Canadian Water Quality Guidelines for the Protection of Aquatic Life

CHLORINATED BENZENES
1,2-dichlorobenzene

Liquid 1,2-dichlorobenzene (CAS 95-50-1, molecular weight 147.01) is used industrially as solvent in various applications and for carbon removal (main uses). It is also used as an intermediate in the synthesis of dyes, herbicides, and degreasers, as a dye carrier, and as a fungicide. (Ware and West 1977; Chemical Marketing Reporter 1990; CIS 1991). 1,2- and 1,4-Dichlorobenzene (the more important congener) are the only chlorobenzenes produced in Canada (Napierville, Quebec). 1,2-Dichlorobenzene is one of the more common chlorobenzene congeners found in the environment, because of its various commercial applications, dissipative use patterns, and long environmental persistence. It is expected that virtually all of the approximately 350 000 kg of 1,2-dichlorobenzene used in Canada is released to the environment via various industrial and municipal effluent streams, as a result of the dispersive nature of its uses. Also, there is evidence that dichlorobenzenes are produced from the dehalogenation of more highly chlorinated benzenes and during incineration of organic matter containing chlorine (Government of Canada 1993).

1,2-Dichlorobenzene has been reported in groundwater at waste disposal sites at levels ranging from 2 to 58 400 $\mu g \cdot L^{-1}$ (Government of Canada 1993) and in surface water in the Great Lakes basin in Ontario at levels ranging from not detectable to 0.24 $\mu g \cdot L^{-1}$ (Government of Canada 1993). Detectable levels in industrial effluents ranged from 0.006 to 15.6 $\mu g \cdot L^{-1}$ for 1,2-dichlorobenzene.

Mackay et al. (1992) have modelled the environmental fate of each of the chlorobenzenes using several versions of a fugacity-based model and available information. These modelling results indicate that chlorobenzene behaviour varies as a function of the degree of chlorination. The simplest model, Fugacity Level I, demonstrates that 1,2-dichlorobenzene tends to partition into air, with small amounts going to water and soil, because of its moderate vapour pressure (196 Pa) and low water solubility (118 $mg \cdot L^{-1}$). Level II modelling indicates that the primary removal processes for all chlorobenzenes are in air. For 1,2-dichlorobenzene, removal is by advection (e.g., deposition, sedimentation) and chemical reaction. Photodegradation is slow, resulting in atmospheric half-lives of 2–6 weeks. In the aquatic environment, 1,2-dichlorobenzene is found mostly in organic phases (organisms, sediments) or associated with suspended/dissolved organic material rather than dissolved in the water phase (log octanol–water partition coefficient 3.4), with half-lives of 6–18 weeks in the water and 1.1–3.4 years in the sediment.

Water Quality Guideline Derivation

The interim Canadian water quality guidelines for 1,2-dichlorobenzene for the protection of aquatic life were developed based on the CCME protocol (CCME 1991). For more information, see the Canadian Environmental Protection Act (CEPA) assessment report and supporting document (Government of Canada 1993) and the supporting document (Environment Canada 1997).

Freshwater Life

The lowest acute data found are for rainbow trout *(Oncorhynchus mykiss)* and consist of a 96-h LC_{50} of 1560 $\mu g \cdot L^{-1}$ (Call et al. 1983) and a 48-h LC_{50} of 2300 $\mu g \cdot L^{-1}$ (Calamari et al. 1983). The lowest acute data for invertebrates are a 48-h LC_{50} of 12 000 $\mu g \cdot L^{-1}$ for midge *(Tanytarsus dissimilis)* (Call et al. 1983), a 24-h EC_{50} (immobilization) of 780 $\mu g \cdot L^{-1}$ for *Daphnia magna* (Calamari et al. 1983), and a 48-h LC_{50} of 2330 $\mu g \cdot L^{-1}$ for *D. magna* (Abernethy et al. 1988).

In chronic exposure bioassays, Black et al. (1982) reported reduced egg hatchability of 6% for rainbow trout *(O. mykiss)* after 23-d exposure to 1,2-dichlorobenzene at 7 $\mu g \cdot L^{-1}$, and a 27-d LC_{11} (4-day posthatching survival) at 7 $\mu g \cdot L^{-1}$. Similar reduced egg hatchability of 10% is reported for the leopard frog *(Rana pipiens)* after 5-d

Table 1. Water quality guidelines for 1,2-dichlorobenzene for the protection of aquatic life (Environment Canada 1997).

