AMBIENT WATER QUALITY ADVISORY

PYRIDINE

OFFICE OF WATER REGULATIONS AND STANDARDS
CRITERIA AND STANDARDS DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

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FOREWORD

The Criteria and Standards Division of the Office of Water Regulations and Standards has instituted water quality advisories as a vehicle for transmitting the best available scientific information concerning the aquatic life and human health effects of selected chemicals in surface waters. Advisories are prepared for chemicals for which information is needed quickly, but for which sufficient data, resources, or time are not available to allow derivation of national ambient water quality criteria.

Data supporting advisories are usually not as extensive as required for derivation of national ambient water quality criteria, and the strength of an advisory will depend upon the source, type, and reliability of the data available. We feel, however, that it is in the best interest of all concerned to make the enclosed information available to those who need it.

Users of advisories should take into account the basis for their derivation and their intended uses. Anyone who has additional information that will supplement or substantially change an advisory is requested to make the information known to us. An advisory for an individual chemical will be revised if any significant and valid new data make it necessary.

We invite comments to help improve this product.

Edmund M. Notzon, Director
Criteria and Standards Division

ACKNOWLEDGMENTS

AQUATIC LIFE

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SECTION I. ADVISORIES

AQUATIC LIFE

If the measured or estimated ambient concentration of pyridine exceeds 116 ug/L in fresh or salt water, one or more of the following options must be completed within a reasonable period of time:

1. Obtain more measurements of the concentration.

2. Improve the estimate of the concentration.

3. Reduce the concentration.

4. Obtain additional laboratory and/or field data on the effect of pyridine on aquatic life so that a new aquatic life advisory or a water quality criterion can be derived.

After a reasonable period of time, unless a consideration of all the available data concerning the ambient concentration and the effects of pyridine on aquatic life demonstrates that the ambient concentration is low enough, it must be reduced.

SECTION II. GENERAL INFORMATION

A. Biological, Chemical and Physical Properties

The following information on the properties of pyridine and its persistence in the aquatic environment was obtained from the QSAR System˜ha˜s on April 28, 1987, or from the CRC Handbook of Chemistry and Physics˜hb˜s. Some of the values were calculated using structure-activity relationships.

Property	Value	Source
Molecular Weight	79.10 g/mole	Calculated
Relative Density (20 C)	0.9819	Measured
Log P	0.665	Calculated
Melting Point	-42.00 C	Measured
Boiling Point	97.00 C	Measured
Vapor Pressure	48.00 mm Hg	Calculated
Heat of Vaporization	8,120.00 cal/mole	Calculated
pKa	5.25	Calculated
Solubility in Water	233.35 mg/L	Calculated
BCF	1.33	Calculated
Absorption Coef.[Log (Koc)]	1.70	Calculated

Hydrolysis Half-life = > 1000 days
Hydrolysis is not likely to be an important transformation mechanism for this chemical.

Biodegradation Half-life Analysis
This chemical is grouped with 10 aromatic chemicals that contain only carbon, oxygen, nitrogen, and hydrogen. QSAR did not find any functional groups that appear to prohibit degradation. The range of half-life values for chemicals in this group is from 3 to 17 days.

Log 10 (Henry's Constant) = -4.67 atmm^3/mole
It could be concluded that a chemical with these properties will volatilize at significant rates from open water.

Neely 100-day Partitioning Pattern

Air	=	0.94%
Water	=	98.96%
Ground	=	0.05%
Hydrosoil	=	0.05%

a For information on the QSAR system, see: Hunter, R., L. Faulkner, F. Culver and J. Hill. Draft user manual for the QSAR system. Center for Data Systems and Analysis, Montana State University. November, 1985.

b Handbook of Chemistry and Physics, 67th Ed., CRC Press, Boca Raton,
FL.1986-1987.

