ENVIRONMENTAL CONTAMINANTS ENCYCLOPEDIA

p-XYLENE ENTRY

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Like a library or many large databases (such as EPA's national STORET water quality database), this document contains information of variable quality from very diverse sources. In compiling this document, mistakes were found in peer reviewed journal articles, as well as in databases with relatively elaborate quality control mechanisms [366,649,940]. A few of these were caught and marked with a "[sic]" notation, but undoubtedly others slipped through. The [sic] notation was inserted by the editors to indicate information or spelling that seemed wrong or misleading, but which was nevertheless cited verbatim rather than arbitrarily changing what the author said.

Most likely additional transcription errors and typos have been added in some of our efforts. Furthermore, with such complex subject matter, it is not always easy to determine what is correct and what is incorrect, especially with the "experts" often disagreeing. It is not uncommon in scientific research for two different researchers to come up with different results which lead them to different conclusions. In compiling the Encyclopedia, the editors did not try to resolve such conflicts, but rather simply reported it all.

It should be kept in mind that data comparability is a major problem in environmental toxicology since laboratory and field methods are constantly changing and since there are so many different "standard methods" published by EPA, other federal agencies, state agencies, and various private groups. What some laboratory and field investigators actually do for standard operating practice is often a unique combination of various standard protocols and impromptu "improvements." In fact, the interagency task force on water methods concluded that [1014]:

> It is the exception rather than the rule that water-quality monitoring data from different programs or time periods can be compared on a scientifically sound basis, and that...
>
> No nationally accepted standard definitions exist for water quality parameters. The different organizations may collect data using identical or standard methods, but identify them by different names, or use the same names for data collected by different methods [1014].

Differences in field and laboratory methods are also major issues related to (the lack of) data comparability from media other than water: soil, sediments, tissues, and air.

In spite of numerous problems and complexities, knowledge is often power in decisions related to chemical contamination. It is therefore often helpful to be aware of a broad universe of conflicting results or conflicting expert opinions rather than having a portion of this information arbitrarily censored by someone else. Frequently one wants to know of the existence of information, even if one later decides not to use it for a particular application. Many would like to see a high percentage of the information available and decide for themselves what to throw out, partly because they don't want to seem uniformed or be caught by surprise by potentially important information. They are in a better position if they can say: "I knew about that data, assessed it based on the following quality assurance criteria, and decided not to use it for this application." This is especially true for users near the end of long decision processes, such as hazardous site cleanups, lengthy ecological risk assessments, or complex natural resource damage assessments.

For some categories, the editors found no information and inserted the phrase "no information found." This does not necessarily mean that no information exists; it simply means that during our efforts, the editors found none. For many topics, there is probably information "out there" that is not in the Encyclopedia. The more time that passes without encyclopedia updates (none are planned at the moment), the more true this statement will become. Still, the Encyclopedia is unique in that it contains broad ecotoxicology information from more sources than many other reference documents. No updates of this document are currently planned. However, it is hoped that most of the information in the encyclopedia will be useful for some time to come even without updates, just as one can still find information in the 1972 EPA Blue Book [12] that does not seem well summarized anywhere else.

Although the editors of this document have done their best in the limited time available to insure accuracy of quotes or summaries as being "what the original author said," the proposed interagency funding of a bigger project with more elaborate peer review and quality control steps never materialized.

> The bottom line: The editors hope users find this document useful, but don't expect or depend on perfection herein. Neither the U.S. Government nor the National Park Service make any claims that this document is free of mistakes.

The following is one chemical topic entry (one file among 118). Before utilizing this entry, the reader is strongly encouraged to read the README file (in this subdirectory) for an introduction, an explanation of how to use this document in general, an explanation of how to search for power key section headings, an explanation of the organization of each entry, an information quality discussion, a discussion of copyright issues, and a listing of other entries (other topics) covered.

See the separate file entitled REFERENC for the identity of numbered references in brackets.

HOW TO CITE THIS DOCUMENT: As mentioned above, for critical applications it is better to obtain and cite the original publication after first verifying various data quality assurance concerns. For more routine applications, this document may be cited as:

> **Irwin, R.J., M. VanMouwerik, L. Stevens, M.D. Seese**, and **W. Basham.** 1997. Environmental Contaminants Encyclopedia. National Park Service, Water Resources Division, Fort Collins, Colorado. Distributed within the Federal Government as an Electronic Document (Projected public availability

on the internet or NTIS: 1998).

Xylene, p- (p-Xylene, para-xylene, CAS number 106-42-3)

NOTE: The majority of the information in this entry is on the p- isomer of xylene. However, "xylene or xylenes" are often a mixture of ortho-, meta-, and para- isomers. The information on isomers is sometimes difficult to separate and the information on mixed xylenes or total xylenes is of some interest in considering p-xylene. Where information on p-xylene is lacking, consult corresponding sections in the more general "Xylenes, Total" entry.

Brief Introduction:

Br.Class: General Introduction and Classification Information:

Xylenes (mixed isomers) are considered volatile organic compounds (VOCs) [868,903]. Xylenes are C2 Benzenes, one class of alkyl benzenes.

Xylene, a widely used industrial solvent, is a mixture of ortho-, meta-, and para- isomers [366].

Xylene produced from petroleum ... contains approx 20% o-xylene, 44% m-xylene, 20% p-xylene, and 15% ethylbenzene. Xylene from coal tar generally consists of 10-15% ortho-xylene, 45-70% meta-xylene, 23% para-xylene, and 6-10% ethylbenzene [366].

While o-xylene is recognized as a distinct product in chemical analyses, the m- and p- isomers are generally not separated during most routine analyses. Therefore, results of analyses of xylenes in environmental samples are usually presented as the concentration of the o-isomer and the total concentration of the combined m- and p- isomers [602].

p-Xylene and m-xylene cannot be separated by distillation because their boiling points are too close. [Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 24(84) 711] [609].

According to the USCG Emergency Response Notification System (1993), p-xylene was one of the top most spilled non-petroleum chemicals in U.S. waters, by volume released [635].

Designated as a hazardous substance under section 311(b)(2)(A) of the Federal Water Pollution Control Act and further regulated by the Clean Water Act Amendments of 1977 and 1978. These regulations apply to discharges of this substance. [40 CFR 116.4 (7/1/88)] [609].

Br.Haz: General Hazard/Toxicity Summary:

This compound often occurs together with other aromatic compounds, some possibly more hazardous than this compound alone (see entries for Benzene and "PAHs as a group").

Except for short term hazards from concentrated spills, this compound has been more frequently associated with risk to humans than with risk to non-human species such as fish and wildlife. This is partly because only very small amounts are taken up by plants, fish, and birds and because this volatile compound tends to evaporate into the atmosphere rather than persisting in surface waters or soils [764]. However, volatiles such as this compound have can pose a drinking water hazard when they accumulate in ground water.

Humans are exposed to p-xylene primarily from air, particularly in areas with heavy traffic, near filling stations, near industrial sources such as refineries or where p-xylene is used as a solvent. Exposure may also arise from drinking contaminated well water such as might occur near leaking underground gasoline storage tanks or from spills of petroleum products. (SRC) [609].

Information on Xylenes in general:

In animals, large amounts of xylene can cause changes in the liver and harmful effects on the kidneys, heart, lungs, and nervous system [764].

Long term exposures of animals to low doses of xylene have not been well studied [764].

The Canadian government (1993) concluded that xylenes are not ordinarily entering the Canadian environment in concentrations that might be expected to cause adverse effects to aquatic biota, terrestrial wildlife, humans, or to depletion of stratospheric ozone (exceptions might be spills or other direct releases) [602].

Additional human health issues related to xylenes have been summarized by ATSDR (not all the highlights from ATSDR have been summarized in this entry) [764].

Br.Car: Brief Summary of Carcinogenicity/Cancer Information:

This compound often occurs together with other aromatic compounds, some possibly more carcinogenic than this compound alone (see entries for Benzene and "PAHs as a group").

Information on Xylenes in general:

Additional human health issues related to xylenes have been summarized by ATSDR (not all the highlights from ATSDR have been summarized in this entry) [764].

