Product Safety Assessment

*Benzene*

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Names

- CAS No. 71-43-2
- Benzene
- DOW™ benzene
- Benzine
- Benzol
- Cyclohexatriene
- Annulene
- Phenyl hydride
- Pyrobenzole
- Pyrobenzol

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Product Overview

- Benzene is the simplest aromatic compound. It is a natural component of crude oil (petroleum) and trace amounts may be present in gasoline. For further details, see Product Description and Manufacture of Product.
- Benzene is used as a chemical building block for the production of many important industrial compounds, such as styrene, phenol, cyclohexane, aniline, alkylbenzenes, and chlorobenzenes. These and other intermediates are used to produce pharmaceuticals, specialty chemicals, plastics, glazing materials, resins, dyes, and pesticides. For further details, see Product Uses.
- DOW™ benzene is manufactured for industrial use only and is not used directly in consumer products. It is manufactured, stored, and transported in closed systems. Control measures, including equipment design and handling procedures, have been established to minimize potential exposure to workers, community, and the environment. Environmental sources of benzene are gasoline, combustion products and cigarette smoke. The level of benzene in gasoline has been significantly reduced because of potential health hazards. Unleaded automobile gasoline generally has a benzene content of about 1%. For further details, see Exposure Potential.
- Benzene has been shown to be toxic to both humans and experimental animals via all routes of administration. Inhalation is the most common type of benzene exposure. However, benzene also can be absorbed into the body by skin contact and ingestion. Very high concentrations of benzene vapors cause narcotic effects and can lead to death. Repeated exposures to benzene in humans lead to depression of white and red blood cells. Benzene is classified as a human carcinogen. Benzene can cause burns to the skin. For further details, see Health Information.

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Benzene evaporates rapidly from water solutions and surfaces, but it is toxic to aquatic organisms. It is classified as readily biodegradable in sewage treatment plants, waterways, sediments, and soils. It does not have a high potential to bioaccumulate. For further details, see Environmental Information.

Benzene is extremely flammable, even at normal storage and handling temperatures. Benzene vapor is heavier than air and can spread along the ground if released, so care must be taken to ensure that the vapor is not ignited by a distant source. Avoid contact with oxidizing materials, strong acids, and halogens. For further details, see Physical Hazard Information.

Manufacture of Product

- **Capacity** – In 2008, annual global consumption of benzene was 40 million metric tons (88 billion pounds). Major petroleum companies are large benzene producers because of their integration with refineries for the production of gasoline and other refined products. The Dow Chemical Company (Dow) is a large global producer of benzene and had 2.2 million metric tons (about 4.8 billion pounds) of benzene production capacity in 2008. Dow is also a large consumer and purchaser of benzene. Dow produces benzene in the following locations: Plaquemine, Louisiana, USA; Terneuzen, The Netherlands; and Boehlen, Germany. Dow uses benzene as a raw material in the following locations: Freeport, Texas, USA; Dow Central Germany; Terneuzen, The Netherlands; and Map Ta Phut, Thailand.

- **Process** – Most benzene is produced by the following three processes:
  1. Catalytic reforming of petroleum-derived naphtha
  2. Extraction from pyrolysis gasoline that is generated during ethylene production
  3. Toluene hydrodealkylation (HDA) or toluene disproportionation (TDP)

DOW™ benzene is predominantly produced from extraction from pyrolysis gasoline. A simplified process schematic for Dow’s production of benzene is shown below.

Product Description

Benzene, \( \text{C}_6\text{H}_6 \), is a volatile, clear, colorless, and flammable liquid aromatic hydrocarbon possessing a distinct, characteristic odor. Benzene is the simplest aromatic compound, with a six-carbon ring, a hydrogen atom attached to each carbon atom, and alternating double bonds in the ring structure. It occurs naturally in fossil raw materials such as crude oil and coal tar.

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Product Uses\(^5,8,9,10,11,12\)

Due to the potential hazards of this material, benzene is no longer used in appreciable quantity as a solvent and has not been used as an industrial solvent for decades. However, it is found in motor fuels and is used extensively as a chemical building block for the production of many important industrial compounds, such as:

- **Ethylbenzene and styrene** – used to manufacture polystyrene plastics, engineering plastics, and synthetic rubber
- **Cumene and phenol** – used to make phenolic resins like epoxies, polycarbonate, and more
- **Cyclohexane** – used to make nylon products
- **Nitrobenzene and aniline** – used to make dyes, polyurethanes, etc.
- **Alkylbenzenes** – used to make detergents
- **Chlorobenzenes and other intermediates** – used to produce pharmaceuticals, specialty chemicals, plastics, glazing materials, resins, dyes, and pesticides

