



## Product Safety Assessment

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# Butadiene

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### Names

- CAS No. 106-99-0
- Butadiene
- Buta-1,3-diene
- $\alpha$ - $\gamma$ -Butadiene
- Bivinyl
- Divinyl
- Biethylene
- Erythrene
- Pyrrolylene
- Vinylethylene

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### Product Overview

- 1,3-Butadiene (butadiene) is a colorless, noncorrosive gas with a mild aromatic or gasoline-like odor at room temperature and pressure.<sup>1</sup> For further details, see [Product Description](#).
- Butadiene is used primarily as a monomer for manufacturing synthetic rubber and plastics. Smaller amounts are used as a chemical intermediate for producing other chemicals.<sup>2</sup> For further details, see [Product Uses](#).
- There are no consumer uses for butadiene and the potential for consumer exposure from industrial/product sources is very low. The primary route of potential human exposure to butadiene is by inhalation. Environmental sources of exposure include automobile exhaust, cigarette smoke, and other combustion sources. Because of the health risks associated with butadiene exposure, emissions of butadiene from manufacturing operations and occupational exposure to butadiene are limited by governmental regulations. Exposure to very low levels of residual butadiene in rubber or plastic products or to very low levels in gasoline is possible.<sup>3</sup> For further details, see [Exposure Potential](#).
- In confined or poorly ventilated areas, butadiene vapors can readily accumulate and cause unconsciousness and death. Butadiene is listed as a human carcinogen by the International Agency for Research on Cancer (IARC) and other agencies. Repeated excessive exposures may affect the kidneys, liver, respiratory tract, ovaries, and testes.<sup>4,5,6</sup> For further details, see [Health Information](#).
- If released, butadiene rapidly evaporates. Limited data suggest butadiene is slightly toxic to aquatic organisms and would not be expected to accumulate in the food chain (low bioconcentration potential). Butadiene breaks down quickly in sunlight and residual butadiene in soil may break down by biological action.<sup>7,8</sup> For further details, see [Environmental Information](#).
- Butadiene is extremely flammable. A release could result in a flash fire. Although butadiene is a reactive monomer, it is stable under recommended storage conditions. Elevated temperatures or depletion of the inhibitor can result in hazardous polymerization.

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Explosive peroxides can be formed with improper storage and handling conditions.<sup>9</sup> For further details, see [Physical Hazard Information](#).

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### Manufacture of Product

- **Capacity** – Global production of butadiene reached 10 million metric tonnes (20.4 billion pounds) in 2011. Global affiliates of Dow manufacture this product at facilities located in Terneuzen, the Netherlands, and in Böhlen, Germany,
- **Process** – Nearly all butadiene is produced as a co-product of the steam cracking of hydrocarbon feedstocks to make [ethylene](#) and [propylene](#). After ethylene and propylene are extracted from the cracker, a “C4 stream” that contains mostly hydrocarbons with four carbon atoms (e.g., butadiene and butenes) is then separated from the process. Butadiene is extracted from the C4 stream, distilled, and purified.

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### Product Description<sup>10</sup>

Butadiene is a colorless, noncorrosive gas with a mild aromatic or gasoline-like odor. It is a gas at normal temperature and pressure. Butadiene is normally stored under pressure as a liquefied or compressed gas. It can be transported by pipeline, railroad tank car, roadway tank truck, barges, or ocean vessels.

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### Product Uses<sup>11</sup>

Butadiene is used primarily as a monomer in the manufacture of synthetic rubbers or elastomers, including styrene-butadiene rubber (SBR), polybutadiene rubber (PBR), poly-chloroprene (Neoprene), and nitrile rubber (NR). In turn, these elastomers are used to produce products such as:

- SBR and PBR are used in tires and plastic materials
- Neoprene is used in gloves, wetsuits, waders, and foams
- Nitrile rubber is used in hoses, gloves, gaskets, and seals

Butadiene is also used as a monomer to produce styrene-butadiene (S/B) latex, which is used as an adhesive and binder to produce carpet, paper coatings, and interior paints. Plastics and resins that incorporate butadiene-based rubbers include acrylonitrile-butadiene-styrene (ABS) resins and high-impact polystyrene (HIPS), although other plastics may use these rubbers as well. Small amounts of butadiene may be used in the manufacture of adiponitrile, a precursor for nylon-6,6, which is used to produce carpets, textiles, and plastic parts.

