ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Benzene: Health Information Summary

Benzene is a colorless, flammable liquid that easily volatilizes. It is produced from both coal and petroleum sources and is naturally present in crude oil. Benzene is used as a gasoline additive at 1 to 2 percent by volume to increase the octane rating. It is an intermediate chemical in the production of plastics, synthetic rubber, nylon, and some pharmaceuticals. At one time, benzene was used as a solvent in consumer products such as paint strippers, automotive grease cleaners, rubber cement, carpet detergents, and furniture wax. However, other solvents have largely replaced benzene in consumer products.

Releases of benzene to the environment are largely to air, which is due to its volatile nature. Major sources of releases to air include gasoline vapor, auto exhaust, and manufacturing industries. Tobacco smoke can be a significant source of exposure (a dose of 1 milligram (mg) for each pack smoked). An estimated 99 percent of total human exposure to benzene is by inhalation. In air, benzene is rapidly degraded within a few hours to a few days. Release of benzene to water may be due to spills or leaks of gasoline, industrial releases, and from landfill leachate. Benzene released to surface water rapidly volatilizes to air. However, benzene that enters groundwater degrades much more slowly.

The low range of the taste threshold for benzene in water is reported as 0.5 parts per million (ppm). The odor threshold for detection in water is 2 ppm and approximately 60 ppm for odor detection in air.

Health Effects

Absorption/Metabolism

Benzene can be toxic by ingestion, inhalation, and absorption through the skin. Studies indicate benzene is absorbed most efficiently by ingestion (close to 100 percent), followed by inhalation (50 percent) and, to a lesser extent, through the skin. Benzene is not stored in the body for long periods. Within 48 hours after exposure, most of the benzene or the chemicals that it has been changed into leaves the body.

Short-Term (Acute) Effects

Acute inhalation exposure to very high levels of benzene may cause central nervous system effects such as dizziness, nausea, vomiting, headache, drowsiness, tremor, and loss of consciousness. The severity of the effects appears to be dependent on the concentration and is reversible once the exposure ends.

Human exposure by inhalation to very high levels of benzene for a short period is associated with effects on blood cells and the bone marrow, which is the site of blood cell formation. As a result of toxicity to the bone marrow, benzene can cause a continuum of changes depending on the concentration and duration of exposure. Benzene exposure can cause reductions in all blood cell types resulting in anemia (red cells), reduced immunity to disease (white cells), and impaired blood-clotting ability (platelets). These changes have been documented in animal studies.

Long Term (Chronic) Effects

Prolonged exposure to low levels of benzene can result in below normal numbers of all blood cell types as described in the "Short-Term Effects" section. When exposure ceases, cell numbers can return to normal. However, continuing exposure at sufficiently high concentrations can lead to the permanent suppression of bone marrow functioning so that few new blood cells are formed, a condition known as aplastic anemia.

Carcinogenic Effects (Ability to Cause Cancer)

Benzene is classified by the U.S. Environmental Protection Agency (EPA) as “carcinogenic to humans” under the revised cancer guidelines. While studies regarding the carcinogenicity of benzene via oral exposure to humans have not been located in the available literature, a large number of studies provide a strong association between occupational exposure to benzene by inhalation and an increased incidence of certain types of leukemia, most often acute myelogenous leukemia (AML). Exposure to benzene in animal studies has sometimes produced leukemia, but more often lymphoma. Additional cancers detected in animal studies include those of the oral and nasal cavities, liver, lung, ovary, and mammary glands.

Reproductive/Developmental Effects

Although there is no conclusive human evidence of reproductive or developmental effects from benzene exposure, in animal studies, benzene's effects on the fetus included low birth weights, a delay in bone formation, and bone marrow damage.

Health Standards and Criteria

The EPA has established a Maximum Contaminant Level Goal (MCLG) of 0 parts per billion (ppb = micrograms per liter or ug/l) for benzene in public drinking water systems. MCLGs are health-based non-enforceable guidelines and have traditionally been set at zero for potential human carcinogens. The EPA has also established a Maximum Contaminant Level (MCL) for benzene. MCLs are enforceable drinking water standards determined by balancing the adverse health effects of a particular chemical against the feasibility and costs of treating contaminated water. The MCL for benzene is 5 ppb.

Because benzene is considered a human carcinogen, there may be some degree of carcinogenic risk even below the MCL. Based upon EPA calculations, the EHP estimates that drinking water containing 5 ppb benzene would be associated with an increased lifetime risk of cancer of five in one million (5 excess cancer cases in 1,000,000 people exposed). This estimate is based on a daily intake of two liters of water per day for 70 years.

The EPA has also developed a toxicity value (Reference Dose or RfD) for non-cancer effects based on a human study. A decrease in lymphocyte cells, which are vital to immune system function, was the most sensitive effect of several measured blood parameters. The adult drinking water equivalent level (DWEL) for this RfD is a benzene concentration in water of 140 ppb.

The Occupational Safety and Health (OSHA) enforceable standard (permissible exposure limit or PEL) for benzene in workplace air is 1 ppm averaged over 8 hours.

For more information, please contact the DES Environmental Health Program, 29 Hazen Drive, Concord, NH 03302-0095; (603) 271-1370.

Suggested Reading and References

Casarett and Doull's Toxicology: The Basic Science of Poisons, Seventh Edition. Klaassen, C.D., ed. McGraw-Hill Publishing Co., Inc., New York, 2008.

Toxicological information on benzene. Integrated Risk Information System (IRIS). U.S. EPA, Office of Health and Environmental Assessment. Last significant revision: April 2003.

Toxicological Profile for Benzene (Update). Agency for Toxic Substances and Disease Registry (ATSDR). Atlanta, GA. August, 2003.

Case Studies in Environmental Medicine: Benzene Toxicity. Agency for Toxic Substances and Disease Registry (ATSDR). Atlanta, GA. June, 2000.