Benzene

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Benzene was first isolated by Faraday in 1825 from a liquid condensed by compressing oil gas [IARC].

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities [ATSDR].

Usage and exposure

Benzene is listed as a high production volume chemical by the Organization for Economic Co-operation and Development**.**

Historically, benzene was used as a degreaser of metals, a solvent for organic materials, a starting and intermediate material in the chemical and drug industries (e.g. to manufacture rubbers, lubricants, dyes, detergents, and pesticides), and an additive to unleaded gasoline. Benzene use has diminished since its carcinogenic properties became widely publicized; however, some countries have continued to use benzene in specific products such as glue**.**

Benzene occurs naturally in petroleum products (e.g. crude oil and gasoline), and is also added to unleaded gasoline for its octane-enhancing and anti-knock properties. Typically, the concentration of benzene in these fuels is 1–2% by volume.

The primary use of benzene today is in the manufacture of organic chemicals. In Europe, benzene is mainly used to make styrene, phenol, cyclohexane, aniline, maleic anhydride, alkylbenzenes, and chlorobenzenes. It is an intermediate in the production of anthraquinone, hydroquinone, benzene hexachloride, benzene sulfonic acid, and other products used in drugs, dyes, insecticides, and plastics [IARC].

Benzene is a ubiquitous pollutant that is present in several industries and occupations, including the production and refining of oil and gas, the distribution, sale, and use of petroleum products, coke production, the manufacture and use of chemical products, automobile repair, shoe production, firefighting, and various operations related to engine exhaust [IARC].

Routs of exposure

Due to the high volatility of benzene, occupational exposure to benzene mainly occurs via inhalation.

Dermal exposure will vary according to the tasks being performed (e.g. dipping machinery parts, immersion of hands, or using petroleum-based products as degreasing agents), the benzene content of the product, the composition of the product containing benzene, contact time, and the area of the body on which the chemical resides [IARC].

Health hazards

Benzene is well absorbed via inhalation as well as by oral and dermal exposure in all species studied, including humans and rodents.

It is widely distributed in the body by blood circulation; unchanged benzene is largely excreted by exhaled breath, with small amounts appearing in urine.

Benzene is metabolized in both liver and lung .

The main urinary metabolites of benzene in humans are phenol, hydroquinone, catechol, trans,transmuconic acid (t,t-MA), and S-phenylmercapturic acid (SPMA).

The method of measuring benzene exposure by biomonitoring dates to the 1980s; the first biomarkers, such as phenol, have been progressively abandoned in favour of biomarkers that are less abundant but more specific. The currently recommended biomarkers for assessment of benzene exposure in the workplace include urinary trans-transmuconic acid (t,t-MA), urinary S-phenylmercapturic acid (SPMA), and urinary benzene [IARC].

Acute (short-term) inhalation exposure of humans to benzene may cause drowsiness, dizziness, headaches, as well as eye, skin, and respiratory tract irritation, and, at high levels, unconsciousness [EPA].

Chronic (long-term) inhalation exposure has caused various disorders in the blood, including reduced numbers of red blood cells and aplastic anemia, in occupational settings.

Reproductive effects have been reported for women exposed by inhalation to high levels, and adverse effects on the developing fetus have been observed in animal tests [EPA].

Many studies in exposed humans have demonstrated haematotoxicity, from decreased leukocyte counts at lower exposures to aplastic anaemia and pancytopenia at higher exposures. Specifically, reduced numbers and/or maturity of B-lymphocytes and CD4+ T-lymphocytes have been reported in multiple studies in exposed humans.

Benzene is metabolically activated to electrophilic metabolites; induces oxidative stress and associated oxidative DNA damage; is genotoxic, inducing DNA damage and chromosomal changes; is immunosuppressive; and causes haematotoxicity.

There is sufficient evidence in humans for the carcinogenicity of benzene. Benzene causes acute myeloid leukaemia in adults.

Positive associations have been observed for non-Hodgkin lymphoma, chronic lymphoid leukaemia, multiple myeloma, chronic myeloid leukaemia, acute myeloid leukaemia in children, and cancer of the lung.

Benzene is carcinogenic to humans (Group 1) [IARC].

References

- ATSDR. Agency for Toxic Substances & Diseases Regystry. Toxic Substances Portal. Benzene. https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=14
- EPA. Environmental Protection Agency. Benzene. https://www.epa.gov/sites/production/files/2016-09/documents/benzene.pdf
- IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 120: 2018 pp:1-301. http://publications.iarc.fr/576