SECTION III. AQUATIC TOXICITY

Introduction

Aquatic life advisory concentrations are conceptually different from national aquatic life water quality criteria. Aquatic life criteria are based on toxicity and bioconcentration data for a sufficiently diverse group of animals and plants to provide reasonable confidence in the appropriateness of the criteria. Advisories are issued for selected chemicals for which sufficient data are not available to allow derivation of national water quality criteria for aquatic life. Because aquatic life advisories are intended to be used to identify situations where there is cause for concern and where appropriate action should be taken, the advisory concentration for a chemical is derived to be equal to or lower than what the Criterion Continuous Concentration (Stephan et al. 1985) would be if a national water quality criterion for aquatic life could be derived for the chemical. If the concentration of a chemical in a variety of surface waters is found to exceed the aquatic life advisory concentration, this may indicate that the U.S. EPA should consider deriving aquatic life water quality criteria for that chemical.

The literature searching and data evaluation procedures used in the derivation of aquatic life advisories are identical to those used in the derivation of water quality criteria for aquatic life (Stephan et al. 1985). However, advisories do not contain a section on "Unused Data" as in a criteria document. This aquatic life advisory concentration for pyridine was derived using the procedures described in the "Guidelines for Deriving Ambient Aquatic Life Advisory Concentrations" (Stephan et al. 1986). A knowledge of these guidelines is necessary in order to understand the following text, tables, and calculations. The latest comprehensive search for information for this aquatic life advisory was conducted in February, 1987.

Based upon the low rates of hydrolysis, biodegradation, and volatilization of pyridine (see Section III), it is assumed that the concentration in static, acute exposure systems should not decrease by more than 50% in 96 hr. This was verified experimentally by Brooke (1987). Therefore, no adjusted values were calculated to interpret results from static tests.

Effects on Freshwater Organisms

Acceptable data on the acute toxicity of pyridine to freshwater organisms are available for two species of cladocerans, two species of fish, and an amphibian (Table 1).

Three researchers have reported 48-hr EC50s for the cladoceran, Daphnia magna, in eight separate tests (Canton and Adema 1978; Dowden and Bennett 1965; Slooff et al. 1983). Results compare favorably and the Species Mean Acute Value (SMAV) for D. magna is 1,234,000 ug/L. Daphnia pulex appeared to be more sensitive to pyridine with a SMAV of 577,000 ug/L, based upon data from Canton and Adema (1978) and Slooff et al. (1983).

The carp, Cyprinus carpio, was the most acutely sensitive organism to pyridine. Juveniles of this species had a 96-hr LC50 of 26,000 ug/L (Rao et al. 1975). The fathead minnow (Pimephales promelas) was about four times less sensitive to pyridine, with a SMAV of 99,700 ug/L, based upon data from Brooke (1987) and Geiger et al. (1986). Davis et al. (1981) exposed several different life stages of an amphibian, Xenopus laevis, to pyridine. The embryo appeared to be a less sensitive stage, therefore data on embryo toxicity was not included in the calculation of its SMAV. The 96-hr LC50 and SMAV for the larva of Xenopus laevis was 1,090,000 ug/L. The ranked Genus Mean Acute Values are presented in Table 2.

No acceptable data are available on the chronic toxicity of pyridine to any freshwater organism. Gorbi (1984) did report a 30-day life-cycle test with the cladoceran Daphnia magna (Table 3), although he neither reported an acceptable acute value from which to calculate an acute-chronic ratio, nor did he measure the concentrations of pyridine in the test chambers. He reported reductions in survival, growth, and reproduction at a concentration of 50,000 ug/L. No significant adverse effects were observed at 25,000 ug/L. This resulted in a chronic value of 35,400 ug/L, based upon nominal concentrations. This value is about 35 times lower than the SMAV for Daphnia magna (Table 1).

