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SECONDARY VALUES FOR ETHYLENE GLYCOL (CAS # 107-21-1)

A search was conducted for information on the chemical properties and toxicity of ethylene glycol (to human health and to fish and aquatic life) using the following databases and search engines: ECOTOX (toxicity to fish and aquatic life), IRIS (Integrated Risk Information System; toxicity to human health), and CHEMFATE (environmental fate).

FISH AND AQUATIC LIFE

To derive an acute toxicity criterion for aquatic life, acute toxicity test results are required for at least one species in each of eight different families. Specific requirements and the data available to meet these requirements are found in Table 1. Following a search for information on the toxicity of ethylene glycol to fish and other aquatic life, it was determined that data are available to meet five out of the eight requirements. Because there are data for a daphnid species, it is possible to calculate a secondary acute value for ethylene glycol.

Cold Water

To calculate a secondary acute value (SAV), the lowest genus mean acute value (GMAV) in the database is divided by the secondary acute factor (SAF; an adjustment factor corresponding to the number of satisfied requirements).

SAF for five out of eight requirements met = 6.1

Lowest GMAV = 13,499,671 (*Ceriodaphnia dubia*)

SAV = GMAV/SAF
= 13,499,671 / 6.1
= 2,213,060 µg/L (2,213 mg/L)

There are currently no chronic data for ethylene glycol. Therefore, a secondary chronic value may be calculated only by using default acute-chronic ratios.

SACR = Geometric mean of 18, 18, and 18 = 18

SCV = SAV/SACR
= 2,213,060 / 18
= **122,948 µg/L (123 mg/L)**

Warm Water Sport Fish, Warm Water Forage Fish, Limited Forage Fish, Limited Aquatic Life

Because the lowest GMAV in the cold water database is for *Ceriodaphnia dubia*, an invertebrate, and because this species will not drop out for any of the other use classifications, secondary values for warm water sport fish, warm water forage fish, limited forage fish and limited aquatic life waters will be the same as for cold waters.

Table 1. Requirements for calculation of an acute toxicity criterion for protection of aquatic life for ethylene glycol, and corresponding acute toxicity data.

Species Name	Common Name	Duration/ Endpoint	Value µg/L	Reference #[a]	Source
1. At least one salmonid fish in the family Salmonidae, in the class Osteichthyes.					
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**>18,500,000**	**5**	**ECOTOX**
2. At least one non-salmonid fish from another family in the class Osteichthyes, preferably a commercially or recreationally important warmwater species.					
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**27,540,000**	**4**	**ECOTOX**
3. At least one planktonic crustacean (e.g., cladoceran, copepod).					
Daphnia magna	**water flea**	**48-h/LC50**	**41,000,000**	**3**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**47,400,000**	**3**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**51,000,000**	**3**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**10,000,000**	**2**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**41,100,000**	**2**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**45,500,000**	**2**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**46,300,000**	**2**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**47,400,000**	**2**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**51,000,000**	**2**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**51,000,000**	**2**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**51,100,000**	**2**	**ECOTOX**
Daphnia magna	**water flea**	**48-h/LC50**	**57,600,000**	**2**	**ECOTOX**
Species Mean Acute Value (SMAV) = 42,115,703					
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**3,440,000**	**1**	**ECOTOX**
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**13,140,000**	**1**	**ECOTOX**
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**10,000,000**	**2**	**ECOTOX**
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**10,500,000**	**2**	**ECOTOX**
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**13,900,000**	**2**	**ECOTOX**

Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**22,600,000**	**2**	**ECOTOX**
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**25,500,000**	**2**	**ECOTOX**
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**25,800,000**	**2**	**ECOTOX**
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**29,700,000**	**2**	**ECOTOX**
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**6,900,000**	**2**	**ECOTOX**
SMAV = 13,499,671					

4. At least one benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish).

***Procambarus* sp.**	**crayfish**	**96-h/LC50**	**91,430,000**	**4**	**ECOTOX**

5. At least one insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge).

6. At least one fish or amphibian from a family in the phylum Chordata not already represented in one of the other subdivisions.

