Water Quality

Ambient Water Quality Guidelines for Diisopropanolamine (DIPA)

Overview Report

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Summary

This document is one in a series which establishes ambient water quality guidelines for British Columbia. It is based on a technical report prepared by Komex International Limited for the Canadian Association of Petroleum Producers (CAPP) and the British Columbia Ministry of Water, Land and Air Protection. The

guidelines (Table 1) are safe conditions or levels which have province-wide application and are set to protect various water uses. This report sets guidelines for diisopropanolamine (DIPA) to protect source water for drinking, freshwater aquatic life, recreation, crop irrigation, and livestock watering.

A major use of the guidelines is to set ambient water quality objectives. The objectives are the guidelines modified or adopted to protect the most sensitive designated water use in a particular body of water. The objectives are used in the preparation of waste management plans, pollution prevention plans, waste management permits, orders, or approvals. The latter three are the only documents that have legal status. The guidelines are also used in contaminated site remediation.

Table 1. Summary of Recommended Water Quality Guidelines for Diisopropanolamine (DIPA). All guidelines are maximum values.

Water Use	Guideline (mg DIPA/L)
Freshwater Aquatic Life	1.6 mg/L
Marine Aquatic Life	Insufficient Data
Irrigation	3.9 mg/L
Livestock Watering	38 mg/L

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Preface

The Ministry of Water, Land and Air Protection develops province-wide ambient water quality guidelines for variables that are important in the surface waters of British Columbia. This work has the following goals:

1. to provide guidelines for the evaluation of data on water, sediment, and biota
2. to provide guidelines for the establishment of site-specific ambient water quality objectives

Ambient water quality objectives for specific waterbodies will be based on the guidelines and also consider present and future uses, waste discharges, hydrology/limnology/oceanography, and existing background water quality. The process for establishing water quality objectives is more fully outlined in *Principles for Preparing Water Quality Objectives in British Columbia*, copies of which are available from the Water Quality Section of the Water Management Branch.

Neither guidelines nor objectives which are derived from them have any legal standing. The objectives, however, can be used to calculate allowable limits or levels for contaminants in waste discharges. These

limits are set out in waste management permits and thus have legal standing. The objectives are not usually incorporated as conditions of the permit.

The definition adopted for a guidelines is: A maximum and/or a minimum value for a physical, chemical or biological characteristic of water sediment or biota, which should not be exceeded to prevent specified detrimental effects from occurring to a water use under specified environmental conditions.

The guidelines are province-wide in application, are use-specific, and are developed for some or all of the following specific water uses:

- Source water for drinking, public water supply, and food processing[1]
- Aquatic life and wildlife
- Agriculture (livestock watering and irrigation)
- Recreation and aesthetics[2]
- Industrial (water supplies)

The guidelines are set after considering the scientific literature, guidelines from other jurisdictions, and general conditions in British Columbia. The scientific literature gives information on the effects of toxicants on various life forms. This information is not always conclusive because it is usually based on laboratory work which, at best, only approximates actual field conditions. To compensate for this uncertainty, guidelines have built-in safety factors which are conservative but reflect natural background conditions in the province.

The site-specific water quality objectives are, in most cases, the same as guidelines. However, in some cases, such as when natural background levels exceed the guidelines, the objectives could be less stringent than the guidelines. In relatively rare instances, for example if the resource is unusually valuable or of special provincial significance, the safety factor could be increased by using objectives which are more stringent than the guidelines. Another approach in such special cases is to develop site-specific guidelines by carrying out toxicity experiments in the field. This approach is costly and time-consuming and therefore seldom used.

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[1] The guidelines apply to an ambient raw water source before it is diverted or treated for domestic use. The Ministry of Health Services regulates the quality of water for domestic use after it is treated and delivered by a water purveyor.

[2] Guidelines relating to public health at bathing beaches will be the same as those developed by the Ministry of Health, which regulates the recreation and aesthetic water use.

