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SECONDARY VALUES FOR FLUORANTHENE (CAS # 206-44-0)

A search was conducted for information on the chemical properties and toxicity of fluoranthene (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), CHEMFATE (environmental fate), BIOLOG (microbial degradation/toxicity), DATALOG (environmental fate bibliography), HSDB (Hazardous Substances Data Bank), CCRIS (Chemical Carcinogenesis Research Info System), GENE-TOX (mutagenicity database), TOXLINE (toxicology bibliography), TERA (Toxicology Excellence for Risk Assessment), and Ingenta (journal article search engine; since 1988). This search yielded some information on fluoranthene's properties (vapor pressure, log octanol/water partition coefficient, Henry's Law, and water solubility), and its biodegradation, and a significant amount of information on its toxicity.

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. All data requirements for establishment of an acute toxicity criterion for aquatic life have been met. It should be noted that there is an additional LC50 value available for *Daphnia magna* that met the basic requirements for inclusion; however, because this LC50 value (320,000 μg/L; LeBlanc 1980) differed from a second LC50 value for the same species by more than a factor of 10, it was not included in the calculations. This value was dropped, and the other kept because the other value (105.7 μg/L; Suedel and Rodgers 1996) is much closer to the value generated for *Ceriodaphnia dubia*, as well as to values generated for several other species. In addition, toxicity data collected for fathead minnows differ by a factor of about 10. The lower LC50 values (6.83 and 9.46 μg/L), published by Diamond et al. (1995), were generated in studies conducted with fathead minnows in the larval stage. What life stage was used in the study conducted by Horne and Oblad (1983) is not known at this time since this value (as listed in the AQUIRE database) was originally published in a difficult-to-obtain report. If, at a later date, it is discovered that this study was conducted with a different life stage (e.g., adult) than the those conducted by Diamond et al. (1995), it may be necessary to exclude the value generated for the more resistant life stage.

Although all requirements for calculation of a criteria have been met, and no adjustment factors were used, the calculated acute criterion will be referred to as a secondary value until such time that NR 105 can be revised to reflect the update.

Table 1. Requirements for calculation of an acute toxicity criterion for protection of aquatic life for fluoranthene, 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**	**187**	**5**	**AQUIRE**
2. At least one non-salmonid fish from another family in the class Osteichthyes, preferably a commercially or recreationally important warmwater species.					
Ictalurus punctatus	**channel catfish**	**96-h/LC50**	**36**	**3**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**4000**	**1**	**AQUIRE**
3. At least one planktonic crustacean (e.g., cladoceran, copepod).					
Ceriodaphnia dubia	**water flea**	**48-h/LC50**	**45**	**6**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/LC50**	**105.7**	**7**	**AQUIRE**
4. At least one benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish).					
Gammarus minus	**amphipod**	**96-h/LC50**	**32**	**5**	**AQUIRE**
5. At least one insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge).					
Chironomus tentans	**midge**	**48-h/LC50**	**>250**	**7**	**AQUIRE**
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**	**6.83**	**2**	**AQUIRE**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**9.46**	**2**	**ET&C**
Species Mean Acute Value (SMAV; geometric mean of LC50 values for this species):			8.04		
Excluded because result was > 10X the other LC50's:					
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**95**	**5**	**AQUIRE**

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

Physa heterostropha	**pond snail**	**96-h/LC50**	**137**	**5**	**AQUIRE**

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.

Rana pipiens	**leopard frog**	**96-h/LC50**	**366**	**4**	**AQUIRE**
Xenopus laevis	**clawed toad**	**96-h/LC50**	**193**	**4**	**AQUIRE**

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[2]Diamond, S.A., J.T. Oris and S.I. Guttman. 1995. Adaptation to fluoranthene exposure in a laboratory population of fathead minnows. Environmental Toxicology and Chemistry 14(8):1393-1400.