EPA 1996 IRIS database information [893]:

Evidence for classification as to human carcinogenicity; weight-of-evidence classification

Classification: D; not classifiable as to human carcinogenicity

BASIS: Orally administered technical xylene mixtures did not result in significant increases in incidences in tumor responses in rats or mice of both sexes.

HUMAN CARCINOGENICITY DATA

None.

ANIMAL CARCINOGENICITY DATA

Inadequate.

Xylene (mixed isomers) has not been treated as a carcinogen for model calculation purposes in some EPA risk-based (RBC and PRG) models [868,903], but this tentative distinction was made for the purpose of choosing a modeling scenario based on current (often inadequate) knowledge rather than for the purpose of strongly stating that this compound is definitely not a carcinogen; the non-carcinogenic benchmarks are sometimes nearly as low as the carcinogenic benchmarks (Stan Smucker, personal communication, EPA, 1996).

Br.Dev: Brief Summary of Developmental, Reproductive, Endocrine, and Genotoxicity Information:

p-Xylene produced toxic developmental effects in rats, mice and cod fish; toxic reproductive effects in cod; and disrupted hormonal balance in rats [609].

Information on Xylenes in general:

In limited studies thus far, the individual isomers were not found to be genotoxic when tested in a number of short-term tests [366].

Some information on immunological, reproductive, fetotoxic, and developmental effects points towards some negative effects of xylene, but the information is limited and mixed [764]. Xylene does not appear to be particularly genotoxic [764].

Br.Fate: Brief Summary of Key Bioconcentration, Fate, Transport, Persistence, Pathway, and Chemical/Physical Information:

Environmental Fate/Exposure Summary [609]:

p-Xylene will enter into the atmosphere primarily from fugitive emissions and exhaust connected with its use in gasoline. Industrial sources include emissions from petroleum refining and its use as a solvent and chemical intermediate. Discharges and spills on land and waterways result from its use in diesel fuel and gasoline and the storage and transport of petroleum products. Most of the p-xylene is released into the atmosphere where it may photochemically degrade by reaction with hydroxyl radicals (half-life 1.7-18 hr). The dominant removal process in water is volatilization. p-Xylene is moderately mobile in soil and may leach into groundwater where it is known to persist for several years despite some evidence that it biodegrades in both soil and groundwater. Bioconcentration is not expected to be significant. The primary source of exposure is from air, especially in areas with high traffic. (SRC)

Information on Xylenes in general:

Like benzene and toluene, xylenes are fairly volatile, and significant xylenes tend to quickly evaporate if exposed to the atmosphere [764]. However, xylenes can be more persistent when in groundwater, sediment, or soil media not directly exposed to atmosphere. Xylenes tend to migrate to groundwater, and persistence is an issue in groundwater, where in some cases, they may persist for months or years [764].

Most xylene in surface water evaporates into the air in less than a day. The rest of it biodegrades slowly into other chemicals. Only very small amounts are taken up by plants, fish, and birds. We do not know exactly how long xylene stays in water, but we do know that it stays longer in groundwater than in lakes and rivers, probably because it can evaporate from the latter [764].

Xylene evaporates from soil surfaces. Xylene below the soil surface stays there for several days and may travel down through the soil and enter groundwater. In the soil and groundwater it may be slowly biodegraded into less harmful compounds. It is not clearly known how long xylene trapped deep underground in soil or groundwater persists, but it may be months or years. Xylene stays longer in wet soil than in dry soil [764].

Xylenes are bioconcentrated in aquatic organisms to a limited extent. Although more information on bioconcentration would be helpful, the phenomenon of biomagnification is not expected to be important for xylene [764].

Synonyms/Substance Identification:

1,4-Dimethylbenzene [609]
1,4-Xylene [609]
Benzene, 1,4-dimethyl- [609]
p-Dimethylbenzene [609]
p-Methyltoluene [609]
Scintillar [609]
p-XYLOL [609]
AI3-52255 [609]

Molecular Formula:
C8-H10 [609]

Associated Chemicals or Topics (Includes Transformation Products):

See also the individual entries:

Xylenes, Total
Xylene, m-
Xylene, o-
BTEX
Ethylbenzene

Metabolism/Metabolites [609]:

Generally, the xylenes are metabolized to corresponding o-, m-, p-toluic acids ... & Excreted in urine free or conjugated with glycine as methylhippuric acid. ... A linear relationship was found between atmospheric xylene concn & excreted toluic acid. /Xylene/ [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 3296].

/When admin to rabbit, rat & guinea pig/ p-xylene was excreted as p-toluic acid deriv, but also a 2,5-dimethylphenol glucuronide was isolated ... According to one report, o-, m-,

& p-xylene, in decreasing order, are demethylated to phenol. Generally, the xylenes are metabolized to corresponding o-, m-, p-toluic acids ... & Excreted in urine free or conjugated with glycine as methylhippuric acid. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 3298].

Rats given single ip injection of p-xylene suffered 65% loss of pulmonary microsomal p-xylene hydroxylase activity. Pretreatment with phenobarbital incr hepatic p-xylene hydroxylase & cytosolic aldehyde dehydrogenase activities but had no effect on alc dehydrogenase activity in hepatic cytosol. Experiments in vitro showed that inactivation of cytochrome p450 by p-xylene required metabolic conversion of p-xylene to p-tolualdehyde. In as much as lung tissue cannot form p-tolualdehyde (because of low activity of p-methylbenzyl alc dehydrogenase), it is assumed that inactivation of lung enzymes in vivo following exposure to p-xylene was due to the aldehyde intermediate which is formed in the liver and transported to the lung. [PATEL JM ET AL; DRUG METAB DISPOS 6 (4): 368-74 (1978)].

In humans ... Exposed to approx 0.2-0.4 Mg/l xylene isomers (o-, m-, p-xylene) or 1:1:1 mixt for up to 8 hr ... Pulmonary retention was 64%, which was ... Independent of dosage or duration of exposure. After exposure, only 5% of retained xylenes were elim in expired air. More than 95% ... Excreted by humans into urine in form of methylhippuric acids. ... Small portion ... Excreted into urine as corresponding xylenols. [National Research Council. Drinking Water and Health. Volume 3. Washington, DC: National Academy Press, 1980. 179].

Pseudomonas aeruginosa converts p-xylene into p-methylbenzyl alcohol & possibly further to methylbenzoic acid. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 3298]

Metab of p-xylene (100 umol) studied in isolated, perfused rabbit livers and lungs. Release of p-tolualdehyde into circulation did not occur in perfused rabbit livers. P-toluric acid (n-p-toluylglycine) was major hepatic metabolite, with smaller amt of toluic acid & p-methylbenzyl alcohol. Rabbit livers did not produce detectable amt of p-tolualdehyde, 2,5-dimethylphenol or any glucuronide conjugates. One major pulmonary metab was p-methylbenzyl alc. Predominance of this metab reflects deficiency of lung tissue in alc dehydrogenase. Perfused lung also produced 2,5-dimethylphenol a derivative not produced in the liver. During p-xylene metab in perfused lungs, derivatives which became covalently bound to lung proteins were formed which suggests that p-xylene metab might proceed at least partially through reactive intermediate(s) causing destruction of pulmonary cytochrome p450. Metab was also characterized using reconstituted monooxygenase systems containing purified rabbit pulmonary lung cytochrome p450 (i) & (II). [SMITH BR ET AL; J PHARMACOL EXP THER 223 (3): 736-42 (1982)].

The involvement of sequential side-chain oxidn, sulfation, & glutathione conjugation in formation of mercapturic acids from xylenes was investigated. The position of methyl groups attached to the aromatic nucleus affected metabolism. Factors that are involved in high yield of mercapturic acids after admin of o-xylene as compared to m-xylene & p-xylene incl relatively low apparent affinity of o-methylbenzyl alcohol for cytosolic alcohol dehydrogenase, the relatively high apparent affinity of o-methylbenzyl alc for cytosolic sulfotransferase, & the high electrophilic reactivity of the o-methylbenzyl sulfate. [VAN DOORN R ET AL; J APPL TOXICOL 1 (4): 236-42 (1981)].