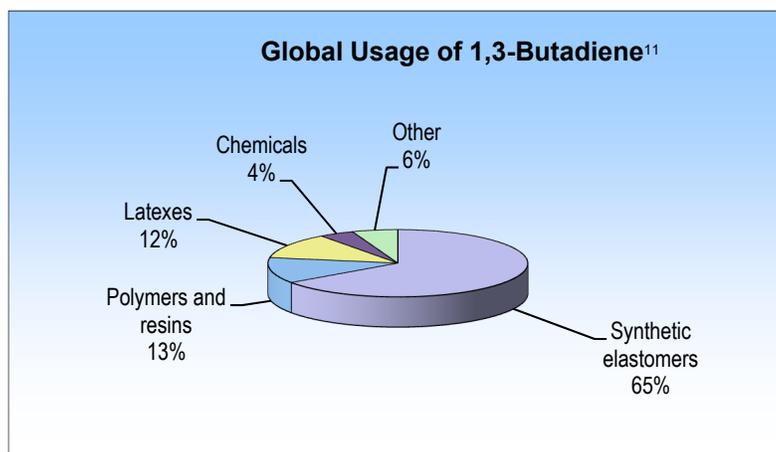
NOTICE: Butane, butylenes, butadiene or crude butadiene products may not be suitable for use in cosmetics.

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### Exposure Potential

Butadiene is used in the production of industrial and consumer products. Based on its uses, individuals could be exposed through:

- **Workplace exposure** – Exposure can occur either in facilities that manufacture butadiene or in the various industrial or manufacturing facilities that use this product. It is produced, transported, stored, and consumed in closed systems. Butadiene may be released due to mechanical failure of a pump seal, valve pack, pipe connection, or gasket. These fugitive emissions are the most common form of industrial release. Manufacturers and users of butadiene minimize such losses since emissions are regulated and controlled by governmental regulations, such as operating permits, and manufacturing standards. Each facility that handles



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butadiene should have a thorough training program for employees and appropriate work processes, ventilation, and safety equipment in place to limit exposure. See [Health Information](#).

- **Consumer exposure to products containing butadiene** – Dow does not sell butadiene for direct consumer use, and there are no known consumer uses for butadiene. Consumers could be exposed to very low or nondetectable levels of butadiene by drinking contaminated water near production or disposal sites, by ingesting foods from food containers or packaging that contain traces of butadiene, or by skin contact with gasoline. Since butadiene is also a product of combustion, consumers could be exposed to butadiene by breathing air that may be contaminated by vehicle exhaust, waste incineration, wood fires, or cigarette smoke.<sup>12</sup> The U.S. EPA National Air Toxics Assessment data tables<sup>13</sup> provide a relative comparison of butadiene levels in the air from various emission sources. See [Health Information](#).
- **Environmental releases**<sup>14</sup> – Butadiene is released into the environment from both industrial and nonindustrial sources. The U.S. Environmental Protection Agency (EPA) National Air Toxics Assessment<sup>15</sup> indicates that on a nationwide basis, mobile sources (on-road and nonroad) are the major contributor of butadiene emissions into the environment (58%). Area sources contribute approximately 38%, and major sources, such as industrial manufacturing operations, contribute approximately 3%. The contribution from each of these sources will vary depending upon the specific location. In the event of a release, the focus is on reducing the potential for fire and on containing the spill to prevent contamination of air, 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, butadiene should be absorbed with sand. Butadiene's high vapor pressure and insolubility in water makes it accumulate (partition) in the air, which creates an inhalation risk. Butadiene breaks down quickly in sunlight. Residual butadiene in the soil may be broken down by biological action. Limited data suggest that butadiene is slightly toxic to aquatic organisms, and it would not be expected to accumulate in the food chain. See [Environmental](#), [Health](#), and [Physical Hazard Information](#).
- **Large release**<sup>16</sup> – Industrial spills or releases are infrequent and generally contained. If a large spill does occur, the product will rapidly evaporate under ambient conditions, making capturing and collecting difficult. For liquid spills, apply foam or other vapor-suppressing materials. Application of water can lead to boiling, frothing, and rapid vaporization. Large releases should be reported immediately to emergency personnel according to governmental regulations. Positive pressure, self-contained breathing apparatus (SCBA) with an approved full-face mask is recommended for emergency work. Eliminate all sources of ignition immediately. Use only explosion-proof equipment; ground and bond all containers and handling equipment. In a nonfire emergency situation, fog can result from the evaporation of butadiene, which cools and condenses water vapor in the air. The invisible, ignitable butadiene/air mixture can extend several feet beyond the visible fog area. Consult the [Butadiene Product Stewardship Guidance Manual](#) for more information about protective equipment and procedures. See [Environmental](#), [Health](#), and [Physical Hazard Information](#).
- **In case of fire** – Deny any unnecessary entry into the area and consider the use of unmanned hose holders. Firefighters should wear positive-pressure, self-contained breathing apparatus (SCBA) and protective firefighting clothing. Butadiene vapors are heavier than air and may travel a long distance and accumulate in low-lying areas. Keep vapors out of sewers. The public should be warned of downwind vapor explosion hazards. In a fire, conditions can develop that could lead to explosions and further fire propagation. Elevated temperatures can cause a build-up of pressure in closed containers, which could result in container failure. When heated under pressure, butadiene may also undergo rapid and uncontrolled polymerization resulting in an explosion.<sup>17</sup> Follow emergency procedures carefully. See [Environmental](#), [Health](#), and [Physical Hazard Information](#).

