release Inventory reported environmental releases of 1.9 million pounds of 1,4-dichlorobenzene, mostly (> 99%) to air. Releases have since declined steadily; in 2007, 11 facilities released a total of 79,317 lb, mostly to air (TRI 2009). When released to water, 1,4-dichlorobenzene volatilizes rapidly; concentrations measured in surface water are generally low (median concentration < 1 ppb) (ATSDR 2006). However, concentrations as high as 400 ppb were measured in 2006 in canal water in a rural settlement in Matamoros, Tamaulipos, Mexico, along the U.S. border (Owens and Niemeyer 2006). 1,4-Dichlorobenzene was also measured in sediments from Bayou d'Inde, a tributary of the Calcasieu River near Lake Charles, Louisiana, at a concentration of 9.5 mg/kg in the solid portion and 67.1 µg/L in the interstitial water (Prytula and Pavlostathis 1996). Measured concentrations for river environments in Canada were 0.6 to 130 ng/L in water, 520 to 34,000 ng/g of dry weight in sediment, and 920 ng/m^3 in the atmosphere (Warren *et al.* 2007). In sampling of groundwater in the Edwards Aquifer, in Texas, only 3 of 27 wells had concentrations above the detection limit of 4 ng/L (Buszka *et al.* 1995). 1,4-Dichlorobenzene was also identified in municipal solid waste in Huntsville, Alabama, at a concentration of 5.8 µg/kg (Leahy *et al.* 2004).

Occupational exposure to 1,4-dichlorobenzene occurs during its manufacture, its conversion to polyphenylene sulfide, and its other industrial uses. Concentrations of up to 4,350 mg/m^3 have been measured in the air for various factory operations. In 1980, EPA reported that about 1 million workers in the United States were exposed to 1,4-dichlorobenzene, primarily by inhalation, whereas an industry survey from the same year reported that fewer than 1,000 workers were exposed during production, captive use, and shipment of 1,4-dichlorobenzene from producers (NTP 1987). The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 33,978 workers, including 9,412 women, potentially were exposed to 1,4-dichlorobenzene (NIOSH 1990).

Regulations

Department of Transportation (DOT)

1,4-Dichlorobenzene is considered a marine pollutant, and special requirements have been set for marking, labeling, and transporting this material.

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 1,4-dichlorobenzene 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 or shellfish and water consumption = 63 µg/L; based on fish or shellfish consumption only = 190 µg/L.
Designated a hazardous substance.

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 = 7.5 mg/L.
Listed Hazardous Waste: Waste codes for which the listing is based wholly or partly on the presence of 1,4-dichlorobenzene = U072, K149, K150.
Listed as a hazardous constituent of waste.

Safe Drinking Water Act

Maximum contaminant level (MCL) = 0.075 mg/L.

Food and Drug Administration (FDA)

Maximum permissible level in bottled water = 0.075 mg/L.
Polyphenylene sulfide resins produced by the reaction of 1,4-dichlorobenzene and sodium sulfide may be used in coatings that come in contact with food, provided the maximum residual 1,4-dichlorobenzene levels do not exceed 0.8 ppm and other requirements are met.

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) = 75 ppm (450 mg/m^3).

Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 10 ppm.

National Institute for Occupational Safety and Health (NIOSH)

Immediately dangerous to life and health (IDLH) limit = 150 ppm.
Listed as a potential occupational carcinogen.

References

Aiso S, Takeuchi T, Arito H, Nagano K, Yamamoto S, Matsushima T. 2005. Carcinogenicity and chronic toxicity in mice and rats exposed by inhalation to para-dichlorobenzene for two years. *J Vet Med Sci* 67(10): 1019-1029.

Akron. 2009. *The Chemical Database.* The Department of Chemistry at the University of Akron. http://ull.chemistry.uakron.edu.erd and search on CAS number. Last accessed: 8/21/09.

ATSDR. 1998. *Toxicological Profile for 1,4-Dichlorobenzene.* Agency for Toxic Substances and Disease Registry. http://www.bvsde.paho.org/bvstox/i/fulltext/toxprofiles/1,4-DICHLOROBENZENE.pdf.

ATSDR. 2006. *Toxicological Profile for Dichlorobenzenes*. Agency for Toxic Substances and Disease Registry. http://www.atsdr.cdc.gov/toxprofiles/tp10.pdf.

Buszka PM, Rose DL, Ozuna GB, Groschen GE. 1995. Determination of nanogram per liter concentrations of volatile organic-compounds in water by capillary gas-chromatography and selected-ion monitoring mass-spectrometry and its use to define groundwater-flow directions in Edwards-Aquifer, Texas. *Anal Chem* 67(20): 3659-3667.