Pimephales promelas	**fathead minnow**	**96-h/LC50**	**72,860,000**	**1**	**ECOTOX**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**8,050,000**	**1**	**ECOTOX**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**>10,000,000**	**6**	**ECOTOX**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**49,000,000**	**7**	**ECOTOX**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**53,000,000**	**7**	**ECOTOX**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**57,000,000**	**7**	**ECOTOX**
SMAV = 30,886,733					

7. At least one organism from a family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca).

8. At least one organism from a family in any order of insect or any other phylum not already represented in subdivisions 1 through 7.

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[4]Khoury, G.A., A.A. Abdelghani, A.C. Anderson, and A. Monkiedje. 1995. Acute toxicity of ethylene glycol to crayfish, bluegill sunfish and soil microorganisms. In: D.H. Hemphill and C.R. Cothern (Eds.), Trace Substances in Environmental Health, Suppl. Volume 12, Proc. Conf. Held in the Hotel Wastin, May 29-June 1, 1989, Cincinnati, Ohio:371-378.

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[6]Conway, R.A. G.T. Waggy, M.H. Spiegel, and R.L. Berglund. 1983. Environmental fate and effects of ethylene oxide. Environmental Science and Technology 17(2):107-112.

[7]Mayes, M.A., H.C. Alexander, and D.C. Dill. 1983. A study to assess the influence of age on the response of fathead minnows in static acute toxicity tests. Bulletin of Environmental Contamination and Toxicology 31(2):139-147.

HUMAN HEALTH SECONDARY VALUES

Carcinogenicity Classification
Not yet assessed (IRIS)

Oral Reference Dose (RfD)
2 mg/Kg/d based kidney toxicity (IRIS; last revised 1989)

Baseline Bioaccumulation Factors (BAFs)
Calculated using method “d” of the GLI, and of Ch. NR 105, as shown below

Fish Consumption Rate
20 g/d (= 0.02 Kg/d; Ch. NR 105, Wisconsin Administrative Code 1997)

Log K_{ow}
-1.36 (CHEMFATE database)

K_{ow}
0.0437

Relative Source Contribution
80% (default, Ch. NR 105, Wisconsin Administrative Code 1997)

There are several steps to calculating a human threshold criterion: 1) calculation of the fraction of freely dissolved chemical; 2) calculation of the "baseline BAF"; 3) calculation of the "human health BAF"; and 4) calculation of the human threshold criterion.

1) Calculation of the freely-dissolved fraction = f_{fd}

Given a standard dissolved organic carbon (DOC) concentration of 0.000002 Kg/L and a particulate organic carbon (POC) concentration of 0.00000004 Kg/L in water, the equation

$$f_{fd} = 1/\{1 + [(DOC)(K_{ow})/10] + [(POC)(K_{ow})]\}$$

can be reduced to:

$$f_{fd} = 1/\{1 + [(0.00000024\ Kg/L)(K_{ow})]\}$$

For ethylene glycol, the K_{ow} = 0.0437

$$f_{fd} = 1/\{1 + [(0.00000024\ Kg/L)(0.0437)]\}$$

$$f_{fd} = 1/1.0000$$

$$f_{fd} = \mathbf{1.0000}$$

2) Calculation of the baseline BAF

The baseline BAF is calculated according to the equations contained in 40 CFR part 132 (Final Water Quality Guidance for the Great Lakes System), Appendix B, using BAF data that was collected in one of four ways (listed in order of most preferred to least preferred):

a) a measured BAF from a field study
b) a predicted BAF based on field-measured BSAFs
c) a predicted BAF using a laboratory-measured BCF and a FCM
d) a predicted BAF using a K_{ow} and a FCM

Using the K_{ow} and a FCM:

Baseline BAF = (FCM) (K_{ow})

where
FCM = food chain multiplier, from Table B-1, in 40 CFR Part 132

The FCM will vary depending on whether it is being used for warm water (trophic level 3) or cold water (trophic level 4).

