



This fact sheet provides Canadian water quality guidelines for sulfolane for the protection of freshwater aquatic life (Table 1). Insufficient data were available to derive a guideline for marine aquatic life. A scientific supporting document is also available (Environment Canada 2005).

Background Information

Sulfolane (C₄H₈SO₂; CAS 126-33-0) is a solvent used for gas treating in a variety of industrial processes. It is known under a variety of synonyms and trade names including bondelane A, 2,3,4,5-tetrahydrothiophene-1,1-dioxide, and tetramethylene sulfone. It has a molecular weight of 120.17 g·mol⁻¹, a density of 1.276 g·cm⁻³ at 15°C, an aqueous solubility of 1,266,000 mg·L⁻¹ at 20°C, a log K_{oc} of 0.07, a mean K_d in aquifer materials of 0.08 L·kg⁻¹, a vapour pressure at 20°C of 1.33 x 10⁻³ kPa, and a Henry's law constant of 8.9 x 10⁻¹⁰ atm·m⁻³·mol⁻¹.

The total worldwide production of sulfolane is estimated at between 18,000 and 36,000 tons per year. Commercially, sulfolane is available as anhydrous sulfolane and as sulfolane containing 3% deionized water.

Sulfolane is widely used for gas treatment processes including: sour gas sweetening, hydrogen selenide removal from gasification of coal, shale, or tarsands; olefin removal from alkanes; nitrogen, helium, and argon removal from natural gas; atmospheric CO₂ removal in nuclear submarines; ammonia and H₂S removal from waste streams; and H₂S, hydrogen chloride (HCl), nitrous oxide (N₂O), and CO₂ removal from various streams. In addition to gas treatment, sulfolane is also used as a polymer solvent, polymer plasticizer, polymerization solvent, and in electronic/electrical applications (Kirk-Othmer 1999).

Reports on the presence of anthropogenic sulfolane in the environment are limited to data collected in the vicinity of sour gas processing facilities in Western Canada (CAPP 1997; Wrubleski and Drury 1997). The maximum measured sulfolane concentrations in groundwater were 800 mg·L⁻¹ in shallow till and 88 mg·L⁻¹ in bedrock. The only report of sulfolane occurring naturally in the environment was in a composite sample of a sponge (*Batzella*) and tunicate (*Lissoclinum*) which contained approximately 50 mg·kg (dry-weight)⁻¹ sulfolane (Barrow and Capon 1992).

Environmental Fate and Behaviour

Laboratory studies indicate that the major physical and chemical processes that determine the transport and distribution of sulfolane in soil and water are adsorption and leaching. Sulfolane is poorly adsorbed to soil and has a high aqueous solubility and low volatility. Sulfolane is highly mobile in the subsurface.

Sorption of sulfolane to soil particles is low with sulfolane partitioning preferentially into porewater (Luther et al. 1998). The high aqueous solubility of sulfolane, in combination with the low K_{oc} and K_d, provides the potential for high concentrations of sulfolane to be present in soil porewater. Volatilisation of sulfolane is minimal due to the low Henry's law constant.

Biodegradation of sulfolane has been investigated in an activated sludge system, in wastewater treatment, in laboratory microcosm studies using contaminated aquifer sediments, and as part of a natural attenuation study in natural wetlands. Most studies have demonstrated that sulfolane biodegrades in nutrient-enriched aerobic microcosms from a variety of sulfolane-contaminated environmental samples (Fedorak and Coy 1996). Data from microcosm and field studies indicate that under typical groundwater conditions (aerobic or anaerobic, but very low in nutrients, particularly phosphate), sulfolane degradation may be very slow or non-existent. However, under conditions typical of surface water (aerobic, sufficient nutrients) it has been shown that sulfolane degradation can be relatively rapid, with complete removal occurring after 5 to 11 weeks (Environment Canada 2005).

Table 1. Water quality guidelines for sulfolane for the protection of aquatic life (Environment Canada 2005).

Aquatic Life	Guideline value (mg·L ⁻¹)
Freshwater	50 ^a
Marine	NRG ^b

^aInterim guideline.

^bNo recommended guideline.