Meta & para isomers are ... Extensively oxidized to toluic acids (about 90% of the dose), & these are conjugated mostly with glycine. Hydroxylation to corresponding xylenols also occurs to a small extent. [Parke, D. V. The Biochemistry of Foreign Compounds. Oxford: Pergamon Press, 1968. 218].

Water Data Interpretation, Concentrations and Toxicity (All Water Data Subsections Start with "W."):

W.Low (Water Concentrations Considered Low):

No information found. See entry entitled "Xylenes, Total."

W.High (Water Concentrations Considered High):

The highest concentrations of xylenes in groundwater in Canada have been recorded near waste disposal sites, including beneath landfill sites (from 0.2 to 191 ug/L m- and p-xylenes combined), near deep injection wells formerly used for the disposal of liquid industrial waste, and near an active industrial chemical waste disposal lagoon (up to 3100 ug/L m- and p-xylenes combined [602].

W.Typical (Water Concentrations Considered Typical):

m- And p-xylene concentrations of 50 ug/L were measured in eight test wells in Ontario, Canada. The xylene was most likely a result of natural bituminous deposits [602].

Information from HSDB [609]:

DRINKING WATER: In a survey of 30 Canadian water treatment facilities, the avg value of p-xylene combined with ethyl benzene was (1 ppb with a maximum value of 10 ppb and 30% of the supplies pos(1). The raw water for the supplies had a lower max concn of <1 ppb(1). p-Xylene has been qualitatively detected in the municipal drinking water supplies of Cleveland, OH(2), Philadelphia, PA(3), Washington, DC(4), Tuscaloosa, AL and Houston, TX(5). [(1) Otson R et al; J Assoc Off Anal Chem 65: 1370-4 (1982) (2) Sanjivamurthy VA; Water Res 12: 31-3 (1978) (3) Suffet IH et al; p 375-97 in Identification and Analysis of Organic Pollutants in Water. Keith H ed. Ann Arbor, MI: Ann Arbor Press (1976) (4) Saunders RA et al; Water Res 9: 1143-5 (1975) (5) Bertsch W et al; J Chromatogr 112: 701-8 (1975) [609].

DRINKING WATER: In a survey of organics in drinking water derived from groundwater sources, p- and o-xylene combined were found in 2.1% of 280 sample sites suppyling <10,000 persons and 1.1% of 186 sites supplying >10,000 persons. The max combined concn were 0.59 and 0.91 ppb, respectively(1). The max combined amount of m- and p-xylene in bank filtered Rhine R water in the Netherlands was 0.1 ppb(2). In 6 drinking water wells near a landfill, 0.3-2.1 ppb of p-xylene was found(3). Detected in all 14 drinking water studies in the lowland of Great Britain, 10 from surface water sources and 4 from ground supplies(4). [(1) Westrick JJ; J Amer Water Works Assoc 76: 52-9 (1984) (2) Piet GR, Morra CF; pp 31-42 in Artifical Groundwater Recharge. Huisman L, Olsthorn TN eds. Pitman Publ (1983) (3) DeWalle FB, Chian ESK; J Amer Water Works Assoc 73: 206 -11 (1981) (4) Fielding M et al; Organic Micropollutants in Drinking Water. TR-159. Medmenham, UK Water Res Ctr (1981) [609].

GROUNDWATER: In groundwater under a landfill in Norman, OK - 0.9 ppb(1) and under a rapid infiltration site in Phoenix, AZ - 0.10-49 ppb(2); under a coal gasification site in Wyoming 15 months after gasification complete - 240-830 ppb(3). In a recovery well from a landfill 7 years after closing - 2.9 ppb p-xylene(4). [(1) Dunlap WJ et al; pp 96-110 in Organic Pollutants Contributed to Groundwater by a Landfill. USEPA-600/9-76-004 (1976) (2) Tomson MB et al; Water Res 15: 1109-16 (1981) (3) Stuermer DH et al; Environ Sci Technol 16: 582-7 (1982) (4) DeWalle FB, Chian ESK; J Amer Water Works Assoc 73: 206-11 (1981) [609].

SURFACE WATER: In the raw water supplies for 30

Canadian treatment facilities, 23% contained a combination of p-xylene and ethyl benzene which averaged <1 ppb and whose max value was <1 ppb in summer and 2 ppb in winter(1). Detected, not quantified in the Black Warrior River in Tuscaloosa, AL(2) and the Glatt River in Switzerland(3). [(1) Otson R et al; J Assoc Off Anal Chem 65: 1370-4 (1982) (2) Bertsch W et al; J Chromatogr 112: 701-8 (1975) (3) Zuercher F, Giger W; Vom Wasser 47: 37-55 (1976) [609].

SEAWATER: In Vineland Sound, MA, samples taken over 15 months ranged from 4.5-66 parts per trillion for the p- and m-xylene combined(1). In open and coastal sections of the Gulf of Mexico, 2.7-24.4 parts per trillion for the p- and m-isomers, combined(2). [(1) Gschwend PM et al; Environ Sci Technol 16: 31-8 (1982) (2) Sauer TC Jr et al; Mar Chem 7: 1-16 (1978) 6. RAIN/SNOW: West Los Angeles, CA, 9 parts per trillion(1). [(1) Kawamura K, Kaplan IR; Environ Sci Technol 17: 497-501 (1983) [609].

W.Concern Levels, Water Quality Criteria, LC50 Values, Water Quality Standards, Screening Levels, Dose/Response Data, and Other Water Benchmarks:

W.General (General Water Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Water Concentrations Versus Mixed or General Aquatic Biota):

The Netherlands' Maximum Permissable Concentration (MPC) for p-xylene for the protection of all species in an aquatic ecosystem is 400 ug/L [655].

The Netherlands' Negligible Concentration (NC) for p-xylene is 1% of the MPC, or 4.0 ug/L [655].

NOTE: Above values are based on ecotoxicological data.

The Netherlands' Harmonized (between media) Maximum Permissible Concentration (MPC) for either 0-xylene, m-xylene, or p-xylene in water is 380 ug/L [655].

Note: Harmonization takes into account whether or not the MPC in one media (such as soil) would lead to exceeding the MPC in another media (such as air, water, or sediment) [655].

The Netherlands' Harmonized (between media)

Negligible Concentration (NC) for either o-xylene, m-xylene, or p-xylene in water is 1% of the MPC, or 3.8 ug/L [655].

W.Plants (Water Concentrations vs. Plants):

No information found. See entry entitled "Xylenes, Total."

W.Invertebrates (Water Concentrations vs. Invertebrates):

The most sensitive freshwater organism was the water flea (Daphnia magna) with a 24-hour LC50 of 3.6 mg/L for p-xylene. Among marine organisms, the most sensitive species was the bay shrimp (Crago franciscorum) with a 96-hour LC50 of 1.7 mg/L for p-xylene [602].

LC100 Tetrahymena pyriformis (ciliate) 3.77 mmole/l/24 hr /Conditions of bioassay not specified/ [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1194] [609].

LC50 Crangon franciscorum (shrimp) 2.0 ppm/96 hr /Conditions of bioassay not specified/ [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1194] [609].

W.Fish (Water Concentrations vs. Fish):

The most sensitive freshwater fish was the rainbow trout (Oncorhynchus mykiss) with a 96-hour LC50 of 2.6 mg/L for the p- isomer. The most sensitive marine species tested was the young of the striped bass (Morone saxatilis) with a 96-hour LC50 of 1.7 mg/L for the p- isomers [602].

Information from HSDB [609]:

LC50 Poecilia reticulata (guppy) 35 ppm/7 day /Conditions of bioassay not specified/ [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1194].

TLm Bluegill fresh water 22 ppm/96 hr /Conditions of bioassay not specified/ [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Manual Two. Washington, DC: U.S. Government Printing Office, Oct., 1978.].

LC50 Morone saxatilis (bass) 2.0 ppm/96 hr /Conditions of bioassay not specified/ [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1194].

LD50 Goldfish 18 mg/l/24 hr /Modified ASTM D 1345 method/ [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1194].