For more information, see the relevant [Safety Data Sheet](#).

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### Health Information<sup>18,19,20</sup>

**Eye contact** – Liquid butadiene may cause frostbite if it contacts the eyes and rapidly evaporates. Butadiene vapors may cause eye irritation experienced as mild discomfort and redness.

**Skin contact** – Butadiene is nonirritating to the skin. Liquid butadiene may cause frostbite if it contacts the skin and rapidly evaporates. No adverse effects are anticipated by absorption through the skin.

**Ingestion** – Swallowing is unlikely because the material is a gas at room temperature and pressure. Contact with liquid butadiene could result in frostbite to the lips. Ingestion of food or beverages that have come into contact with containers that may contain residual butadiene could result in ingestion of very small amounts. However, materials used for food packaging and storage must meet stringent health regulations before approval for this use.

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**Inhalation** – In confined or poorly ventilated areas, butadiene vapors can readily accumulate and cause unconsciousness and death. Excessive exposures may cause irritation to the upper respiratory system (nose and throat) or central nervous system effects. Symptoms may include anesthetic or narcotic effects, including dizziness or drowsiness.

**Repeated exposure** – With repeated excessive exposures, effects have been reported on the kidneys, liver, ovaries, respiratory tract, and testes. Excessive exposure may cause damage to blood-forming organs (bone marrow and spleen).

**Carcinogenicity** – Butadiene is listed as a human carcinogen by the International Agency for Research on Cancer (IARC), among others.<sup>21</sup> It has been shown to cause cancer in laboratory animals. Butadiene epidemiology studies have linked employment in two different chemical operations, each with a different type of cancer. The factors causing these excess cancers have not been determined because the workers were also exposed to other chemicals.

**Other** – Butadiene has caused birth defects in laboratory animals, but only at doses toxic to the mother. It has also been toxic to the fetus in laboratory animals at doses toxic to the mother.

For more information, see the relevant [Safety Data Sheet](#).

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### **Environmental Information**<sup>22,23,24</sup>

If released to the environment, butadiene rapidly evaporates to the air because of its high vapor pressure, even from water and soil. Limited data suggest butadiene is slightly toxic to aquatic organisms. It would not be expected to accumulate in the food chain (low bioconcentration potential).

Butadiene breaks down quickly in sunlight. In sunny weather, half breaks down in approximately 2 hours. When not sunny, it takes a few days for approximately half of it to break down in the air. Residual butadiene in the soil may also be broken down by biological action.

For more information, see the relevant [Safety Data Sheet](#).

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### **Physical Hazard Information**<sup>25,26</sup>

Butadiene is a significant fire and explosion hazard based on its flash point, vapor pressure, and boiling point. It forms explosive mixtures in air quite readily as a result of its high vapor pressure. Therefore, preventive measures must be taken to minimize the potential for a fire or explosion.