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[4]Hatch, A.C. and G.A. Burton, Jr. 1998. Effects of photoinduced toxicity of fluoranthene on amphibian embryos and larvae. Environmental Toxicology and Chemistry 17(9):1777-1785.

[5]Horne, J.D. and B.R. Oblad. 1983. Aquatic toxicity studies of six priority pollutants. Report No. 4380, NUS Corp., Houston Environ. Center, Houston, TX. 99 p.

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[7]Suedel, B.C. and J.H. Rodgers, Jr. 1996. Toxicity of fluoranthene to *Daphnia magna*, *Hyalella azteca*, *Chironomus tentans* and *Stylaria lacustris* in water-only and whole sediment exposures. Bulletin of Environmental Contamination and Toxicology 57(1):132-138.

Acute criteria were calculated for both cold water and warm water sport fish use designations for comparison.

Cold Water

Genus mean acute values (GMAV; geometric mean of SMAVs), ordered from high to low and ranked (1 for the lowest, and 11 for the highest) are found below. The cumulative probability (P) was calculated for each GMAV as P=R/(N+1).

Rank (R)	Species	GMAV (µg/L)	P
11	Bluegill	4000	0.9167
10	Leopard frog	366	0.8333
9	Midge	250	0.7500
8	Clawed toad	193	0.6667
7	Rainbow trout	187	0.5833
6	Pond snail	137	0.5000
5	Water flea (*Daphnia*)	105.7	0.4167
4	Water flea (*Ceriodaphnia*)	45	0.3333
3	Channel catfish	36	0.2500
2	Amphipod	32	0.1667
1	Fathead Minnow	8.038	0.0833

Using the four GMAVs with Ps closest to 0.05 (fathead minnow, amphipod, channel catfish, and *Ceriodaphnia* water flea), the acute toxicity criterion is calculated as follows:

Let EV = sum of the four ln GMAVs
= ln 8.038 + ln 32 + ln 36 + ln 45
= 2.0842 + 3.4657 + 3.5835 + 3.8067
= 12.9401

Let EW = sum of the four squares of the ln GMAVs
= $(2.0842)^2 + (3.4657)^2 + (3.5835)^2 + (3.8067)^2$
= 4.3439 + 12.0111 + 12.8415 + 14.4910
= 43.6875

Let EP = sum of the four Ps
= 0.0833 + 0.1667 + 0.2500 + 0.3333
= 0.8333

Let EPR = sum of the four square roots of P
= 0.2886 + 0.4083 + 0.5000 + 0.5773
= 1.7742

Let JR = square root of 0.05
= 0.2236

$S = ((EW - (EV)^2/4)/(EP-(EPR)^2/4))^{0.5}$
$= ((43.6875 - (12.9401)^2/4)/(0.8333 - (1.7742)^2/4))^{0.5}$
$= ((43.6875 – 41.8615)/(0.8333 - 0.7869))^{0.5}$
$= (1.8260/0.0464)^{0.5}$
$= (39.353)^{0.5}$
$= 6.273$

$L = (EV - S(EPR))/4$
$= (12.9401 – 6.273(1.7742))/4$
$= 0.450$

$A = (JR)(S) + L$
$= (0.2236)(6.273) + 0.450$
$= 1.854$

Final Acute Value (FAV) = e^A
$=e^{1.854}$
$=6.386$

ATC = FAV/2
=6.386/2
= 3.19

ATC for Cold Water = 3.19

<u>Warm Water Sportfish</u>

Because the Milwaukee River is designated as warm water sportfish, non-public water supply, the rainbow trout will drop out of the database. Since it's not one of the four most sensitive genera, the database is smaller with the same four most sensitive genera. The ATC shall be set equal to the coldwater ATC.
However, because the ATC for warm water sportfish is lower than the ATC for cold water, the ATC for cold water will apply to warm water sportfish as well.