TLm Fathead minnow 27-29 mg/l/24-96 hr. /Conditions of bioassay not specified/ [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1194].

Cod eggs were exposed to seawater solutions of xylenes. Treatment during fertilization with m-xylene or p-xylene induced significant decr in fertilization rate at concentrations greater than 10 ppm. Fertilized eggs were exposed 3 hr or 6 hr before 1st cleavage. Effects upon the early cleavage pattern were significant from a concn interval of 2-7 ppm. Characteristic effects incl inhibition of formation of cleavage furrow. Small cells or total absence of cleavage occurred in highest concentrations (16-35 ppm), while at 8-15 ppm, incomplete or uneven cleavage was usual. Exposure to lower concentrations could give a very wrinkled cleavage membrane. [KJOERSVIK E ET AL; SARSIA 67 (4) : 299-308 (1982) [609].

W.Wildlife (Water Concentrations vs. Wildlife or Domestic Animals):

No information found. See entry entitled "Xylenes, Total."

W.Human (Drinking Water and Other Human Concern Levels):

California's Action Limit for p-xylene in drinking water is 0.620 mg/L [859].

EPA Region 9 Preliminary remediation goal (PRG) for Tap Water, 1995 [868]: No information given.

EPA Region 3 risk based concentration (RBC) value for drinking water: 520 ug/L [903].

W.Misc. (Other Non-concentration Water Information):

No information found. See entry entitled "Xylenes, Total."

Sediment Data Interpretation, Concentrations and Toxicity (All Sediment Data Subsections Start with "Sed."):

Sed.Low (Sediment Concentrations Considered Low):

No information found. See entry entitled "Xylenes, Total."

Sed.High (Sediment Concentrations Considered High):

No information found. See entry entitled "Xylenes, Total."

Sed.Typical (Sediment Concentrations Considered Typical):

In unspecified sediment 100 ppb(1). [(1) Storet Data Base [609].

Sed.Concern Levels, Sediment Quality Criteria, LC50 Values, Sediment Quality Standards, Screening Levels, Dose/Response Data and Other Sediment Benchmarks:

Sed.General (General Sediment Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Sediment Concentrations Versus Mixed or General Aquatic Biota):

Based on equilibrium partitioning, the Netherlands' Maximum Permissable Concentration (MPC) for p-xylene for the protection of all sediment-dwelling organisms is 11 mg/kg dry weight [655].

Based on equilibrium partitioning, the Netherlands' Negligible Concentration (NC) for p-xylene is 1% of the MPC, or 0.11 mg/kg dry weight [655].

The above values based on ecotoxicity considerations.

The Netherlands' Harmonized (between media) Maximum Permissible Concentration (MPC) for either o-xylene, m-xylene, or p-xylene in sediments is 14 mg/kg [655].

Note: Harmonization takes into account whether or not the MPC in one media (such as soil) would lead to exceeding the MPC in another media (such as air, water, or sediment) [655].

The Netherlands' Harmonized (between media) Negligible Concentration (NC) for either o-xylene, m-xylene, or p-xylene in sediments is 1% of the MPC, or 0.14 mg/kg [655].

Sed.Plants (Sediment Concentrations vs. Plants):

No information found. See entry entitled "Xylenes, Total."

Sed.Invertebrates (Sediment Concentrations vs. Invertebrates):

No information found. See entry entitled "Xylenes, Total."

Sed.Fish (Sediment Concentrations vs. Fish):

No information found. See entry entitled "Xylenes, Total."

Sed.Wildlife (Sediment Concentrations vs. Wildlife or Domestic Animals):

No information found. See entry entitled "Xylenes, Total."

Sed.Human (Sediment Concentrations vs. Human):

No information found. See entry entitled "Xylenes, Total."

Sed.Misc. (Other Non-concentration Sediment Information):

No information found. See entry entitled "Xylenes, Total."

Soil Data Interpretation, Concentrations and Toxicity (All Soil Data Subsections Start with "Soil."):

Soil.Low (Soil Concentrations Considered Low):

No information found. See entry entitled "Xylenes, Total."

Soil.High (Soil Concentrations Considered High):

No information found. See entry entitled "Xylenes, Total."

Soil.Typical (Soil Concentrations Considered Typical):

No information found. See entry entitled "Xylenes, Total."

Soil.Concern Levels, Soil Quality Criteria, LC50 Values, Soil Quality Standards, Screening Levels, Dose/Response Data and Other Soil Benchmarks:

Soil.General (General Soil Quality Standards, Criteria, and Benchmarks Related to Protection of Soil-dwelling Biota in General; Includes Soil Concentrations Versus Mixed or General Soil-dwelling Biota):

Based on equilibrium partitioning, the Netherlands' Maximum Permissable Concentration (MPC) for p-xylene for the protection of all soil-dwelling organisms is 11 mg/kg dry weight [655].

Based on equilibrium partitioning, the Netherlands' Negligible Concentration (NC) for p-xylene is 1% of the MPC, or 0.11 mg/kg dry weight [655].

The Netherlands' Harmonized (between media) Maximum Permissible Concentration (MPC) for either o-xylene, m-xylene, or p-xylene in soil is 14 mg/kg [655].

Note: Harmonization takes into account whether or not the MPC in one media (such as soil) would lead to exceeding the MPC in another media (such as air, water, or sediment) [655].

The Netherlands' Harmonized (between media) Negligible Concentration (NC) for either 0-xylene, m-xylene, or p-xylene in soil is 1% of the MPC, or 0.14 mg/kg [655].

Soil.Plants (Soil Concentrations vs. Plants):

No information found. See entry entitled "Xylenes, Total."

Soil.Invertebrates (Soil Concentrations vs. Invertebrates):

No information found. See entry entitled "Xylenes, Total."

Soil.Wildlife (Soil Concentrations vs. Wildlife or Domestic Animals):

No information found. See entry entitled "Xylenes, Total."

Soil.Human (Soil Concentrations vs. Human):

EPA 1996 National Generic Soil Screening Level

(SSL) designed to be conservative and protective at the majority of sites in the U.S. but not necessarily protective of all known human exposure pathways, land uses, or ecological threats [952]:

SSL = 1.6E+05 mg/kg for ingestion pathway [952].

SSL = 460 mg/kg for inhalation pathway [952].

SSL = 10 to 200 mg/kg for protection from migration to groundwater at 1 to 20 Dilution-Attenuation Factor (DAF) [952].

EPA 1995 Region 9 Preliminary remediation goals (PRGs), 1995 [868]:

Residential Soil: 9.9E+02 mg/kg wet wt.
Industrial Soil: 9.9E+02 mg/kg wet wt.

NOTE:
1) PRGs focus on the human exposure pathways of ingestion, inhalation of particulates and volatiles, and dermal absorption. Values do not consider impact to groundwater or ecological receptors.
2) Values are based on a non-carcinogenic hazard quotient of one.
3) PRGs for residential and industrial landuses are slightly lower concentrations than EPA Region III RBCs, which consider fewer aspects [903].

EPA 1995 Region 3 Risk based concentration (RBC) to protect from transfers to groundwater:

220 mg/Kg dry weight [903].

Soil.Misc. (Other Non-concentration Soil Information):

No information found. See entry entitled "Xylenes, Total."

Tissue and Food Concentrations (All Tissue Data Interpretation Subsections Start with "Tis."):

Tis.Plants:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Plants:

No information found. See entry entitled "Xylenes, Total."

B) Body Burden Residues in Plants: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found. See entry entitled "Xylenes, Total."

Tis.Invertebrates:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Invertebrates:

No information found. See entry entitled "Xylenes, Total."

B) Concentrations or Doses of Concern in Food Items Eaten by Invertebrates:

No information found. See entry entitled "Xylenes, Total."

C) Body Burden Residues in Invertebrates: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found. See entry entitled "Xylenes, Total."

Tis.Fish:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Fish (Includes FDA Action Levels for Fish and Similar Benchmark Levels From Other Countries):

No information found. See entry entitled "Xylenes, Total."

B) Concentrations or Doses of Concern in Food Items Eaten by Fish:

No information in IRIS 1996 (EPA Database) [893] or in PRGs [868] or RBCs [903].