Uptake of sulfolane by wetland vegetation was studied as part of a research program to evaluate natural attenuation processes in contaminated wetlands (CAPP 1998, 1999, 2000). Roots, stems, leaves, flower heads, seed heads, and berries of cattail, dogwood, sedge, marsh reed grass, cow parsnip, and smooth brome growing in a sulfolane-impacted wetland were included in the study (CAPP 1999, 2000; Headley et al. 1999a,b). Analytical results indicated highly variable sulfolane concentrations for different parts of the same species (e.g., roots versus leaves), between different plant species (e.g., cattail leaves versus sedge leaves), and even between different samples of the same part of the same species. The maximum measured sulfolane concentration in water within the wetland was $185 \text{ mg}\cdot\text{L}^{-1}$, and concentrations measured in the plants were as high as $256 \text{ mg}\cdot\text{kg}^{-1}$.

Water Quality Guideline Derivation

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

Freshwater Life

Available data on the toxicity of sulfolane to freshwater biota were screened for data quality based on the CCME (1991) protocol. Primary and secondary data are summarized in Figure 1 and are the only data considered in the following discussion. Sufficient data were available to meet the requirements for interim guideline development. Estimates of the acute toxicity of sulfolane to freshwater fish and invertebrates range from $>1000 - 1264 \text{ mg}\cdot\text{L}^{-1}$ and $40 - 3274 \text{ mg}\cdot\text{L}^{-1}$, respectively.

No chronic studies were available for freshwater fish. Chronic results for invertebrates include a 7-day LOEC for *Ceriodaphnia dubia* reproduction of $500 \text{ mg}\cdot\text{L}^{-1}$, and a 7-day LOEC for *Ceriodaphnia dubia* survival of $1000 \text{ mg}\cdot\text{L}^{-1}$ (ERAC 1998). Chronic results for plants include a 72-hour EC_{50} for *Selenastrum capricornutum* growth of $723 \text{ mg}\cdot\text{L}^{-1}$ (ERAC 1998).

Because acute toxicity values for *D. magna* spanned two-orders of magnitude (40 to $3274 \text{ mg}\cdot\text{L}^{-1}$; Girling 1987; ERAC 1998), an additional study was commissioned for confirmation (Environment Canada, 2003). This study yielded a LC_{50} for *D. magna* of $1245 \text{ mg}\cdot\text{L}^{-1}$, based on mean measured sulfolane concentrations at the beginning and end of the test. This value was taken to be definitive because: 1) the results of the reference toxicant test that were within quality control limits; 2) the chemical analysis for sulfolane was conducted at the beginning

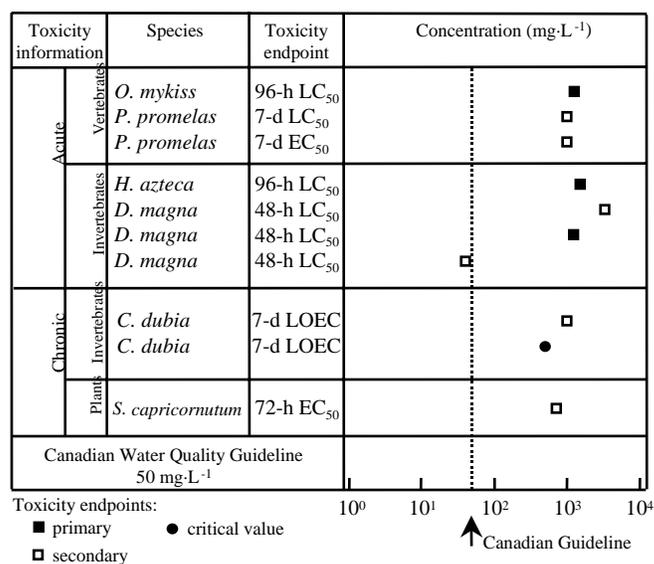


Figure 1. Select freshwater toxicity data for sulfolane

and end of the test; and, 3) the carefully controlled and reported conditions in this study (Komex 2003).

The interim sulfolane water quality guideline for the protection of freshwater life is $50 \text{ mg}\cdot\text{L}^{-1}$. It was derived by multiplying the 7-day LOEC for *Ceriodaphnia dubia* reproduction of $500 \text{ mg}\cdot\text{L}^{-1}$ by a safety factor of 0.1 (CCME 1991).

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