Water Quality

Ambient Water Quality Guidelines for Ethylbenzene

Overview Report

Prepared pursuant to Section 2(e) of the
Environment Management Act, 1981

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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 for the Canadian Council of Ministers of Environment (CCME) proposing Water Quality Guidelines for Ethylbenzene (April 1996 update). This overview report assesses those guidelines for use in British Columbia and makes amendments where appropriate to suit BC conditions. The guidelines are safe conditions or levels which have province-wide application and are set to protect various water uses. This report sets guidelines for ethylbenzene to protect drinking water, freshwater and marine aquatic life and recreation. Based on this evaluation, the CCME guidelines were adopted by the province, except where adjustments were deemed necessary for the protection of aquatic life (fresh water and marine).

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.

Tables

Table 1: Summary Table of Recommended Guidelines for Ethylbenzene

Water Use	Guideline (mg/L ethylbenzene

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Raw Drinking Water (aesthetics)	0.0024 mg/L
Fresh Water Aquatic Life	0.20* mg/L
Marine Aquatic Life	0.25* mg/L
Recreation	0.0024 mg/L
Crop Irrigation	insufficient data
Livestock Watering	insufficient data

1. Revised interim BC guidelines based on review of CCME Water Quality Guidelines for Ethylbenzene
2. All guidelines are maximum values.

Preface

THE MINISTRY OF ENVIRONMENT, LANDS AND PARKS (now called 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 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 guideline 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, including aquatic life, 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:

- Raw drinking, public water supply and food processing
- Aquatic life and wildlife
- Agriculture (livestock watering and irrigation)
- Recreation and aesthetics
- 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.

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

The guidelines apply to the ambient raw water source before it is diverted or treated for domestic use.

The Ministry of Health regulates the quality of water for domestic use after it is treated and delivered by a water purveyor.

Guidelines relating to public health at bathing beaches are the same as those used by the Ministry of Health which regulates the recreation and aesthetic use.

Introduction

Ethylbenzene is a colourless liquid at room temperature with a gasoline-like aroma. It occurs naturally in coal, tar and petroleum and is found in consumer products such as paint, ink, pesticides and gasoline. In Canada, ethylbenzene is used for producing styrene and as a solvent in the chemical and rubber industries.

Ethylbenzene can enter aquatic environments during production, usage, storage, transportation and spills. It is released into the air from burning oil, gas and coal and is generally associated with smog. Physical, chemical and biological breakdown removes ethylbenzene from all media so there is little tendency for it to accumulate in environmental compartments. Ethylbenzene is resistant to hydrolysis, and photolysis of ethylbenzene in water is minimal. It binds moderately to soil and aquatic sediments and thus may leach into ground water if released to land. Ethylbenzene is volatile with a half-life of up to two weeks in water. The log octanol-water partition coefficient (Kow) is 3.2.

Ethylbenzene has been detected throughout North America in effluents from municipalities, industries, industrialized river basins, ground water, sediments, soil and water.

In performing toxicity testing, the most sensitive freshwater species to ethylbenzene reported in the literature was Daphnia magna with a 48 hour EC_{50} of 1.8 mg/L for immobilization. Three separate studies conducted independently reported the 48 hour EC_{50}s for immobilization of this species ranged from 1.8 to 2.1 mg/L. One study reported a 24 hour EC_{50} (immobilization) of 2.2 mg/L. A 96 hour LC_{50} of 4.2 mg/L was reported for rainbow trout, Oncorhynchus mykiss, in soft water whereas a 72 hour EC_{50} of 4.6 mg/L for growth inhibition was reported for the green algae Selenastrum capricornutum.

In marine water, sensitive species included the Atlantic silversides, *Mendidia mendidia*, and Mysid shrimp, *Mysidopsis bahia*. The no observed effects concentration (NOEC) using survival of Atlantic silversides was 3.3 mg/L, while the lowest concentration at which there was a statistical difference in survival from the control group was 5.9 mg/L after 96 hours. For Mysid shrimp, the NOEC (survival) was 1.0 mg/L, while the lowest observed effects concentration (LOEC) was 2.7 mg/L after a 96-hour exposure.