Guidelines are subject to review and revision as new information becomes available, or as other circumstances dictate.

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Introduction

Diisopropanolamine (DIPA) is an organic chemical used for a wide variety of commercial, industrial, and household applications. At room temperature, DIPA is a white solid compound with a mild ammoniacal odour. Also, it is hygroscopic, completely miscible in water, and a polar, basic solvent. DIPA attaches strongly to clay minerals, and hence its mobility in the subsurface is dependent on the mineralogy in the aquifer. Biodegradation under typical aquifer conditions can be very slow. The primary uses of DIPA include natural gas processing, cosmetics, detergents, and corrosion inhibition.

An extensive literature search was conducted on toxicity of DIPA to humans, mammals, freshwater and marine aquatic life, terrestrial plants, and other organisms. For freshwater aquatic life, toxicological data were identified for vertebrates (rainbow trout (*Oncorhynchus mykiss*), fathead minnow (*Pimephales promelas*), goldfish (*Carassius auratus*), clawed toad (*Xenopus laevis*), ide (*Leuciscus idus*), mosquito fish (*Gambusia sp.*), and stickleback); invertebrates (water fleas (*Daphnia magna* and *Ceriodaphnia dubia*), and sideswimmer (*Hyalella azteca*)); plants (green algae (*Selenastrum capricornutum* and *Scenedesmus suspicatius*) and duckweed (*Lemna minor*)); and other freshwater aquatic organisms (cyanobacterium (*Aphanizomenon flos-aquae*) and diatom (*Cyclotella meneghiana*)). The lowest chronic effect concentration (LOEC) was 16 mg/L for the 7 day reproduction endpoint for *Ceriodaphnia dubia*. The lowest LC_{50} in the acute dataset was 74 mg/L for a 72 hour growth endpoint for *Selenastrum capricornutum*.

For marine aquatic life, toxicological data were identified only for the marine bacterium (*Vibrio fischerii*). The lowest EC_{50} in the acute marine dataset was 50 mg/L for *Vibrio fischerii* luminescence.

For terrestrial plants, toxicological data were identified for four species (lettuce (*Lactuca sativa*), carrot (*Daucus carota*), alfalfa (*Medicago sativa*), and timothy (*Phleum pratense*)). The lowest effect in the terrestrial plant dataset was 424 mg/kg for a root elongation LOEC in lettuce and carrot grown in a sandy soil.

Toxicological data were identified for mammalian laboratory animals, but not for livestock species or birds. Data were available for the rat, mouse, guinea-pig, and rabbit. Eight acute, two subchronic, and two chronic Primary Data studies were available. Acute effects from oral exposure to DIPA ranged from 2,120 to 6,720 mg/kg body weight. Subchronic and chronic NOAELs for oral exposure to DIPA ranged from 0.22 to 600 mg/kg bw/day. Moderate to severe effects occurred in the dose range of 1,200 to 3,000 mg/kg bw/day in a subchronic oral exposure study.

Toxicological data for human oral exposures to DIPA were not available. One study was available on the effects of dermal exposure to a 1% solution of DIPA in sunscreen. The dermal study concluded that the sunscreen product that contained DIPA was not a strong irritant, but that it may be capable of inducing contact sensitization.

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Recommended Guidelines

Freshwater aquatic life, irrigation, and livestock watering guidelines were developed using the available toxicological effects data. Because of the lack of sufficient data, water quality guidelines for the protection of drinking water, recreational water, and industrial water uses were not derived. The guidelines are summarized in Table 1.

1. DRINKING WATER

Drinking water guideline for DIPA is not recommended at this time. Health Canada has not developed a drinking water guideline for DIPA.

2. FRESHWATER AQUATIC LIFE

To protect freshwater aquatic life, it is recommended that the maximum concentration of DIPA should not exceed 1.6 mg/L. This guideline is consistent with the draft CCME guideline, which is based on the same data set.