C) Body Burden Residues in Fish: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

Xylene has been detected in distillates of rainbow trout and in carp tissue samples from three rivers not known to be contaminated. The estimated tissue concentrations of m- and p-xylene (combined) in rainbow trout and carp were 0.05 and 0.12 mg/kg (ppm), respectively [764].

Tis.Wildlife: Terrestrial and Aquatic Wildlife, Domestic Animals and all Birds Whether Aquatic or not:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Wildlife, Domestic Animals, or Birds:

No information found. See entry entitled "Xylenes, Total."

B) Concentrations or Doses of Concern in Food Items Eaten by Wildlife, Birds, or Domestic Animals (Includes LD50 Values Which do not Fit Well into Other Categories, Includes Oral Doses Administered in Laboratory Experiments):

No information found. See entry entitled "Xylenes, Total."

C) Body Burden Residues in Wildlife, Birds, or Domestic Animals: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

Following exposure of rabbits to atmosphere of about 3,000 mg/cu m for 8 hr/day, 6 days/wk, for 130 days, xylene was found at slightly higher avg concentrations in the adrenal (148 ppm), bone marrow (130 ppm), spleen (115 ppm), & brain (100 ppm) than in blood (91 ppm) or in other organs. /Xylenes/ [Hayes, Wayland J., Jr. Pesticides Studied in Man. Baltimore/London: Williams and Wilkins, 1982. 123] [609].

Tis.Human:

A) Typical Concentrations in Human Food Survey Items:

No information found. See entry entitled "Xylenes, Total."

B) Concentrations or Doses of Concern in Food Items Eaten by Humans (Includes Allowable Tolerances in Human Food, FDA, State and Standards of Other Countries):

No information found. See entry entitled "Xylenes, Total."

C) Body Burden Residues in Humans: Typical, Elevated, or of Concern Related to the Well-being of Humans:

No information found. See entry entitled "Xylenes, Total."

Tis.Misc. (Other Tissue Information):

No information found. See entry entitled "Xylenes, Total."

Bio.Detail: Detailed Information on Bioconcentration, Biomagnification, or Bioavailability:

Bioconcentration Factors (log BCF) for p-xylene [902]:

1.17 for goldfish,
1.68 and 1.17 for fish,
2.41 for Selenastrum capricornutum (green alga)

Little bioconcentration is expected, the log BCF = 1.37 for eels(1). Based on the log octanol/water partition coefficient of 3.15(2), one estimates the log BCF in fish to be 2.2(3,SRC). [(1) Ogata M, Miyake Y; Water Res 12: 1041-4 (1978) (2) Hansch C, Leo AJ; Medchem project no. 19 Claremont CA: Pomona College (1981) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. New York, NY McGraw Hill p 5-5 (1982)] [609].

Interactions:

Information from HSDB [609]:

Sixteen men were studied in an exposure chamber to assess the effect of four hr exposure to toluene (3.25 mmole/cu m), p-xylene (2.84 mmole/cu m) a mixture of toluene and p-xylene (2.20 + 0.94 mmol/cu m) and a control condition. With the aid of microcomputers subjects performed tests of simple reaction time, short term memory, and choice reaction time immediately after entering the chamber, after two, and after four hours of exposure. The results indicate that the performance on the tests was unaffected by exposure. In the light of this result, the risk of an acute effect on central nervous functions after exposure for four hours at these concn was considered to be minimal. [Olson BA et al; Brit J Ind Med 42: 117-22 (1985)].

Eight male subjects were exptl exposed to toluene, p-xylene, and a combination of toluene and p-xylene to study the influence of coexposure and exposure to different levels of each solvent on their uptake and elimination. The exposures were performed for 4 hr at exposure levels equiv to or lower than the Swedish threshold limit value for toluene, 300 mg/cu m (3.2 mmol/cu m). During and after the exposure, solvent concn were measured in blood and in expired air. In addition, the pulmonary ventilation rate was measured during the exposure. Decreases in the blood/end exhaled air concn ratio were found for both toluene and p-xylene when given in combination compared with separate exposure. The total solvent uptake relative to the exposure level was decreased after exposure to the higher solvent concn, and the apparent clearance was also decreased after exposure to the higher concn of solvent. Finally, the blood solvent concn were lower at the end of the exposure compared with the maximal concn during each exposure condition. In the kinetics of toluene and p-xylene, the total amt of toluene or p-xylene, or both, seems to be of major importance. The change in blood/end exhaled air concn ratio may indicate an effect of coexposure. [Wallen M et al; Br J Ind Med 42 (2): 111-6 (1985)].

In vitro activation expt demonstrated that ... Rabbit hepatic but not pulmonary microsomal enzyme systems were affected by phenobarbital pretreatment. /In rabbits/ phenobarbital, 3-methylcholanthrene, & chlorpromazine raise lc50 of inhaled p-xylene, but only 3-methylcholanthrene had any effect on injected solvent. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 3298].
When consumed prior to exposure, ethanol decreases the metabolic clearance of xylene by approximately one-half. /Xylenes/ [Ellenhorn, M.J. and D.G. Barceloux. Medical Toxicology - Diagnosis and Treatment of Human Poisoning. New York, NY: Elsevier Science Publishing Co., Inc. 1988. 963

Pretreatment of rats with phenobarbital incr the ld50 of para-xylene more than 20%. [HARPER C ET AL; BIOL REACT INTERMED, (PROC INT CONF) 302-11 (1977)

Humans exposed to 46 or 92 ppm of o-, m-, p-xylene or a mixture (1:1:1) of the three for 8 hr absorbed approx 64% of the inhaled xylene. No difference in the absorption rate was reported due to level of exposure, length of exposure, or the type and/or mixture of the xylene isomers. The absorption of xylene appeared to vary among individuals due to differences in ventilation rate. ... Individuals with an incr ventilation rate retained less xylene. [NCI; Monograph on Human Exposure to Chemicals in the Workplace: Xylene p.4-2 (July/1985)].

Male Wister rats exposed to xylene in air (80% m-xylene, 12% p-xylene) for 6 hr/day, 5 days/week for 2 weeks accumulated 64.8 mg/xylene/g of perirenal fat after five exposures and 127.0 mg/xylene/g of perirenal fat after 10 exposures to xylene. [NCI; Monograph on Human Exposure to Chemicals in the Workplace: Xylene p.4-4 (July/1985)

Uses/Sources:

Major Uses [609]:

Synthesis of terephthalic acid for polyester resins and fibers ("Dacron," "Mylar," "Terylene"); pharmaceutical synthesis; insecticides [Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand

Reinhold Co., 1987. 1243].

Chem intermed for dimethyl terephthalate & terephthalic acid [SRI].

Chem intermed for dimethyl tetrachloroterephthalate-herbicide [SRI].

SOLVENT [SRI].

p-Xylene ... frequently ... used for paints or in the printing trade. [Wallen M et al; Brit J Indust Med 42: 111-6 (1985)].

Natural Occurring Sources [609]:

Petroleum(1). [(1) NAS; The Alkyl Benzenes page I-1 to I-99 (1980)].

Artificial Sources [609]:

Present in exhaust of gasoline engines at 1.9 vol% of emitted HC /m- and p-xylenes/; exhaust of diesel engines at 1.9% emitted HC /m- and p-xylene/; reciprocating gasoline engine at 1.3% of emitted HC; rotary gasoline engine at 5.6% of emitted HC /m- and p-xylene/ [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 119].

Emissions from petroleum refining, gasoline and diesel engines (1); evaporative losses during the transport and storage of gasoline and carburetor losses(1,2). Emissions from its use as a chemical intermediate in the production of dimethyl terephthalate and terephthalic acid for polyester production(3). Evaporative losses from its use as a solvent(1,2). [(1) NAS; The Alkyl Benzenes page I-1 to I-99 (1980) (2) Graedel TE; Chemical Compounds in the Atmosphere. New York Academic Press p 109 (1978) (3) Chemical Marketing Reporter Aug 22 (1983)].