Recommended Guidelines

These guidelines are based on a review of the technical background information used to prepare the CCME Water Quality Guidelines for Ethylbenzene (April 1996 update). The guidelines have been revised where appropriate to suit BC conditions, and are summarized in Table 1.

1. DRINKING WATER SUPPLY

An aesthetic objective of 0.0024 mg/L for ethylbenzene in drinking water has been recommended by the Federal-Provincial Subcommittee on Drinking Water, Health Canada (1993) and is adopted for ambient conditions.

Rationale

This concentration yields no objectionable taste or smell, or no adverse health effects. Without treatment prior to entering a water distribution system, ethylbenzene concentrations will change little from ambient concentrations, especially when time from withdrawal to use is small. Therefore, the recommended concentration for water distribution systems will be the ambient water quality concentration for ethylbenzene.

2. FRESHWATER AQUATIC LIFE

The maximum concentration of ethylbenzene should not exceed the BC guideline of 0.2 mg/L. This guideline has been revised from the CCME guideline of 0.09 mg/L.

Rationale

We found that the data quality from the researchers considered by CCME was satisfactory. There were three independent studies on the most sensitive species *Daphnia magna* that derived similar concentration levels to ensure confidence in the endpoint. In developing their guideline, the CCME applied a safety factor of 20:1. However, studies indicate that ethylbenzene has high volatility, low bioaccumulation potential and would not be expected to remain in the environment for prolonged periods of time (half-life is up to two weeks in water). The LOEC/NOEC ratios for freshwater aquatic life is expected to be low as in the marine environment, although such data were not available for freshwater species. Therefore, the recommended guideline is based on a reduction in the applied safety factor from 20:1 to 10:1.

3. MARINE AND ESTUARINE LIFE

The maximum concentration of ethylbenzene should not exceed 0.25 mg/L. This guideline has been revised from the CCME guideline of 0.02 mg/L.

Rationale

The critical study used by the CCME to derive the guideline was classified as secondary data. In BC, we eliminated this study for determining the BC guideline as the concentrations were not measured at the end of the test. This is due to rapid and large losses in the compound concentration (greater than 99% after 24 hours), which precluded accurately predicting concentrations at any time interval. The next lowest critical study had a 96 hour LC_{50} of 2.6 mg/L for Mysid shrimp, *Mysidopsis bahia*.

The safety factor used by CCME was reduced from 20:1 to 10:1 for BC based on ethylbenzene's short half-life and low potential to bioaccumulate. We felt further justified in reducing the safety factor since there were paired data showing ratios of 96 hour LC_{50} (LOEC) to NOEC values of <3:1.

4. CROP IRRIGATION

No water quality guideline for this use is recommended as there are insufficient data on the adverse effects of ethylbenzene in irrigation water.

5. LIVESTOCK WATERING

Due to lack of data, guidelines for livestock watering was not recommended at this time in BC.

Application of the Guidelines

Ethylbenzene is a very volatile substance, and for this reason, we felt justified to reduce the safety factor in deriving the guidelines for freshwater and marine waters from 20:1 to 10:1. 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 ethylbenzene in the field.

Setting Water Quality Objectives

Care must be exercised when the water quality guidelines are applied to assess environmental impacts of ethylbenzene, since there will be situations where ethylbenzene concentrations are continuously renewed (e.g., discharge from an industrial operation). In these types of situations, a site-specific study should be undertaken and appropriate site-specific water quality objectives developed based on species present and actual ethylbenzene persistence and concentrations.

In many cases, water quality objectives will be the same as the guidelines. When concentrations of ethylbenzene in developed waterbodies are constantly maintained due to a continuous source or an environmental condition that prevents its degradation, then water quality objectives that are more stringent than the recommended guidelines may be justified. In some cases, socioeconomic or other factors may justify objectives which are less stringent than the guidelines. Site-specific impact studies would be required in such cases.

Methods (e.g., water effects ratio, 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.