Other data on the effects of pyridine on freshwater organisms are found in Table 3. Several investigators have reported on effects in microorganisms (Bringmann 1973,1978; Bringmann and Kuhn 1959, 1977a,b, 1980a,b; Bringmann et al. 1980; Schultz and Allison 1979; Schultz and Moultan 1984, 1985a,b; Schultz et al. 1980). Generally, these organisms appeared to be insensitive to pyridine, with the exception of two protozoa tested by Bringmann et al. (1980) in which incipient effects on cell replication occurred at 3,500 to 3,900 ug/L.

Slooff et al. (1983) and Slooff (1983) reported 48-hr LC50s for ten species, including a hydra, planarian, snail, insects, fish and an amphibian. The most sensitive fish was the fathead minnow (Pimephales promelas) which had a 48-hr LC50 of 115,000 ug/L. The mosquito, Culex pipiens, was the most sensitive invertebrate tested, with a 48-hr EC50 (immobility) of 66,000 ug/L.

Shumway and Palensky (1973) studied the effect of pyridine exposure on the quality of fish as a human food stuff. A 48-hr exposure of bluegills (Lepomis macrochirus) to 100,000 ug/L resulted in a significant reduction in the flavor quality of fish. No flavor impairment was noted when fish were exposed to 10,000 ug/L for 48 hrs.

Effects on Saltwater Organisms

The acute toxicity of pryidine to saltwater organisms has been studied for a single species, a mysid shrimp. Carr (1987) reported a 96-hr LC50 for Mysidopsis bahia of 232,380 ug/L (Table 1).

No acceptable data are available on the chronic toxicity of pyridine to any saltwater organisms.

Calculation of Advisory Concentration

A total of six Species Mean Acute Values (SMAV) and five Genus Mean Acute Values (GMAV) are available for freshwater and saltwater organisms (Table 2). Values range from 26,000 ug/L for Cyprinus to 1,090,000 ug/L for Xenopus. Based upon a total of five GMAVs, the lowest GMAV (26,000 ug/L) is divided by a factor of 9.0, in accordance with the guidelines, resulting in an Advisory Acute Value (AAV) of 2,890 ug/L. In the absence of any experimentally determined acute-chronic ratios, an Advisory Acute-Chronic Ratio (AACR) of 25 is assumed. Dividing the AAV (2,890 ug/L) by the AACR (25) results in an Advisory Concentration of 116 ug/L.

Table 1. Acute Toxicity of Pyridine to Aquatic Animals

Species	Method[a]	Chemical	Hardness (mg/L as $CaCO_3$)	LC50 or EC50 (µg/L)	Species Mean Acute Value (µg/L)	References
			FRESHWATER SPECIES			
Cladoceran (<24 hr), *Daphnia magna*	S, U	-	-	1,210,000	-	Canton and Adema 1978
Cladoceran (<24 hr), *Daphnia magna*	S, U	-	-	1,120,000	-	Canton and Adema 1978
Cladoceran (<24 hr), *Daphnia magna*	S, U	-	-	1,570,000	-	Canton and Adema 1978
Cladoceran (<24 hr), *Daphnia magna*	S, U	-	-	1,940,000	-	Canton and Adema 1978
Cladoceran (<24 hr), *Daphnia magna*	S, U	-	-	1,120,000	-	Canton and Adema 1978
Cladoceran (<24 hr), *Daphnia magna*	S, U	-	-	1,140,000	-	Canton and Adema 1978
Cladoceran (<24 hr), *Daphnia magna*	S, U	-	-	1,080,000	-	Slooff et al. 1983

Table 1. (continued)