FCM for Trophic Level 3 = 1.000
FCM for Trophic Level 4 = 1.000

Because the Log Kow for ethylene glycol is less than 2.0, the FCM will be the same for trophic levels 3 and 4.

Baseline BAF for cold and warm water

Baseline BAF = (1.000) (0.0437)

Baseline BAF = 0.0437

3) Calculation of the human health BAF

Because ethylene glycol is an organic substance, the appropriate equations for calculating human health BAFs follow.

a) Human health BAF for warm water

$$\text{Human health BAF}_{warm} = \{[(\text{baseline BAF}_{warm})(0.013)] + 1\}\ (f_{fd})$$

where
baseline BAF_{warm} = the baseline BAF_{warm} calculated in 2)

0.013 = fraction lipid value for warm water fish and aquatic life communities

f_{fd} = fraction freely dissolved

Human health BAF_{warm} = {[(0.0437)(0.013)] + 1} (1.0000)

Human health BAF_{warm} = 1.0006

b) Human health BAF for cold water

Human health BAF_{cold} = {[(baseline BAF_{cold})(0.044)] + 1} (f_{fd})

where

baseline BAF_{cold} = the baseline BAF_{cold} calculated in 2)

0.044 = fraction lipid value for cold water fish and aquatic life communities

f_{fd} = fraction freely dissolved

Human health BAF_{cold} = {[(0.0437)(0.044)] + 1} (1.0000)

Human health BAF_{cold} = 1.0019

4) Calculation of the human threshold criterion

Human threshold criterion = [(ADE)(70 Kg)(RSC)]/[W_H +(F_H)(BAF)]

where

ADE = acceptable daily exposure in mg/kg/d (= oral reference dose)

70 Kg = average weight of an adult

RSC = relative source contribution to account for other routes of exposure (= 0.8 in the absence of other data)

W_H = average per capita daily water consumption (= 2 L/d for public water supplies, and 0.01 L/d for non-public water supplies)

F_H = average consumption of sport-caught fish in Wisconsin (= 0.02 Kg/d)

BAF = appropriate (warm or cold) human health BAF calculated in 3).

a) Non-Public Water Supply; Limited Aquatic Life

Human threshold criterion = [(2 mg/Kg/d)(70 Kg)(0.8)]/[0.01 L/d +(0)]
Note: For limited aquatic life waters, it is assumed that no fish are being caught and consumed.

Human threshold criterion = 11,200 mg/L = 11,200,000 μg/L

b) Non-Public Water Supply; Warm Water Sport, Warm Water Forage, Limited Forage

Human threshold criterion = [(2 mg/Kg/d)(70 Kg)(0.8)]/[0.01 L/d +(0.02 Kg/d)(1.0006)]

Human threshold criterion = 3,733 mg/L = 3,733,000 ug/L

c) Non-Public Water Supply; Cold Water

Human threshold criterion = [(2 mg/Kg/d)(70 Kg)(0.8)]/[0.01 L/d +(0.02 Kg/d)(1.0019)]

Human threshold criterion = 3,733 mg/L = 3,733,000 ug/L

d) Public Water Supply; Warm Water Sport

Human threshold criterion = [(2 mg/Kg/d)(70 Kg)(0.8)]/[2 L/d +(0.02 Kg/d)(1.0006)]

Human threshold criterion = 55.4455 mg/L = 55,445 ug/L

e) Public Water Supply; Cold Water

Human threshold criterion = [(2 mg/Kg/d)(70 Kg)(0.8)]/[2 L/d +(0.02 Kg/d)(1.0019)]

Human threshold criterion = 55.4455 mg/L = 55,445 μg/L