Exposure Potential

DOW™ benzene is manufactured for industrial use only and is primarily used to produce other DOW products. Benzene is commonly used to produce other chemicals and products with which consumer may come in contact. For health, safety, and environmental reasons, benzene is manufactured, stored, and transported in closed systems. Likewise, the product is used only in closed systems. Control measures, including equipment design and handling procedures, have been established to minimize the exposure potential to workers, community, and the environment. Based on the uses for benzene, the public could be exposed through:

- **Workplace exposure** – Exposure can occur either in a benzene manufacturing facility, during the transport of benzene, or in the various industrial or manufacturing facilities that use benzene. It is produced, transported, distributed, stored, and used in closed systems. Those working with benzene could be exposed during maintenance, sampling, testing, transfer or other procedures. Each manufacturing facility and transportation operation should have a thorough training program for employees and appropriate work processes and safety equipment in place to limit benzene exposure for workers and the public. Occupational exposure guidelines designed to be protective of worker health for benzene vary, but are approximately 0.5 parts per million (or 500 parts per billion) over an 8-hour period, significantly higher than exposures generally experienced by the public. Occupational exposure can potentially be one of the largest sources of benzene exposure.\(^13,14\) See Health Information.
- **Consumer exposure to benzene\(^15,16\)** – Benzene is a natural component of petroleum and the public may be exposed to trace amounts from gasoline, which contains some benzene, as well as other environmental sources such as cigarette smoke, city traffic, and open fires. The largest source of personal exposure to benzene is cigarette smoke, and the largest

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source of environmental exposure comes from gasoline and combustion in automobiles and other mobile sources. Benzene exposure sources have been regulated for many years and new regulations for mobile sources (like automobiles), which comprise a large portion of ambient sources, were announced in the U.S. in March 2006, with others scheduled to take effect in 2011. The level of benzene in gasoline has been significantly reduced because of potential health hazards. Unleaded automobile gasoline generally has a benzene content of less than 1% in the U.S. and as much as 5% in other countries. Heavier fuels such as jet fuel, kerosene, and diesel fuel have much less benzene content, generally less than 0.02%. Virtually all benzene in indoor air comes from fuels and combustion sources including infiltration of outdoor air, tobacco smoke, wood stoves, cooking, and infiltration from attached garages. The typical indoor air concentration of 2.5 μg/m³ (approximately parts per billion) was determined from the average of the median benzene air concentrations from 11 residential studies. The high-end indoor air concentration of 11.5 μg/m³ was determined from studies of homes with attached garages, which is attributable to storage of gasoline in vehicles and/or lawn/garden equipment. Occupational exposure guidelines designed to be protective of worker health for benzene vary, but are approximately 0.5 parts per million (or 500 parts per billion) over an 8-hour period, significantly higher than exposures generally experienced by the public. Benzene produced in the chemical industry is used almost exclusively as an intermediate to make other products, and extensive measures are taken to minimize emissions. Thus, consumer exposure to DOW™ benzene is unlikely except in the event of an accidental release or spill. See Health Information.

- **Environmental releases** – In the event of a spill, the focus is on containing the spill to prevent contamination of soil and surface or ground water. Respiratory protection is necessary for cleaning up spills and leaks. Eliminate all sources of ignition immediately. For small spills, benzene should be absorbed with inert materials such as soil or sand. This material is toxic to fish on an acute basis. Its high vapor pressure and low water solubility means benzene will largely volatilize to the air. See the relevant Safety Data Sheet, Environmental, Health and Physical Hazard Information.

- **Large release** – Industrial spills or releases of benzene are infrequent and generally contained. Benzene emissions from industrial facilities are subject to governmental requirements. These regulations cover not only emissions of benzene but also emissions of other volatile organic compounds. As a result of these regulations and plant operating conditions, the typical ambient air levels of benzene at the fence lines of production facilities will be in the low parts per billion. If a large spill should occur, the material should be captured, collected, and reprocessed or disposed of according to applicable governmental requirements. Follow emergency procedures carefully. A positive-pressure, self-contained breathing apparatus (SCBA) with a full-face mask approved by NIOSH is recommended for emergency work. Eliminate all sources of ignition immediately. Use only explosion-proof equipment, and ground and bond all containers and handling equipment.

- **In case of fire** – Immediately withdraw all personnel from the area in case of rising sounds from venting safety device or discolorations of the container. In case of fire, deny any unnecessary entry into the area and consider the use of unmanned hose holders. Use dry-chemical extinguishers on small fires and alcohol foam or water fog or spray on larger fires. Use of a direct water stream may spread fire. The public should be warned of downwind vapor explosion hazards. Vapors are heavier than air and may travel a long distance and accumulate in low-lying areas, so care needs to be taken to ensure that the vapor is not ignited by a distant source. Keep vapors out of sewers. Combustion gases can be toxic, and smoke is black and sooty. See Environmental, Health and Physical Hazard Information.

For more information, request the relevant Safety Data Sheet.