Composite gasoline samples from Los Angeles m- and p-xylene combined are 6.73 wt%(1). [(1) NAS; The Alkyl Benzenes page I-1 to I-99 (1980)].

Forms/Preparations/Formulations:

Research, 99.99%; Pure, 99.8%; Technical, 99.0%. [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.] [609].

Chem.Detail: Detailed Information on Chemical/Physical Properties:

Solubilities:

78 to 223 mg/L at 25 degrees C (most values 180 to 200) [902].

Sol in alcohol, ether, acetone, benzene [Weast, R.C. (ed.) Handbook of Chemistry and Physics, 68th ed. Boca Raton, Florida: CRC Press Inc., 1987-1988.,p. C-550] [609].

Vapor Pressure:

1160 to 1206 Pa at 25 degrees C (most values near 1170) [902].

138.3 deg C @ 760 mm Hg [Weast, R.C. (ed.) Handbook of Chemistry and Physics, 68th ed. Boca Raton, Florida: CRC Press Inc., 1987-1988.,p. D-204] [609].

Henry's Law Constant:

506 to 1185 Pa m(3)/mol (most values 710 to 778) [902].

Octanol/Water Partition Coefficient, log Kow:

2.85 to 3.50 (most values near 3.15) [902].

log Kow = 3.15 (est) [Hansch, C., A. Leo. Substituent Constants for Correlation Analysis in Chemistry and Biology. New York, NY: John Wiley and Sons, 1979. 232] [609].

Sorption Partition Coefficient, log Koc:

2.05 to 3.08 (most values near 2.52) [902].

Molecular Weight:

106.17 [Weast, R.C. (ed.) Handbook of Chemistry and Physics, 68th ed. Boca Raton, Florida: CRC Press Inc., 1987-1988.,p. C-550] [609].

Density/Specific Gravity:

0.86104 @ 20 deg C/4 deg C [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1448] [609].

Boiling Point:

138.37 deg C [Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 24(84) 710] [609].

Melting Point:

13.3 deg C [Flick, E.W. Industrial Solvents Handbook. 3rd ed. Park Ridge, NJ: Noyes Publications, 1985. 6418] [609].

Color/Form:

Colorless plates or prisms at low temp [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1448] [609].

Colorless liquid [Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. 1243] [609].

Color: Saybolt units +30 (research, pure & technical grades) [Flick, E.W. Industrial Solvents Handbook. 3rd ed. Park Ridge, NJ: Noyes Publications, 1985. 49] [609].

Odor:

Sweet [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5] [609].

Fate.Detail: Detailed Information on Fate, Transport, Persistence, and/or Pathways:

Half-lives of p-xylene in surface water [902]: 168-672 hours, based on estimated aqueous aerobic biodegradation half-life.

Half-lives of p-xylene in groundwater [902]: 336-8640 hours, based on estimated aqueous aerobic and anaerobic biodegradation half-lives; estimated half-life from observed persistence in groundwater of the Netherlands, 0.3 years; abiotic hydrolysis or dehydrohalogenation half-life of 1150 months.

Half-lives of p-xylene in soil [902]: 168-672 hours based on estimated aqueous aerobic biodegradation half-life; disappearance half-life from test soils, 2.2 days.

Xylenes can be degraded by micro-organisms in the water. Half-lives for biodegradation by unacclimated organisms in water have been estimated to be between 7 and 28 days for each of the three isomers in aerobic systems, and between 28 and 112 days for m- and p-isomers in anaerobic systems [602].

Environmental Fate [609]:

TERRESTRIAL FATE: When spilled on land, p-xylene will volatilize and leach into the ground. p-Xylene may be degraded during its passage through soil. The extent of the degradation will depend on its concentration, residence time in the soil, the nature of the soil, and whether resident microbial populations have been acclimated. (SRC)

AQUATIC FATE: In surface waters, volatilization appears to be the dominant removal process (half-life 1-5.5 days(1,SRC)). Some adsorption to sediment will occur. Although p-xylene is biodegradable and has been observed to degrade in seawater, there is insufficient data to access the rate of this process in surface waters. Although it has been observed to degrade in groundwater in one study, it is known to persist for many years in groundwater, at least at sites where the concentration might have been quite high(SRC). [(1) Lyman WJ et al; Handbook of Chemical Estimation Methods. McGraw-Hill, NY p 15-1 to 15-34 (1982)].

ATMOSPHERIC FATE: When released into the atmosphere, p-xylene may degrade by reaction with photochemically produced hydroxyl radicals (half-life 1.7 hr in summer and 18 hr in winter(1)). However, ambient levels are detected because of large emission (SRC). [(1) Ravishankara AR et al; Int J Chem Kinetics 10: 783-804 (1978)].

Biodegradation [609]:

p-Xylene is degraded in standard biodegradability tests using a variety of inoculums including sewage, activated sludge and seawater(1-4). It was completely degraded within 8 days in groundwater in a gas-oil mixture; the acclimation period was 3-4 days(5). [(1) Bridie AL et al; Water Res 13: 627-30 (1979) (2) Kitano M; Biodegradation and Bioaccumulation Test on Chemical Substances, OECD Tokyo Mtg TSU-No. 3 (1978) (3) Malaney GW, McKinney RE; Water Sewage Works 113: 302-9 (1966) (4) VanderLinden AC; Dev Biodeg Hydrocarbons 1: 165-200 (1978) (5) Kappeler T, Wuhrmann K; Water Res 12: 327-33 (1978)].

Abiotic Degradation [609]:

p-Xylene reacts with hydroxyl radicals in the troposphere(1-3) with a half-life ranging from 1.7 hr in summer to 18 hr in winter(1) or a typical loss of 67%/day(3). It is moderately reactive under photochemical smog conditions with reported loss rates varying from 4-25% per hr(4-9), rates typical of its reaction with hydroxyl radicals(9). Xylenes are resistant to hydrolysis based upon the lack of hydrolyzable function. (SRC) [(1) Ravishankara AR et al; Int J Chem Kinetics 10: 783-804 (1978) (2) Hansen DA et al; J Phys Chem 79: 1763-6 (1975) (3) Singh HB et al; Atmos Environ 15: 601-12 (1981) (4) Yanagihara S et al; 4th Int Clean Air Conf: Photochemical reactivities of hydrocarbons p 472-7 (1977) (5) Dilling WL et al; Environ Sci Technol 10: 351-6 (1976) (6) Washida N et al; Bull Chem Soc Japan 51: 2215-21 (1978) (7) Kopczynski SL et al; Environ Sci Technol 6: 342 (1972) (8) Altshuller AP et al; Environ Sci Technol 4: 503-6 (1970) (9) Doyle GJ et al; Environ Sci Technol 9: 237-41 (1975) (10) VanAalst RM et al; Comm Eur Comm Symp Phys Chem Behav Atmos Poll EUR6621 1: 136-49 (1980].

Soil Adsorption/Mobility [609]:

No measured values for Koc of p-xylene could be found in the literature. However, low to moderate adsorption would be expected based on the log Kow value of 3.15(4). The measured permeability for fire clay is 1x10-9 cm/sec and a factor of 4 and 50 times faster in ranger shale and kaoline respectively(1). It has been detected in groundwater under a rapid infiltration site(2) and passed through soil at a dune-infiltration site on the Rhine River unchanged in concentration(3). [(1) Green WJ et al; J Water Pollut Control Fed 53: 1347-54 (1981) (2) Tomson MB et al; Wat Res 15:1109-16 (1981) (3) Piet GJ et al; in Quality of Groundwater. Int Symp Proc Van Duijvenbooden W et al eds; Studies Environ Sci 17: 557-64 (1981) (4) Hansch C, Leo JJ; Medchem project no. 19 Claremont CA: Pomona College (1981)].