Species	Method[a]	Chemical	Hardness (mg/L as $CaCO_3$)	LC50 or EC50 (µg/L)	Species Mean Acute Value (µg/L)	References
Cladoceran, *Daphnia magna*	S, U	-	-	944,000	1,234,000	Dowden and Bennett 1965
Cladoceran (<24 hr), *Daphnia pulex*	S, U	-	-	530,000	-	Canton and Adema 1978
Cladoceran (<24 hr), *Daphnia pulex*	S, U	-	-	630,000	-	Canton and Adema 1978
Cladoceran (<24 hr), *Daphnia pulex*	S, U	-	-	575,000	57~~7~~5,000	Slooff et al. 1983
Carp (juvenile), *Cyprinus carpio*	S, U	-	75-90	26,000	26,000	Rao et al. 1975
Fathead minnow (juvenile), *Pimephales promelas*	S, U	-	-	91,510	-	Brooke 1987
Fathead minnow (juvenile), *Pimephales promelas*	S, M[b]	-	-	94,810	-	Brooke 1987
Fathead minnow (juvenile), *Pimephales promelas*	F, M	-	-	93,800	-	Brooke 1987; Geiger et al. 1986

Table 1. (continued)

Species	Method[a]	Chemical	Hardness (mg/L as $CaCO_3$)	LC50 or EC50 (µg/L)	Species Mean Acute Value (µg/L)	References
Fathead minnow (juvenile), *Pimephales promelas*	F, M	-	-	106,000	99,700	Brooke 1987; Geiger et al. 1986
African clawed frog (mid-blastula embryo), *Xenopus laevis*	R, U	-	-	1,200,000[c]	-	Davis et al. 1981
African clawed frog (tailbud embryo), *Xenopus laevis*	R, U	-	-	2,460,000[c]	-	Davis et al. 1981
African clawed frog (larva), *Xenopus laevis*	R, U	-	-	1,090,000	1,090,000	Davis et al. 1981

Table 1. (continued)

Species	Method[a]	Chemical	Salinity (g/kg)	LC50 or EC50 (µg/L)	Species Mean Acute Value (µg/L)	References
			SALTWATER SPECIES			
Mysid (<96 hr), *Mysidopsis bahia*	S, U	- (>99%)	32.0	232,380	232,380	Carr 1987

[a] S = Static; R = Renewal; F = Flow-through; M = Measured; U = Unmeasured.
[b] Based upon 0-hr measurement only.
[c] Values for insensitive life-stages were not used in calculation of Species Mean Acute Value.

Table 2. Ranked Genus Mean Acute Values with Species Mean Acute-Chronic Ratios

Rank[a]	Genus Mean Acute Value (µg/L)	Species	Species Mean Acute Value (µg/L)[b]	Species Mean Acute-Chronic Ratio
5	1,090,000	African clawed toad, *Xenopus laevis*	1,090,000	-
4	834,800	Cladoceran, *Daphnia magna*	1,234,000	-
		Cladoceran, *Daphnia pulex*	577,000	
3	232,380	Mysid, *Mysidopsis bahia*	232,380	-
2	99,700	Fathead minnow, *Pimephales promelas*	99,700	-
1	26,000	Carp, *Cyprinus carpio*	26,000	-

[a] Ranked from most resistant to most sensitive based on Genus Mean Acute Value.
[b] From Table 1.

Advisory Acute Value = (26,000 µg/L)/ 9.0 = 2,890 µg/L.

Advisory Acute-Chronic Ratio = 25

Advisory Concentration = (2,890 µg/L)/ 25 = 116 µg/L

Table 3. Other Data on Effects of Pyridine on Aquatic Organisms

Species	Chemical	Hardness (mg/L as $CaCO_3$)	Duration	Effect	Concentration (µg/L)	Reference
FRESHWATER SPECIES						
Bacterium, *Pseudomonas putida*	-	-	16 hr	Incipient inhibition	340,000	Bringmann 1973; Bringmann and Kuhn 1977a,1980b
Blue-green alga, *Microcystis aeruginosa*	-	-	8 days	Incipient inhibition	28 ~~38~~,000	Bringmann and Kuhn 1978a,b
Green alga, *Selenastrum capricornutum*	-	-	4 hr	No effect on photosynthesis	1,000,000	Giddings 1979
Green alga, *Scenedesmus quadricauda*	-	-	8 days	Incipient inhibition	120,000	Bringmann and Kuhn 1977a;1978a,b;1980b
Protozoan, *Chilomonas paramaecium*	-	-	48 hr	Incipient inhibition	3,900	Bringmann et al. 1980
Protozoan, *Entosiphon sulcatum*	-	-	72 hr	Incipient inhibition	3,500	Bringmann 1978; Bringmann and Kuhn 1980b; Bringmann et al. 1980

