Technical Factsheet on: BENZENE

List of Contaminants

As part of the Drinking Water and Health pages, this fact sheet is part of a larger publication:
National Primary Drinking Water Regulations

Drinking Water Standards

MCLG: Zero
MCL: 0.005 mg/L
HAL: 1 to 10 day: 0.2 mg/L; Longer-term: 0.2 mg/L

Health Effects Summary

Acute: Acute exposure to high levels of benzene produces central nervous system (CNS) effects and death. At lower levels, above the MCL, mild CNS effects appear to be concentration dependent and rapidly reversible. Other effects include immune system depression and bone marrow toxicity leading to aplastic anemia.

Drinking water levels which are considered "safe" for short-term exposures: For a 10 kg (22 lb.) child consuming 1 liter of water per day: upto a ten-day exposure to 0.2 mg/L.

Chronic: Benzene has the potential to cause chromosomal aberrations in people who are chronically exposed at levels above the MCL.

Cancer: Benzene has the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of benzene in the USA in 1993 was over 12 billion lbs.

Used for printing & lithography, paint, rubber, dry cleaning, adhesives & coatings, detergents, extraction and rectification, preparation and use of inks in the graphic arts industries, as a thinner for paints and as a degreasing agent. In the tire industry and in shoe factories, benzene is used extensively.

Used primarily as a raw material in the synthesis of styrene (polystyrene plastics and synthetic rubber), phenol (phenolic resins), cyclohexane (nylon), aniline, maleic anhydride (polyester resins), alkylbenzenes (detergents), chlorobenzenes, and other products used in the production of drugs, dyes, insecticides, and plastics.

In future, coal will increasingly replace petroleum & natural gas as a source of hydrocarbons both for fuel & petrochemicals. Processes such as USA Steel Corporation's Clean Coke process, which yields 38% coke & 20% chemical by-products compared to 73% coke & 2% chemical by-products in conventional coking technology, should soon be used commercially. New coking, liquefaction, & gasification processes for coal are all potential sources of benzene.

Release Patterns

Benzene will enter the atmosphere primarily from fugitive emissions and exhaust connected with its use in gasoline. Another important source is emissions associated with its production and use as an industrial intermediate. In addition, there are discharges into water from industrial effluents and losses during spills.

Benzene is also released from its indirect production in coke ovens; from nonferrous metal manufacture, ore mining, wood processing, coal mining and textile manufacture. Although most public drinking water supplies are free of benzene or contain <0.3 ppb, exposure can be very high from consumption of contaminated sources drawn from wells contaminated by leaky gasoline storage tanks, landfills, etc.

From 1987 to 1993, according to the Toxics Release Inventory, releases of benzene to water totalled 583,210 lbs. Releases to land totalled 1,566,900 lbs. As indicated in the Table below, these releases were primarily from petroleum refining industries, with the greatest releases occuring in Texas and Alabama.

Environmental Fate

If benzene is released to soil, it will be subject to rapid volatilization near the surface and that which does not evaporate will be highly to very highly mobile in the soil and may leach to groundwater. It may be subject to biodegradation based on reported biodegradation of 24% and 47% of the initial 20 ppm benzene in a base-rich para-brownish soil in 1 and 10 weeks, respectively. It may be subject to biodegradation in shallow, aerobic groundwaters, but probably not under anaerobic conditions.

If benzene is released to water, it will be subject to rapid volatilization; the half-life for evaporation in a wind-wave tank with a moderate wind speed of 7.09 m/sec was 5.23 hrs; the estimated half-life for volatilization of benzene from a model river one meter deep flowing 1 m/sec with a wind velocity of 3 m/sec is estimated to be 2.7 hrs at 20 deg C. It will not be expected to significantly adsorb to sediment, bioconcentrate in aquatic organisms or hydrolyze.

It may be subject to biodegradation based on a reported biodegradation half-life of 16 days in an aerobic river die-away test. In a marine ecosystem biodegradation occurred in 2 days after an acclimation period of 2 days and 2 weeks in the summer and spring, respectively, whereas no degradation occurred in winter. According to one experiment, benzene has a half-life of 17 days due to photodegradation which could contribute to benzene's removal in situations of cold water, poor nutrients, or other conditions less conductive to microbial degradation.

If benzene is released to the atmosphere, it will exist predominantly in the vapor phase. Gas-phase benzene will not be subject to direct photolysis but it will react with photochemically produced hydroxyl radicals with a half-life of 13.4 days calculated using an experimental rate constant for the reaction. The reaction time in polluted atmospheres which contain nitrogen oxides or sulfur dioxide is accelerated with the half-life being reported as 4-6 hours. Products of photooxidation include phenol, nitrophenols, nitrobenzene, formic acid, and peroxyacetyl nitrate.

Benzene is fairly soluble in water and is removed from the atmosphere in rain. The primary routes of exposure are inhalation of contaminated air, especially in areas with high traffic, and in the vicinity of gasoline service stations and consumption of contaminated drinking water.

Chemical/Physical Properties

CAS Number: 71-43-2

Color/ Form/Odor: Clear, colorless aromatic liquid; highly flammable M.P.: 5.5 C B.P.: 80.1 C

Vapor Pressure: 100 mm Hg at 26.1 C

Octanol/Water Partition (Kow): Log Kow = 2.13

Density/Spec. Grav.: 0.8787 at 15 C

Solubilities: 1.8 g/L of water at 25 C; Slightly soluble in water;

Soil sorption coefficient: Koc estimated at 98; high to very high mobility in soil

Odor/Taste Thresholds: Taste threshold in water is 0.5 to 4.5 mg/L

Bioconcentration Factor: 3.5 to 4.4 in fish; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 0.0053 atm-cu m/mole;

Trade Names/Synonyms: Benzol 90, Pyrobenzol, Polystream, Coal naphtha, Phene

Other Regulatory Information

Monitoring:

--For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

--Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis

Reference Source	**Method Numbers**
EPA 600/4-88-039	502.2; 524.2

Treatment/Best Available Technologies: Granular Activated Charcoal and Packed Tower Aeration

Toxic Release Inventory - Releases to Water and Land, 1987 to 1993 (in pounds):

	Water	**Land**	
TOTALS	**564,546**	**1,539,385**	
Top Six States*			
TX	1,436	1,135,994	
AL	199,642	0	
LA	137,599	4,347	
CO	0	40,793	
NM	0	38,199	
IL	3	34,110	
Major Industries*			
Petroleum refining		32,411	1,049,800
Primary Metal Ind.		133,339	18,078
Industrial chemicals		73,000	250,103
Alkalies, chlorine		122,240	0

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

For Additional Information

EPA can provide further regulatory or other general information:
EPA Safe Drinking Water Hotline - 800/426-4791

Other sources of toxicological and environmental fate data include:
Toxic Substance Control Act Information Line - 202/554-1404
Toxics Release Inventory, National Library of Medicine - 301/496-6531
Agency for Toxic Substances and Disease Registry - 404/639-6000