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Health Information\textsuperscript{17,18,19,20}

Liquid benzene is irritating to the skin and eyes. Exposure to high levels of benzene vapor – well above the odor threshold – can cause drowsiness, respiratory irritation, dizziness, rapid heart rate, headache, tremor, confusion, and unconsciousness. Oral ingestion of high levels of benzene can cause vomiting, stomach irritation, dizziness, sleepiness, convulsions, rapid heart rate, and death. The major effect of repeated exposures to benzene is on the blood. Benzene causes harmful effects on the bone marrow and can cause a decrease in red blood cells leading to anemia, and white blood cells leading to alterations in the function of the immune system. It can also cause excessive bleeding and increase chances of infection.

Long-term exposure to high levels of benzene vapor can also cause leukemia, particularly acute myelogenous leukemia (AML), a cancer of the blood-forming organs. The U.S. Department of Health and Human Services classifies benzene as a known carcinogen. The International Agency for Research on Cancer (IARC) and the U.S. Environmental Protection Agency (EPA) classify benzene as a known human carcinogen.

Benzene can pass from the mother’s blood to a fetus. Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals were exposed to high concentrations of benzene vapor well above those experienced by either workers or public consumers.

For more information, request the relevant Safety Data Sheet.

Environmental Information\textsuperscript{21,22}

If spilled in water, benzene is toxic to fish. However, benzene is only slightly soluble in water and evaporates rapidly from water solutions and surfaces. It is considered readily biodegradable in sewage treatment plants, waterways, sediments, and soils. In the atmosphere, benzene is degraded quickly by photo-oxidation.

Studies in fish show that benzene has a low bioaccumulation potential. Given its high volatility, accumulation of benzene is not expected to be important in any terrestrial or aquatic organism, and there are no reports indicating significant bioconcentration in organisms or that it will accumulate in the food chain. Benzene is classified as a hazardous waste, and benzene emissions and effluent streams from petroleum refineries or benzene processing plants are subject to strict federal regulations.

For more information, request the relevant Safety Data Sheet.

Physical Hazard Information\textsuperscript{5}

Benzene is extremely flammable, even at normal storage and handling temperatures. Combustion gases can be toxic, and smoke is black and sooty. Benzene should be stored away from potential sources of ignition and handled only where adequate ventilation is provided. It should be stored in closed systems. Avoid contact with oxidizing materials, strong acids, and halogens. Benzene vapor is heavier than air and will spread along the ground if released, so care needs to be taken to ensure that the vapor is not ignited by a distant source. It will also float on water and can be ignited on surface water.

For more information, request the relevant Safety Data Sheet.
Regulatory Information

Regulations may exist that govern the manufacture, sale, transportation, use, and/or disposal of benzene. These regulations may vary by city, state, country, or geographic region. Information may be found by requesting the relevant Safety Data Sheet or through Contact Us.

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Additional Information

- Safety Data Sheet (www.dow.com/webapps/msds/msdssearch.aspx)
- Contact Us (www.dow.com/aromatics/contact/)
- “Benzene,” Kirk-Othmer Encyclopedia of Chemical Technology, Wiley InterScience
- Association of Petrochemical Producers in Europe (APPE) website (http://www.petrochemistry.net/?HID=14&L=B)
- “ToxFaqs™ for Benzene,” Agency for Toxic Substances and Disease Registry (ATSDR), Division of Toxicology and Environmental Medicine, U.S. Department of Health and Human Services, September 2005 (http://www.atsdr.cdc.gov/toxFAQs/tf.asp?id=38&tid=14)
- Screening Information Data Set (SIDS) Initial Assessment Profile Benzene CAS No. 71-43-2, Organisation for Economic Co-operation and Development (OECD), United Nations Environment Programme (UNEP), October 18–20, 2005

For more business information about benzene, visit the Dow Aromatics website at www.dow.com/aromatics/about/index.htm or Contact Us at www.dow.com/aromatics/contact/.

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References

2. Voluntary Children’s Chemical Evaluation Program (VCCEP) Tier 1 Pilot Submission for BENZENE (CAS No. 71-43-2) Docket Number OPPTS-00274D, American Chemistry Council Benzene, Toluene, and Xylenes VCCEP Consortium
4. SIDS Initial Assessment Profile Benzene CAS No. 71-43-2, OECD UNEP: SIAM


17 “Benzene (CAS #71-43-2) ToxFAQs,” Agency for Toxic Substances and Disease Registry (ATSDR), Division of Toxicology and Environmental Medicine, U.S. Department of Health and Human Services, September 2005, pages 1–2. (www.atdr.cdc.gov/ToxFAQs.html)


NOTICES:

As part of its 2015 Sustainability Goals, Dow has committed to make publicly available safety assessments for its products globally. This product safety assessment is intended to give general information about the chemical (or categories of chemicals) addressed. It is not intended to provide an in-depth discussion of health and safety information. Additional information is available through the relevant Safety Data Sheet, which should be consulted before use of the chemical. This product safety assessment does not replace required communication documents such as the Safety Data Sheet.

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