



Canadian Water Quality Guidelines for the Protection of Aquatic Life

ANILINE

Aniline (C_6H_7N) has been mainly used in Canada to manufacture chemicals such as mercaptobenzothiazole (MBT), 2-mercaptobenzothiazyl disulphate (MBTS), and zinc 2-mercaptobenzothiazole used in the production of rubber (CIS 1990). Aniline has also been used as a hardener in industrial epoxies and as a corrosion inhibitor (OMOE 1980). Aniline has a CAS name and number of benzeneamine and 62-53-3, respectively, and is highly soluble in water ($35 \text{ g}\cdot\text{L}^{-1}$) (Merck Index 1983). Aniline is not produced in Canada, and domestic use has declined from 1300 t in 1983 to 28 t in 1990 (CIS 1990; Statistics Canada 1990). In 1991, however, use in Canada increased to 107 t (Maguire and Bobra 1992).

Aniline occurs naturally in minute quantities in coal tars. Most of the aniline found in the environment, however, has resulted from wastewater effluents and atmospheric emissions from industries associated with its use or production. Aniline may enter soil environments during spills, underground coal gasification, or through leachate from industrial landfill sites (Stuermer et al. 1982; Howard 1989). Aniline is a breakdown product of pesticides that contain nitroaromatic compounds and may be found in soil and water associated with the use of these pesticides (Lu and Metcalf 1975; El-Dib and Aly 1976; Hallas and Alexander 1983).

The only reported detections of aniline in Canadian surface waters were found near a former industrial site. Concentrations ranged from 41 to $300 \text{ mg}\cdot\text{L}^{-1}$ at the site (Lesage et al. 1990) and concentrations of up to 8% were also found in the dense nonaqueous phase liquid beneath the former waste-holding lagoon (CH₂M Hill Engineering 1991).

Aniline biodegrades and photodegrades extensively, and, to some extent, adsorbs to sediment and humic material (Howard 1989). Microbial degradation was found to be the most significant removal process after studying the effects of hydrolysis, ionization, photolysis, volatilization, partitioning, and microbial degradation on aniline (Sanders 1979). The half-life for combined photolysis and biodegradation in an estuary was reported to be 27 h (Hwang et al. 1987). Hwang et al. (1987) concluded that photolysis was a more effective process only in the surface waters.

The Henry's law constant of $1.9\cdot 10^{-6} \text{ atm}\cdot\text{m}^{-3}\cdot\text{mol}^{-1}$ (USEPA 1985) and vapour pressure of 40 Pa (Verschueren 1983) suggests volatilization of aniline is very slow. Lyons et al. (1984) reported that volatilization accounted for only 0.002% of aniline removal per day from pond water. In the atmosphere, aniline will degrade primarily by direct photolysis (half-life of 2.1 d) or by reaction with photochemically produced hydroxy radicals (half-life of 3.3 h) (Howard 1989). Oxidation is not expected to be a significant removal process (Filby and Güsten 1978).

The relatively low log octanol–water partition coefficient for aniline ($\log K_{ow} = 0.90$) suggests that it does not have a high bioaccumulation potential (Kenaga 1980). Calculated BCF values for fish are <10 ; therefore, aniline is unlikely to bioconcentrate in aquatic organisms (Freitag et al. 1982; Isnard and Lambert 1988).

Water Quality Guideline Derivation

The Canadian water quality guideline for aniline for the protection of freshwater life was developed based on the CCME protocol (CCME 1991).

Freshwater Life

Acute toxicity (96-h LC_{50}) values for fish range from $10.6 \text{ mg}\cdot\text{L}^{-1}$ for rainbow trout (*Oncorhynchus mykiss*) (Abram and Sims 1982) to $187 \text{ mg}\cdot\text{L}^{-1}$ for goldfish (*Carassius auratus*) (Holcombe et al. 1987). The 7-d LC_{50} estimate for juvenile rainbow trout was $8.2 \text{ mg}\cdot\text{L}^{-1}$ (Abram and Sims 1982). Acute toxicity (48-h LC_{50}) values for invertebrates ranged from $0.10 \text{ mg}\cdot\text{L}^{-1}$ for *Daphnia pulex*

Table 1. Water quality guidelines for aniline for the protection of aquatic life (CCME 1993).