Rationale

Toxicological data data were sufficient to develop an Interim guideline that meets Canadian Council of Ministers of the Environment requirements. The recommended guideline (1.6 mg/L) is based the application of a 10-fold safety factor to the lowest LOEC in the chronic dataset (16 mg/L for *Ceriodaphnia dubia*).

3. MARINE AND ESTUARINE LIFE

Toxicological data were not sufficient to meet the Canadian Council of Ministers of the Environment(CCME) and BC Ministry of Water, Land and Air Protection requirements. Therefore, a marine life guideline is not available at this time.

4. RECREATION

Water quality guidelines to protect recreational water uses were not recommended due to lack of sufficient data. Health Canada has not recommended a guideline to protect recreational water uses for adverse effects of DIPA.

5. IRRIGATION

To protect agricultural crops, the maximum concentration of DIPA should not exceed 3.9 mg/L in irrigation water supplies.

Rationale

Toxicological data were sufficient to develop an interim guideline that meets the CCME's requirements. Four guidelines were calculated for two soil types "poor soil" (e.g., sand or till) and loam, and two crop types (tame hay, cereal and pasture crops and other crops). The overall irrigation guideline is the lowest of these four guidelines (3.9 mg/L). The species maximum acceptable toxicant concentration (SMATC) for tame hay, cereal and pasture crops was 91 mg/L (loam), and 78 mg/L (poor soil). For other crops the SMATC was 36 mg/L (loam), and 3.9 mg/L (poor soil). These guidelines were based on the acceptable soil concentrations calculated from a 10-fold uncertainty factor and the NOEC and LOEC. The acceptable soil concentrations were: 56 mg/kg for tame hay, cereal and pasture crops grown in loam, based on the root length endpoint for alfalfa; 48 mg/kg for tame hay, cereal and pasture crops grown in poor soil, based on the biomass endpoint for timothy in sand; 224 mg/kg for other crops grown in loam, based on the root length endpoint for lettuce; and, 24 mg/kg for other crops grown in poor soil, based on the root length endpoint for lettuce and carrot in sand.

6. LIVESTOCK WATERING

To protect livestock from adverse effects of DIPA, the maximum concentration of DIPA should not exceed 38 mg/L in their drinking water supplies.

Rationale

Toxicological data did not meet the CCME's requirements for this water use. However, the quality of the toxicological data was determined to be satisfactory to develop a preliminary guideline. The recommended guideline is based on the CCME's protocols with the application of additional safety factors. The tolerable daily intake (TDI) was calculated by applying a safety factor of 700 to the mean of acute toxicity data for laboratory animals (4,260 mg/kg bw/day). The 700-fold safety factor was based on a factor of 70 to extrapolate from acute to chronic data, and a factor of 10 to extrapolate from rodent data to livestock. The recommended guideline was based on dairy cattle, which have a high water consumption to body weight ratio.

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Application of the Guidelines

The water quality guidelines recommended in this document are primarily based on controlled, laboratory bioassays that do not account for factors that may modify the toxicity of DIPA in the field. Therefore, care must be exercised when the water quality guidelines are applied to assess environmental impacts of DIPA. In those situations, a site-specific study should be undertaken to develop site-specific water quality objectives based on local species and actual DIPA persistence and concentrations.

In many cases, water quality objectives are the same as the guidelines. In sensitive and high economic value environments, water quality objectives that are more stringent than the recommended guidelines

may be justified. In some cases, socio-economic or other factors may justify objectives which are less stringent than the guidelines.

Methods (*e.g.*, water effects ratio[3], resident species toxicity in the field, etc.) are available to adapt the recommended guidelines to a given site by considering these factors. Where necessary, these methods can be employed to set site-specific water quality objectives. Because these approaches are costly and time-consuming, they are seldom used.

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[3] See BC Ministry of Water, Land and Air Protection publication *Methods for Deriving Site-Specific Water Quality Objectives in British Columbia and Yukon*