Aquatic life	Guideline value ($\mu g \cdot L^{-1}$)
Freshwater	0.70*
Marine	42*

*Interim guideline.

exposure at 150 μg·L^{-1}, and a 4-d posthatching mortality as 9-d LC_4 of 12 μg·L^{-1}. The 23-d EC_6 (reduced egg hatchability) of 7 μg·L^{-1} for rainbow trout, reported by Black et al. (1982) is considered to be the lowest ecologically relevant endpoint reported, and is multiplied by a safety factor of 0.1 to derive the interim water quality guideline for the protection of freshwater life of 0.70 μg·L^{-1} for 1,2-dichlorobenzene.

Other chronic data for fish were for an early-life-stage study (28-d LOEL, growth and survival) with fathead minnow *(Pimephales promelas)* of 2000 μg·L^{-1} (USEPA 1978).

Chronic information on invertebrates were for *D. magna*; a 14-d EC_{50} and 14-d EC_{16} (reduced fertility) of 550 μg·L^{-1} and 370 μg·L^{-1}, respectively, were found (Calamari et al. 1983), as well as and a 21-d NOEC of 630 μg·L^{-1} (Kühn et al. 1989).

Calamari et al. (1983) reported data where the alga *Selenastrum capricornutum* exhibited a 96-h EC_{50} of 2200 g·L^{-1}, based on growth inhibition, and a 3-h EC_{50} of 10 000 μg·L^{-1}, based on inhibition of photosynthesis.

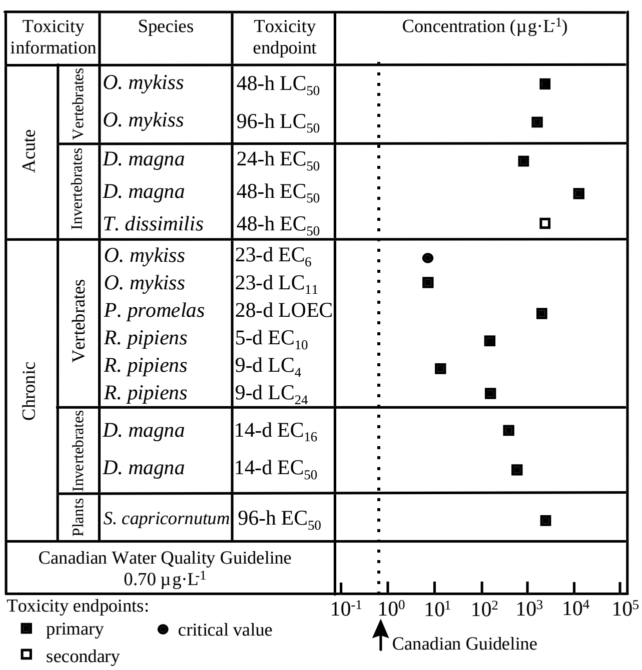

Figure 1. Select freshwater toxicity data for 1,2-dichlorobenzene.

Marine Life

The interim water quality guideline for 1,2-dichlorobenzene for the protection of marine life is 42 μg·L^{-1}. It was derived by multiplying the 96-h LC_{50} of 4190 μg·L^{-1} for sole *(Solea solea)* (Furay and Smith 1995), by a safety factor of 0.01. Furay and Smith (1995) also found a 96-h LC_{50} of 4620 μg·L^{-1} for flounder *(Platichthys flesus)*. Acute data for marine invertebrates were a 24-h LC_{50} of 14 900 μg·L^{-1} for *Artemia nauplii* (Abernethy et al. 1988), and a 96-h LC_{50} of 71 100 μg·L^{-1} for opossum shrimp *(Mysidopsis bahia)* (USEPA 1978).

The USEPA (1978) reported a 96-h EC_{50} for reduction in cell numbers of 342 000 μg·L^{-1} for the marine alga *Skeletonema costatum*.

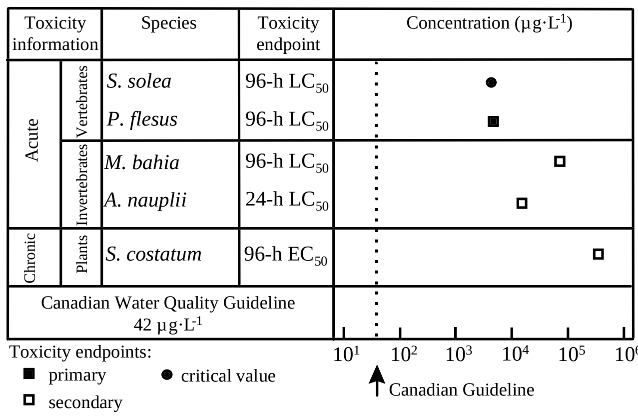

Figure 2. Select marine toxicity data for 1,2-dichlorobenzene.