Volatilization from Water/Soil [609]:

Using the Henry's Law constant = 0.314(1), the half-life for evaporation of p-xylene from water with a wind speed of 3 m/sec, a current of 1 m/sec, and a depth of 1 m is calculated to be 3.1 hr(2, SRC). An experiment which measured the rate of evaporation of m- and p-xylene from a 1:1000 jet fuel:water mixture found that it averaged 0.64 times the oxygen reaeration rate(3). Combining this ratio with the oxygen reaeration rates of typical bodies of water(2), one estimates that the half-life for evaporation from a typical river or pond is 27 and 135 hr, respectively(SRC). [(1) NAS; The Alkyl Benzenes II-1 to II-51 (1980) (2) Lyman WJ et al; Handbook of Chemical Estimation Methods. New York, NY McGraw Hill p 15-1 to 15-34 (1982) (3) Smith JH, Harper JC; 12th Conf on Environ Toxicol: Behavior of hydrocarbon fuels in the aquatic envionment p 336-53 (1980)].

Absorption, Distribution and Excretion [609]:

For exposure to xylene at concn averaging 100 ppm, the mean methyl hippuric acid concn should average 1.5 to 2 g/g creatinine (range 1.0-3.0) in a sample collected during the second part of the exposure period. Almost total urinary excretion of xylene occurs by 24 hours. The rapid xylene clearance from blood (plasma half-life of 4 hours) prevents adequate biological monitoring of serum samples. /Xylenes/ [Ellenhorn, M.J. and D.G. Barceloux. Medical Toxicology - Diagnosis and Treatment of Human Poisoning. New York, NY: Elsevier Science Publishing Co., Inc. 1988. 963].

Xylenes have been reported to cross the human placenta. /XYLENES/ [National Research Council. Drinking Water and Health. Volume 3. Washington, DC: National Academy Press, 1980. 180].

Xylene, when ingested, is readily absorbed by the human system, as has been shown in accidental ingestions. Absorption through intact & broken skin occurs readily. ... Xylene is absorbed mainly through mucous membranes & pulmonary system. ... Absorbed xylene is translocated through the vascular system. ... /XYLENES/ [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 3296].

Humans exposed to 46 or 92 ppm of o-, m-, p-xylene or a mixture (1:1:1) of the three for 8 hr absorbed approx 64% of the inhaled xylene. No difference in the absorption rate was reported due to level of exposure, length of exposure, or the type and/or mixture of the xylene isomers. The absorption of xylene appeared to vary among individuals due to differences in ventilation rate. ... Individuals with an incr ventilation rate retained less xylene. [NCI; Monograph on Human Exposure to Chemicals in the Workplace: Xylene p.4-2 (July/1985)].

Male Wister rats exposed to xylene in air (80% m-xylene, 12% p-xylene) for 6 hr/day, 5 days/week for 2 weeks accumulated 64.8 mg/xylene/g of perirenal fat after five exposures and 127.0 mg/xylene/g of perirenal fat after 10 exposures to xylene. [NCI; Monograph on Human Exposure to Chemicals in the Workplace: Xylene p.4-4 (July/1985)].

Laboratory and/or Field Analyses:

For optimum risk or hazard assessment work, volatile compound lab methods with very low detection limits [such as EPA Method 8260 modified for Selective Ion Mode (SIM) Enhanced Detection Limits] should be used. The investigator should also specify the addition of any relevant compounds (such as related alkyl volatiles) suspected of being present but not typically found on the standard EPA scans. In concert with need to compare values with low benchmark concentrations, the regulatory requirements of States such as Wisconsin and the capabilities of better labs, detection limits should be as low as possible and in all cases no higher than 25 ppb [913] in soil, sediment, or tissue, and if possible no higher than 1 ppb (better labs can achieve 0.3 ppb) in water. Wisconsin requires a detection limit of 0.5 ug/L for all VOCs [923].

For drinking water, in the past, EPA has recommended the following less rigorous methods for analyses of certain volatiles: Purge and trap capillary gas chromatography (EPA 502.2); gas chromatographic/mass spectrometry (EPA 524.2); purge and trap gas chromatography (EPA 503.1); gas chromatography/mass spectrometry (EPA 524.1); PQL= 0.005 mg/L [893].

Regardless of what lab methods are used, the investigator must take special precautions to prevent the escape of volatiles during sample shipment, storage, extraction, and cleanup [798]. The results of analyses of volatiles can be dramatically effected by small details such as how the samples are collected, stored, held, and analyzed in the lab, since volatile compounds can readily volatilize from samples in both field and lab procedures. The realization that better methods were needed began when the lab results of EPA methods 8020 and 8240 were negative even when contamination by volatiles was obvious in the field, in other words, when investigators began seeing clearly false negative results [798]. The use of brass liners for collection resulted in 19 fold higher VOCs than when 40 mL vials were used [798]. After researching various papers which documented volatile losses of 9 to

99% during sampling and then finding 100% losses in samples held over 14 days in their own facilities, the Wisconsin DNR requires the following for soil sampling of volatiles:

1) methanol preservation be used for all samples [913,923], and

2) samples stored in brass tubes must be preserved in methanol within 2 hours and samples stored in EN CORE samplers must be preserved in 48 hours [913,923].

3) Detection limits should be no higher than 25 ug/Kg (ppb) dry weight for VOCs or petroleum volatiles in soil samples [913].

For additional details on methods for volatiles and xylenes, and, when to choose various methods, and how to prevent loss of volatiles in the field and in the lab, see xylenes entry.

Contaminants data from different labs, different states, and different agencies, collected by different people, are often not very comparable (see also, discussion in the disclaimer section at the top of this entry, and the more detailed discussions in the xylenes entry).

It should be kept in mind that quality control field and lab blanks and duplicates will not help in the data quality assurance goal as well as intended if one is using a method prone to false negatives. Methods may be prone to false negatives due to the use of detection limits that are too high, the loss of contaminants through inappropriate handling, or the use of an inappropriate methods such as many of the EPA standard scans. This is one reason for using the NOAA expanded scan for PAHs [828]; or method 8270 [1013] modified for Selective Ion Mode (SIM) detection limits (10 ppt for water, 0.3 to 1 ppb for solids) and additional alkyl PAH analytes in response to oil spills. Alkyl PAHs are more persistent and less volatile than xylenes. Thus, rigorous low-detection-limit scans for alkyl PAHs are less prone to false negatives than many of the standard EPA high-detection-limit analyses for xylenes (Roy Irwin, National Park Service, Personal Communication, 1997).

Description of EPA standard methods 8240 and 8260 from EPA EMMI Database on Lab methods [861]:

Note: 8260 is replacing 8240 [1013].

EPA Method 8240 for Volatile Organics [861]:

OSW 8240A S Volatile Organics - Soil, GCMS 73 SW-846 GCMS ug/kg EQL Method 8240A "Volatile Organics by Gas Chromatography/Mass Spectrometry (GC/MS): Packed Column Technique" The volatile compounds are introduced into the gas chromatograph by the purge and trap method or by direct injection (in limited applications) [861]. The components are separated via the gas chromatograph and detected using a mass spectrometer, which is used to provide both qualitative and quantitative information [861]. The chromatographic conditions, as well as typical mass spectrometer operating parameters, are given [861]. If the above sample introduction techniques are not applicable, a portion of the sample is dispersed in methanol to dissolve the volatile organic constituents [861]. A portion of the methanolic solution is combined with organic-free reagent water in a specially designed purging chamber [861]. It is then analyzed by purge and trap GC/MS following the normal water method [861]. The purge and trap process - An inert gas is bubbled through the solution at ambient temperature, and the volatile components are efficiently transferred from the aqueous phase to the vapor phase [861]. The vapor is swept through a sorbent column where the volatile components are trapped [861]. After purging is complete, the sorbent column is heated and backflushed with inert gas to desorb the components, which are detected with a mass spectrometer [861].

OSW 8240A W Volatile Organics - Water, GCMS 73
SW-846 GCMS ug/L EQL Method 8240A
"Volatile Organics by Gas Chromatography/Mass Spectrometry (GC/MS): Packed Column Technique" The volatile compounds are introduced into the gas chromatograph by the purge and trap method or by direct injection (in limited applications) [861]. The components are separated via the gas chromatograph and detected using a mass spectrometer, which is used to provide both qualitative and quantitative information [861]. The chromatographic conditions, as well as typical mass spectrometer operating parameters, are given [861]. If the above sample introduction techniques are not applicable, a portion of the sample is dispersed in methanol to dissolve the volatile organic constituents [861]. A portion of the methanolic solution is combined with organic-free reagent water in a specially designed purging chamber [861]. It is then analyzed by purge and trap GC/MS following the normal water method [861]. The purge and trap process - An inert gas is bubbled through the solution at ambient temperature, and the volatile components are efficiently transferred from the aqueous phase to the vapor phase [861]. The vapor is swept through a sorbent column where the volatile components are trapped [861]. After purging is complete, the sorbent column is heated and backflushed with inert gas to desorb the components, which are detected with a mass spectrometer [861].