Aquatic life	Guideline value ($\mu\text{g}\cdot\text{L}^{-1}$)
Freshwater	2.2
Marine	NRG*

*No recommended guideline.

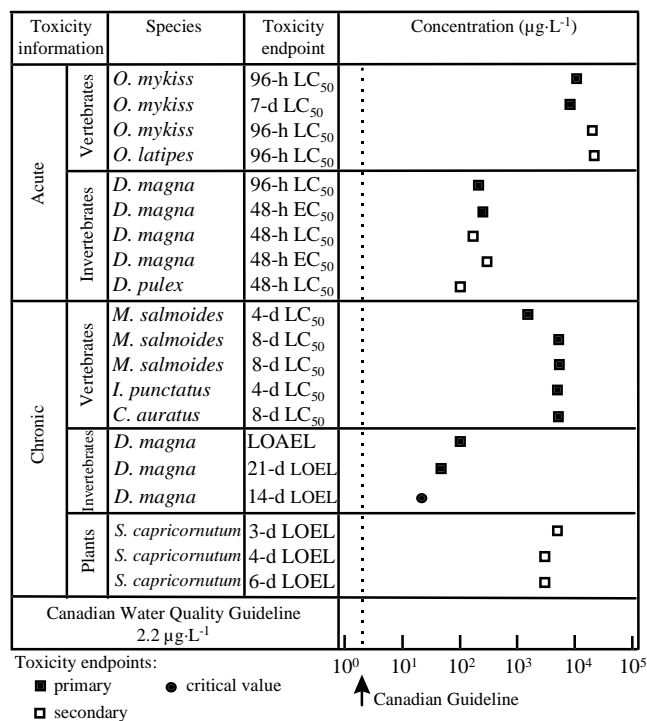


Figure 1. Select freshwater toxicity data for aniline.

(Canton and Adema 1978) to $800 \text{ mg}\cdot\text{L}^{-1}$ for the snail (*Lymnaea stagnalis*) (Slooff et al. 1983).

Chronic toxicity (LC₅₀) values, for fish eggs at hatching, were 5.5 (4.5 d), 9.3 (4.0 d), and $32.7 \text{ mg}\cdot\text{L}^{-1}$ (3.5 d) for catfish, goldfish, and bass, respectively (Birge et al. 1979). When the exposure time was extended to 4 d posthatch, the LC₅₀s were 5.0, 5.5, and $11.8 \text{ mg}\cdot\text{L}^{-1}$ for catfish, goldfish, and bass, respectively. At 8 d posthatch exposure, the LC₅₀s were 5.1 and $5.4 \text{ mg}\cdot\text{L}^{-1}$ for the goldfish and the bass, respectively. A 28-d LC₅₀ of $39 \text{ mg}\cdot\text{L}^{-1}$ was found for the zebra fish (*Brachydanion rerio*) (van Leeuwen et al. 1990).

In chronic toxicity data available for *Daphnia magna*, the 14-d LOEC was found to be $21.8 \mu\text{g}\cdot\text{L}^{-1}$ (Gersich and Milazzo 1990). Toxicity estimates for algae range from an 8-d toxic threshold of $0.16 \text{ mg}\cdot\text{L}^{-1}$ for the blue-green alga *Anacystis aeruginosa* (Bringmann and Kühn 1978) to a 12 to 13-d inhibiting effect on growth of $183.9 \text{ mg}\cdot\text{L}^{-1}$ for the green alga *Chlorella vulgaris* (Ammann and Terry 1985).

The water quality guideline for aniline for the protection of freshwater life ($2.2 \mu\text{g}\cdot\text{L}^{-1}$) was derived by multiplying the LOEC of $21.8 \mu\text{g}\cdot\text{L}^{-1}$ (Gersich and Milazzo 1990) for the most sensitive organism to aniline, the water flea (*D. magna*), by a safety factor of 0.1 (CCME 1993).

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