Canadian Water Quality Guidelines for the Protection of Aquatic Life

CHLORINATED BENZENES

1,4-dichlorobenzene

Solid 1,4-dichlorobenzene (CAS 106-46-7, molecular weight 147.01) is used industrially as a disinfectant, a deodorizer and air freshener, an insect and bird repellent, and in the synthesis of polyethylene sulphide resin (Ware and West 1977; Chemical Marketing Reporter 1990; CIS 1991). Domestic uses are primarily as a moth repellent (moth balls), as an air freshener, and as a toilet block deodorant (Verschueren 1983). 1,2- and 1,4-Dichlorobenzene are the only chlorobenzenes produced in Canada (Napierville, Quebec), with 1,4-dichlorobenzene being the more important congener (CIS 1991). 1,4-Dichlorobenzene is one of the more common chlorobenzene congeners found in the environment, because of its commercial applications, dissipative use patterns, and long environmental persistence. As a result of the dispersive nature of the uses, it is expected that virtually all of the approximately 35 000 000 kg of 1,4-dichlorobenzene used in Canada is released to the environment via various industrial and municipal effluent streams. Also, there is evidence of production of dichlorobenzenes from the dehalogenation of more highly chlorinated benzenes and during incineration of organic matter containing chlorine (Government of Canada 1993).

1,4-Dichlorobenzene has been reported in groundwater at levels ranging from 0.002 to 23 100 $\mu g \cdot L^{-1}$, and in surface water during a monitoring program in Eastern Canada at levels ranging from not detectable to 0.13 $\mu g \cdot L^{-1}$ (Government of Canada 1993). Detectable levels in industrial effluents ranged from 0.002 to 9.4 $\mu g \cdot L^{-1}$.

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 1,4-dichlorobenzene tends to partition into air, with small amounts going to water and soil, because of its vapour pressure (90.2 Pa) and low water solubility (83 $mg \cdot L^{-1}$). Level II modelling indicates that the primary removal processes for all chlorobenzenes are in air. For 1,4-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, 1,4-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 water and 1.1–3.4 years in sediment.

Water Quality Guideline Derivation

The interim Canadian water quality guideline for 1,4-dichlorobenzene for the protection of freshwater life was 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

Acute data for fish consist of a 96-h LC_{50} of 1100 $\mu g \cdot L^{-1}$ for rainbow trout *(Oncorhynchus mykiss)* (Ahmad et al. 1984) and a 96-h LC_{50} of 2850 $\mu g \cdot L^{-1}$ for fathead minnows *(Pimephales promelas)* (Sijm et al. 1993). Acute data for invertebrates are for *Daphnia magna*, with a 24-h EC_{50} (immobilization) of 1600 $\mu g \cdot L^{-1}$ (Calamari et al. 1983), and a 48-h LC_{50} of 12 000 $\mu g \cdot L^{-1}$ (NOEC of 940 $\mu g \cdot L^{-1}$) for midges *(Chironomus riparius)* (Roghair et al. 1994).

The interim water quality guideline for 1,4-dichlorobenzene for the protection of freshwater life is 26 $\mu g \cdot L^{-1}$. It was derived by multiplying the reduction in larval survival after a 10-d exposure of 263 $\mu g \cdot L^{-1}$ (Smith et al. 1991) for the American flagfish *(Jordanella floridae)* by a safety factor of 0.1 (CCME 1991). Chronic data for fish consist of a 32-d NOEC of 570 $\mu g \cdot L^{-1}$ and a 32-d LOEL of 1000 $\mu g \cdot L^{-1}$ for fathead minnows *(P. promelas)* (Carlson and Kosian 1987),

Table 1. Water quality guidelines for 1,4-dichlorobenzene for the protection of aquatic life (Environment Canada 1997).

Aquatic life	Guideline value ($\mu g \cdot L^{-1}$)
Freshwater	26*
Marine	NRG†

*Interim guideline.

†No recommended guideline.

and a 28-d NOEC of 650 $\mu g \cdot L^{-1}$ for zebra fish *(Brachydanio rerio)* (van Leeuwen et al. 1990). The lowest chronic data for invertebrates are a 16-d EC_{50} and 14-d EC_{16} (reduced fertility) of 930 $\mu g \cdot L^{-1}$ and 640 $\mu g \cdot L^{-1}$, respectively, for *D. magna* (Calamari et al. 1983).

Calamari et al. (1983) reported a result where the alga *Selenastrum capricornutum* exhibited a 96-h EC_{50} of 1600 $\mu g \cdot L^{-1}$, based on inhibition of growth, and a 3-h EC_{50} of 5200 $\mu g \cdot L^{-1}$, based on inhibition of photosynthesis.

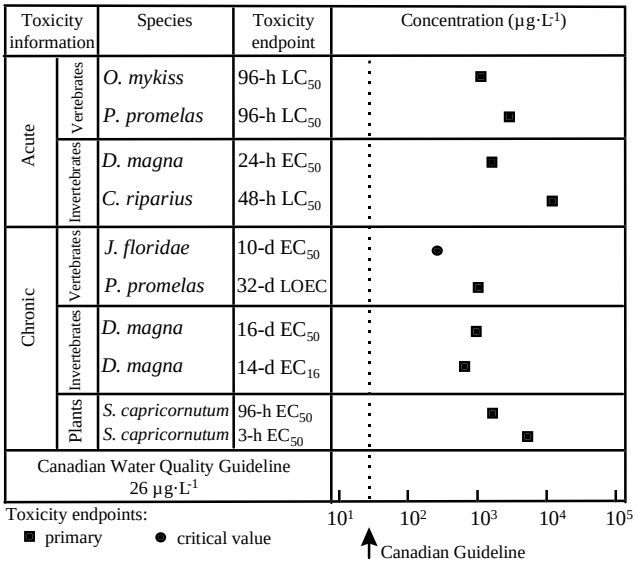

Figure 1. Select freshwater toxicity data for 1,4-dichlorobenzene.

Marine Life

Insufficient information exists to derive a marine interim guideline for 1,4-dichlorobenzene. Heitmuller et al. (1981) reported a 48-h LC_{50} of 7200 $\mu g \cdot L^{-1}$ for sheepshead minnows *(Cyprinodon aggregata)*. Mortimer and Connell (1994) reported a 96-h LC_{50} of 738 $\mu g \cdot L^{-1}$ for the sand crab *(Portunus pelagicus*), and Abernethy et al. (1988) reported a 24-h LC_{50} of 13 700 $\mu g \cdot L^{-1}$ for *Artemia nauplii*. Mortimer and Connell (1995) reported growth rate reductions of 10% and 50% after 40-d exposures of 64.7 $\mu g \cdot L^{-1}$ (the lowest-effect-level) and 201.4 $\mu g \cdot L^{-1}$, respectively, for the sand crab *P. pelagicus*.

The USEPA (1978) reported a 96-h EC_{50} for decrease in chlorophyll *a* of 56 500 $\mu g \cdot L^{-1}$ for the marine diatom *Skeletonema costatum*.

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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

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Facsimile: (204) 945-7172
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