Table 3. (continued)

Species	Chemical	Hardness (mg/L as $CaCO_3$)	Duration	Effect	Concentration (µg/L)	Reference
Protozoan, _Tetrahymena pyriformis_	-	-	72 hr	EC50 (growth)	1,211,800	Schultz et al. 1980; Schultz and Allison 1979
Protozoan, _Tetrahymena pyriformis_	-	-	60 hr	EC50 (growth)	1,678,580	Schultz and Moulton 1984,1985a,b
Protozoan, _Uronema parduczi_	-	-	20 hr	Incipient inhibition	183,000	Bringmann and Kuhn 1980a; Bringmann et al. 1980
Hydra, _Hydra oligactis_	-	-	48 hr	LC50	1,150,000	Slooff 1983; Slooff et al. 1983
Planarian, _Dugesia lugubris_	-	-	48 hr	LC50	1,900,000	Slooff 1983
Snail, _Lymnaea stagnalis_	-	-	48 hr	LC50	350,000	Slooff 1983; Slooff et al. 1983
Cladoceran, _Daphnia magna_	-	-	24 hr	EC50 (immobility)	495,000	Gorbi 1984
Cladoceran, _Daphnia magna_	-	-	30 days	Reduction in reproduction	50,000	Gorbi 1984

Table 3. (continued)

Species	Chemical	Hardness (mg/L as $CaCO_3$)	Duration	Effect	Concentration (µg/L)	Reference
Cladoceran, *Daphnia magna*	-	-	30 day	Reduction in survival	50,000	Gorbi 1984
Cladoceran, *Daphnia magna*	-	-	30 day	Reduction in growth	50,000	Gorbi 1984
Cladoceran, *Daphnia magna*	-	-	30 day	No significant effects	25,000	Gorbi 1984
Cladoceran, *Daphnia magna*	-	-	30 day	Chronic value	35,400	Gorbi 1984
Mayfly (larva), *Cloeon dipterum*	-	-	48 hr	LC50	165,000	Slooff 1983
Mosquito (larva), *Aedes aegypti*	-	-	48 hr	EC50 (immobility)	130,000	Slooff et al. 1983
Mosquito (larva) *Culex pipiens*	-	-	48 hr	EC50 (immobility)	66,000	Slooff et al. 1983
Rainbow trout, *Salmo gairdneri*	-	-	48 hr	LC50	560,000	Slooff et al. 1983
Fathead minnow, *Pimephales promelas*	-	-	48 hr	LC50	115,000	Slooff et al. 1983
Guppy, *Poecilia reticulata*	-	-	48 hr	LC50	1,390,000	Slooff et al. 1983

Table 3. (continued)

Species	Chemical	Hardness (mg/L as $CaCO_3$)	Duration	Effect	Concentration (µg/L)	Reference
Bluegill, *Lepomis macrochirus*	-	-	48 hr	No effect on flavor	10,000	Shumway and Palensky 1973
Bluegill, *Lepomis macrochirus*	-	-	48 hr	Reduced flavor quality	100,000	Shumway and Palensky 1973
Clawed-toad (larva), *Xenopus laevis*	-	-	48 hr	LC50	1,400,000	Slooff and Baerselman 1980; Slooff et al. 1983

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SECTION V. EPA CONTACTS

AQUATIC LIFE ADVISORIES

For further information regarding the aquatic life and fish and water exposure advisories contact:

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