To derive a chronic toxicity criterion for aquatic life, chronic toxicity test results are required for at least one freshwater species in each of eight different families. Specific requirements and the data available to meet these requirements are found in Table 2. Complete data requirements for establishment of a chronic toxicity criterion for fluoranthene, for the protection of aquatic life, have not been met. While toxicity tests have been conducted that examined the chronic effects of fluoranthene on several different species, in most cases, either no endpoint was reported, or only an NOEC (no observable effect concentration) or an LOEC (lowest observable effect concentration) alone were reported. When both an NOEC and an LOEC are reported, it is possible to calculate a chronic value, the MATC (maximum allowable toxicant concentration) as the geometric mean of the NOEC and the LOEC.

Table 2. Requirements for calculation of a chronic toxicity criterion for protection of aquatic life for fluoranthene, and corresponding chronic 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.					
2. At least one non-salmonid fish from another family in the class Osteichthyes, preferably a commercially or recreationally important warmwater species.					
3. At least one planktonic crustacean (e.g., cladoceran, copepod).					
Ceriodaphnia dubia	**water flea**	**7-day/MATC**	**51.1**	**1**	**AQUIRE**
Ceriodaphnia dubia	**water flea**	**7-day/MATC**	**35.6**	**1**	**AQUIRE**
Species Mean Chronic Value (SMCV; geometric mean of MATC values for this species):			42.6516		
4. At least one benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish).					
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.					
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.					

[1]Oris, J.T., R.W. Winner and M.V. Moore. 1991. A four-day survival and reproduction toxicity test for *Ceriodaphnia dubia*. Environmental Toxicology and Chemistry 10(2):217-224.

When all eight family requirements are not met, it may still be possible to generate the chronic toxicity values necessary to calculate a final chronic value, by calculating acute-chronic ratios. However, a final chronic value can be calculated only if at least one acute-chronic ratio is available for at least one species in at least three different families, provided that one is a fish, one is an invertebrate, and one is a relatively sensitive freshwater species (the other two may be saltwater species). Chronic values (MATCs) and corresponding acute values were available for *Ceriodaphnia dubia*. However, data were not available to calculate acute-chronic ratios for a fish, or any other freshwater or saltwater species.

A secondary chronic value (SCV) may be calculated by dividing the final acute value (FAV) by a secondary acute-chronic ratio. The secondary acute-chronic ratio (SACR) is equal to the geometric mean of the three acute-chronic ratios for the fish, invertebrate, and relatively sensitive freshwater species. Since data are only available for the invertebrate, the default acute-chronic ratio of 18 is used for each of the other two.

Ceriodaphnia dubia	7-day/MATC	51.1 μg/L	Oris et al. 1991
	48-h/LC50	45 μg/L	Oris et al. 1991
	Acute-chronic ratio = 0.8806		
Ceriodaphnia dubia	7-day/MATC	35.6 μg/L	Oris et al. 1991
	48-h/LC50	45 μg/L	Oris et al. 1991
	Acute-chronic ratio = 1.2640		

Species mean acute-chronic ratio = 1.0550 for *Ceriodaphnia dubia*

SACR = geometric mean of 18, 18, and 1.0550 = 6.9920

SCV = FAV/SACR
= 6.38/6.9920
= 0.91

So, for fluoranthene, the **secondary acute value is 3.19 μg/L** and the **secondary chronic value is 0.93 μg/L.**.

HUMAN HEALTH

To calculate a criteria or secondary value for the protection of human health, it is first necessary to determine if the substance has been shown to be carcinogenic (which will result in the calculation of a human cancer criteria or secondary value) or not (which will result in the calculation of a human threshold criteria or secondary value). Fluoranthene is currently classified as "D", not classifiable, by the U.S. EPA (IRIS, 1998) based on inadequate data from animal bioassays and no human data, although a search of the CCRIS database on TOXNET (National Institutes of Health) revealed that all eight carcinogenicity studies listed there (conducted with mice, intraperitoneal route of exposure) yielded positive (adenoma and/or tumor) results. **The State of Wisconsin has established a human threshold criterion (HTC) for fluoranthene for cold water public water supplies. It is 610 μg/L.**

REFERENCES

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