ChemSources. 2009. *Chem Sources - Chemical Search*. Chemical Sources International. http://www.chemsources.com/chemonline.html and search on dichlorobenzene. Last accessed: 8/21/09.

CMR. 2004. Chemical profile – chlorobenzene. *Chem Mark Rep* 4/5/04. http://www.icis.com/Articles/2005/12/02/570444/Chemical-Profile-CHLOROBENZENE.html.

EPA. 2004. *Non-confidential IUR Production Volume Information*. U.S. Environmental Protection Agency. http://www.epa.gov/oppt/iur/tools/data/2002-vol.html and search on CAS number. Last accessed: 4/21/05.

EPA. 2009. *Non-confidential 2006 IUR Records by Chemical, Including Manufacturing, Processing and Use Information.* U.S. Environmental Protection Agency. http://cfpub.epa.gov/iursearch/2006_iur_natlcheminfo.cfm?id=2720. Last accessed: 10/09.

FDA. 2006. *Total Diet Study Market Baskets 1991-3 through 2003-4.* U.S. Food and Drug Administration. http://www.fda.gov/downloads/Food/FoodSafety/FoodContaminantsAdulteration/TotalDietStudy/UCM184304.pdf. Last accessed: 9/28/05.

HSDB. 2009. *Hazardous Substances Data Bank*. National Library of Medicine. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB and search on CAS number. Last accessed: 8/21/09.

IARC. 1974. *ortho-* and *para-* Dichlorobenzenes. In *Some Anti-thyroid and Related Substances, Nitrofurans and Industrial Chemicals*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 7. Lyon, France: International Agency for Research on Cancer. pp. 231-244.

IARC. 1982. *ortho-* and *para-* Dichlorobenzenes. In *Some Industrial Chemicals and Dyestuffs*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 29. Lyon, France: International Agency for Research on Cancer. pp. 213-238.

IARC. 1987. *ortho*-Dichlorobenzene and *para*-dichlorobenzene. In *Overall Evaluations of Carcinogenicity.* IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, suppl. 7. Lyon, France: International Agency for Research on Cancer. pp. 192-193.

IARC. 1999. Dichlorobenzenes. In *Some Chemicals that Cause Tumors of the Kidney or Urinary Bladder in Rodents and Some Other Substances*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 73. Lyon, France: International Agency for Research on Cancer. pp. 223-276.

Leahy JG, Carrington TE, Eley MH. 2004. Analysis of volatile and semivolatile hydrocarbons recovered from steam-classified municipal solid waste. *J Environ Qual* 33(4): 1556-1561.

NIOSH. 1990. *National Occupational Exposure Survey (1981-83)*. National Institute for Occupational Safety and Health. Last updated: 7/1/90. http://www.cdc.gov/noes/noes1/24006sic.html.

NTP. 1987. *Toxicology and Carcinogenesis Studies of 1,4-Dichlorobenzene (CAS No. 106-46-7) in F344/N Rats and B6C3F$_1$ Mice (Gavage Studies)*. Technical Report Series no. 319. Research Triangle Park, NC: National Toxicology Program. 198 pp.

Owens JE, Niemeyer ED. 2006. Analysis of chemical contamination within a canal in a Mexican border colonia. *Environ Pollut* 140(3): 506-515.

Prytula MT, Pavlostathis SG. 1996. Effect of contaminant and organic matter bioavailability on the microbial dehalogenation of sediment-bound chlorobenzenes. *Water Res* 30(11): 2669-2680.

Rius MA, Hortos M, Garcia-Regueiro JA. 2005. Influence of volatile compounds on the development of off-flavours in pig back fat samples classified with boar taint by a test panel. *Meat Sci* 71(4): 595-602.

SRI. 2009. *Directory of Chemical Producers*. Menlo Park, CA: SRI Consulting. Database edition. Last accessed: 8/21/09.

TRI. 2009. *TRI Explorer Chemical Report*. U.S. Environmental Protection Agency. http://www.epa.gov/triexplorer and select 1,4-Dichlorobenzene. Last accessed: 8/21/09.

USITC. 2009. *USITC Interactive Tariff and Trade DataWeb.* United States International Trade Commission. http://dataweb.usitc.gov/scripts/user_set.asp and search on HTS no. 29036130.

Wang MJ, Jones KC. 1994. Occurrence of chlorobenzenes in 9 United-Kingdom retail vegetables. *J Agric Food Chem* 42(10): 2322-2328.

Warren C, Mackay D, Whelan M, Fox K. 2007. Mass balance modelling of contaminants in river basins: Application of the flexible matrix approach. *Chemosphere* 68(7): 1232-1244.