References

Abernethy, S.G., D. Mackay, and L.S. McCarty. 1988. "Volume fraction" correlation for narcosis in aquatic organisms: The key role of partitioning. Environ. Toxicol. Chem. 7:469–481.

Black, J.A., W.J. Birge, W.E. McDonnell, A.G. Westerman, and B.A. Ramey. 1982. The aquatic toxicity of organic compounds to embryo-larval stages of fish and amphibians. Report no. 133. University of Kentucky, Water Resources Research Institute, Lexington, KY.

Calamari, D., S. Galassi, F. Setti, and M. Vighi. 1983. Toxicity of selected chlorobenzenes to aquatic organisms. Chemosphere 12:253–262.

Call, D.J., L.T. Brooke, N. Ahmad, and J.E. Richter. 1983. Toxicity and metabolism studies with EPA priority pollutants and related chemicals in freshwater organisms. EPA-600/3-83-095. U.S. Environmental Protection Agency, Environmental Research Laboratory-Duluth, Duluth, MN.

CCME (Canadian Council of Ministers of the Environment) 1991. Appendix IX—A protocol for the derivation of water quality guidelines for the protection of aquatic life (April 1991). In: Canadian water quality guidelines, Canadian Council of Resource and Environment Ministers. 1987. Prepared by the Task Force on

Water Quality Guidelines. [Updated and reprinted with minor revisions and editorial changes in Canadian environmental quality guidelines, Chapter 4, Canadian Council of Ministers of the Environment, 1999, Winnipeg.]

Chemical Marketing Reporter. 1990. Chemical profile *p*-dichlorobenzene.

CIS (Camford Information Services). 1991. CPI product profiles: Chlorobenzenes (mono, di, tri, tetra, penta, hexachlorobenzenes). CIS, Don Mills, ON.

Environment Canada. 1997. Canadian water quality guidelines for chlorinated benzenes. Supporting document. Environment Canada, Science Policy and Environmental Quality Branch, Ottawa. Unpub. draft doc.

Furay, V.J., and S. Smith. 1995. Toxicity and QSAR of chlorobenzenes in two species of benthic flatfish, flounder *(Platichthys flesus* L.*)* and sole *(Solea solea* L.*)*. Bull. Environ. Contam. Toxicol. 54:36–42.

Government of Canada. 1993. 1,2-Dichlorobenzene. Canadian Environmental Protection Act Priority Substances List Assessment Report. Environment Canada and Health Canada, Ottawa.

Kühn, R., M. Pattard, K.-D. Pernak, and A. Winter. 1989. Results of the harmful effects of water pollutants to *Daphnia magna* in the 21-day reproduction test. Water Res. 23:501–510.

Mackay, D., W.Y. Shiu, and K.C. Ma. 1992. Illustrated handbook of physical-chemical properties and environmental fate for organic chemicals I. Monoaromatics, chlorobenzenes, and PCBs. Lewis Publishers Inc., Boca Raton, FL.

USEPA (U.S. Environmental Protection Agency). 1978. In-depth studies on health and environmental impacts of selected water pollutants. (Table of data available from Charles E. Stephan.) USEPA, Duluth, MN.

Ware, S.A., and W.L. West. 1977. Investigation of selected potential environmental contaminants: Halogenated benzenes. EPA 560/2-77/004. USEPA, Washington, DC.

Reference listing:

Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of aquatic life: Chlorinated benzenes—1,2-Dichlorobenzene. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

For further scientific information, contact:

Environment Canada
Guidelines and Standards Division
351 St. Joseph Blvd.
Hull, QC K1A 0H3
Phone: (819) 953-1550
Facsimile: (819) 953-0461
E-mail: ceqg-rcqe@ec.gc.ca
Internet: http://www.ec.gc.ca

For additional copies, contact:

CCME Documents
c/o Manitoba Statutory Publications
200 Vaughan St.
Winnipeg, MB R3C 1T5
Phone: (204) 945-4664
Facsimile: (204) 945-7172
E-mail: spccme@chc.gov.mb.ca

Excerpt from Publication No. 1299; ISBN 1-896997-34-1

Aussi disponible en français.