EPA Method 8260 (for GC/MS Volatile Organics):

EPA description [861]:

OSW 8260 Volatile Organics - CGCMS 58 SW-846 CGCMS ug/L MDL Method 8260 "Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): Capillary Column Technique" The volatile compounds are introduced into the gas chromatograph by the purge and trap method or by direct injection (in limited applications) [861]. Purged sample components are trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the sorbent tube is heated and backflushed with helium to desorb trapped sample components [861]. The analytes are desorbed directly to a large bore capillary or cryofocussed on a capillary precolumn before being flash evaporated to a narrow bore capillary for analysis [861]. The column is temperature programmed to separate the analytes which are then detected with a mass spectrometer interfaced to the gas chromatograph [861]. Wide capillary columns require a jet separator, whereas narrow bore capillary columns can be directly interfaced to the ion source [861]. If the above sample introduction techniques are not applicable, a portion of the sample is dispersed in solvent to dissolve the volatile organic constituents [861]. A portion of the solution is combined with organic- free reagent water in the purge chamber [861]. It is then analyzed by purge and trap GC/MS following the normal water method [861]. Qualitative identifications are confirmed by analyzing standards under the same conditions used for samples and comparing resultant mass spectra and GC retention times [861]. Each identified component is quantified by relating the MS response for an appropriate selected ion produced by that compound to the MS response for another ion produced by an internal standard [861].

Other Misc. (mostly less rigorous) lab methods which have been used in the past in media such as drinking water for volatiles [893] (lab method description from EPA [861]):

EMSLC 502.2 ELCD VOA's - P&T/CGCELCD/CGCPID 44 DRINKING_WATER CGCELD ug/L MDL "Volatile Organic Compounds in Water by Purge and Trap Capillary Column Gas Chromatography with

Photoionization and Electrolytic Conductivity Detectors in Series" This method is used for the identification and measurement of purgeable volatile organic compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. The method is applicable to a wide range of organic compounds, including the four trihalomethane disinfection by-products, that have sufficiently high volatility and low water solubility to be efficiently removed from water samples with purge and trap procedures [861]. An inert gas is bubbled through a 5 mL water sample [861]. The volatile compounds with low water solubility are purged from the sample and trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the tube is heated and backflushed with helium to desorb trapped sample components onto a capillary gas chromatography (GC) column [861]. The column is temperature programmed to separate the analytes which are then detected with photoionization detector (PID) and halogen specific detectors in series [861]. Analytes are identified by comparing retention times with authentic standards and by comparing relative responses from the two detectors [861]. A GC/MS may be used for further confirmation [861].

EMSLC 502.2 PID VOA's - P&T/CGCELCD/CGCPID 33 DRINKING_WATER CGCPID ug/L MDL "Volatile Organic Compounds in Water by Purge and Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series" This method is used for the identification and measurement of purgeable volatile organic compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. The method is applicable to a wide range of organic compounds, including the four trihalomethane disinfection by-products, that have sufficiently high volatility and low water solubility to be efficiently removed from water samples with purge and trap procedures [861]. An inert gas is bubbled through a 5 mL water sample [861]. The volatile compounds with low water solubility are purged from the sample and trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the tube is heated and backflushed with helium to desorb trapped sample components onto a capillary gas chromatography (GC) column [861]. The column is temperature programmed to separate the analytes which are then detected with photoionization detector (PID) and halogen specific detectors in series [861]. Analytes are identified by comparing retention times with authentic standards and by comparing relative responses from the two detectors [861]. A GC/MS may be used for further confirmation [861].

EMSLC 503.1 Volatile Aromatics in Water 28 DRINKING_WATER GCPID ug/L MDL "Volatile Aromatic and Unsaturated Organic Compounds in Water by Purge and Trap Gas Chromatography" This method is applicable for the determination of various volatile aromatic and unsaturated compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. Highly volatile organic compounds with low water solubility are extracted (purged) from a 5-ml sample by bubbling an inert gas through the aqueous sample [861]. Purged sample components are trapped in a tube containing a suitable sorbent material [861]. When purging is complete, the sorbent tube is heated and backflushed with an inert gas to desorb trapped sample components onto a gas chromatography (GC) column [861]. The gas chromatograph is temperature programmed to separate the method analytes which are then detected with a photoionization detector [861]. A second chromatographic column is described that can be used to help confirm GC identifications or resolve coeluting compounds [861]. Confirmation may be performed by gas chromatography/mass spectrometry (GC/MS) [861].

APHA 6230 D Volatile Halocarbons - CGCELCD STD_METHODS GCELCD "6230 Volatile Halocarbons" GCPID 6230 D [861]. Purge and Trap Capillary-Column Gas Chromatographic Method: This method is similar to Method 6230 C., except it uses a wide-bore capillary column, and requires a high-temperature photoionization detector in series with either an electrolytic conductivity or microcoulometric detector [861]. This method is equivalent to EPA method 502.2; see EMSLC\502.2 [861]. Detection limit data are not presented in this method, but the method is identical to 502.2; therefore, see EMSLC\502.2 for detection limit data [861]. Method 6230 B., 17th edition, corresponds to Method 514, 16th edition [861]. The other methods listed do not have a cross-reference in the 16th edition [861].

EMSLC 524.1 Purgeable Organics - GCMS 48 DRINKING_WATER GCMS ug/L MDL "Measurement of Purgeable Organic Compounds in Water by Packed Column Gas Chromatography/Mass Spectrometry" This is a general purpose method for the identification and simultaneous measurement of purgeable volatile organic compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. Volatile organic compounds and surrogates with low water solubility are extracted (purged) from the sample matrix by bubbling an inert gas through the aqueous sample [861]. Purged sample components are trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the trap is backflushed with helium to desorb the trapped sample components into a packed gas chromatography (GC) column interfaced to a mass spectrometer (MS) [861]. The column is temperature programmed to separate the method analytes which are then detected with the MS [861]. Compounds eluting from the GC column are identified by comparing their measured mass spectra and retention times to reference spectra and retention times in a data base [861]. Reference spectra and retention times for analytes are obtained by the measurement of calibration standards under the same conditions used for samples [861]. The concentration of each identified component is measured by relating the MS response of the quantitation ion produced by that compound to the MS response of the quantitation ion produced by a compound that is used as an internal standard [861]. Surrogate analytes, whose concentrations are known in every sample, are measured with the same internal standard calibration procedure [861].

EMSLC 524.2 Purgeable Organics - CGCMS 60 DRINKING_WATER CGCMS ug/L MDL "Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry" This is a general purpose method for the identification and simultaneous measurement of purgeable volatile organic compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. Volatile organic compounds and surrogates with low water solubility are extracted (purged) from the sample matrix by bubbling an inert gas through the aqueous sample [861]. Purged sample components are trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the sorbent tube is heated and backflushed with helium to desorb the trapped sample components into a capillary gas chromatography (GC) column interfaced to a mass spectrometer (MS) [861]. The column is temperature programmed to separate the method analytes which are then detected with the MS [861]. Compounds eluting from the GC column are identified by comparing their measured mass spectra and retention times to reference spectra and retention times in a data base [861]. Reference spectra and retention times for analytes are obtained by the measurement of calibration standards under the same conditions used for samples [861]. The concentration of each identified component is measured by relating the MS response of the quantitation ion produced by that compound to the MS response of the quantitation ion produced by a compound that is used as an internal standard [861]. Surrogate analytes, whose concentrations are known in every sample, are measured with the same internal standard calibration procedure [861].

Xylenes are a component of BTEX (see also BTEX entry).