Although butadiene is extremely flammable, it is stable under recommended storage conditions. If a release occurs, vapors may travel a long distance and ignition and/or flash back may occur. Butadiene vapors are heavier than air, so the public should be warned of downwind explosion hazards and to stay out of low-lying areas where gases (fumes) may accumulate.

Dow adds an inhibitor to prevent unwanted polymerization of butadiene. It is important to maintain appropriate inhibitor levels to avoid this problem. Be aware that:

- Uninhibited monomer vapors can polymerize and plug relief devices.
- Elevated temperatures can cause hazardous polymerization of butadiene.
- Polymerization can be catalyzed by air, peroxides, or rust.
- Monomer contaminated with peroxides can form polymer at ambient conditions.
- Dry polymer that contains peroxides at greater than 15% concentration can be detonated by slight mechanical shock or heat. Avoid contact with air to prevent formation of explosive peroxides.

Additional information concerning polymerization and safe handling of butadiene during storage and transport is available in the [Butadiene Product Stewardship Guidance Manual](#).

For more information, see the relevant [Safety Data Sheet](#).

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## Regulatory Information

Regulations may exist that govern the manufacture, sale, transportation, use, and/or disposal of butadiene. These regulations may vary by city, state, country, or geographic region. Information may be found by consulting the relevant [Safety Data Sheet](#) or [Ask the Commercial Coordinator](#).

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## Additional Information

- Safety Data Sheet ([www.dow.com/webapps/msds/msdssearch.aspx](http://www.dow.com/webapps/msds/msdssearch.aspx))
- *Butadiene Product Stewardship Guidance Manual*, American Chemistry Council, March 2002 ([www.dow.com/productsafety/pdfs/butadiene\\_guide.pdf](http://www.dow.com/productsafety/pdfs/butadiene_guide.pdf))
- "ToxFAQs for 1,3-Butadiene," Agency for Toxic Substances and Disease Registry (ATSDR), Public Health Service, U.S. Department of Health and Human Services, September 2009 (<http://www.atsdr.cdc.gov/toxfaqs/tfacts28.pdf>)
- "Draft Toxicological Profile for 1,3-Butadiene" Agency for Toxic Substances and Disease Registry (ATSDR), Public Health Service, U.S. Department of Health and Human Services, September 2009 (<http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=459&tid=81>)
- "1,3-Butadiene," Integrated Risk Information System (IRIS), U.S. Environmental Protection Agency (EPA) (<http://www.epa.gov/iris/subst/0139.htm>)
- "Buta-1,3-diene," IUCLID Dataset ([http://esis.jrc.ec.europa.eu/doc/IUCLID/data\\_sheets/106990.pdf](http://esis.jrc.ec.europa.eu/doc/IUCLID/data_sheets/106990.pdf))
- "1,3-Butadiene," *Summary Risk Assessment Report*, European Commission Joint Research Centre, Institute for Health and Human Protection, European Chemicals Bureau, Special Publication I.02.110, 2002 (<http://echa.europa.eu/documents/10162/cf3931bd-8b42-49e2-a0b9-4acc71a37375>)
- "1,3-Butadiene 106-99-0," Screening Information Data Set (SIDS) Initial Assessment Profile, SIAM 4, May 20–22, 1996 (<http://webnet.oecd.org/Hpv/UI/handler.axd?id=18e5c60e-765a-400c-a932-c5bfe98dec52>)
- U.S. Environmental Protection Agency Technology Transfer Network, *2002 National-Scale Air Toxics Assessment*, 2002, Risk summary (<http://www.epa.gov/nata2002/risksum.html>) Data tables (<http://www.epa.gov/nata2002/tables.html>)

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## References

- <sup>1</sup> *Butadiene Material Safety Data Sheet*, The Dow Chemical Company, April 5, 2011, Section 2: Hazards Identification and Section 9: Physical and Chemical Properties.
- <sup>2</sup> Davis, Sean, "Marketing Research Report: Butadiene," *Chemical Economics Handbook*, SRI Consulting, October 2009, pages 16–30.
- <sup>3</sup> "ToxFAQs for 1,3-Butadiene," Agency for Toxic Substances and Disease Registry (ATSDR), Public Health Service, U.S. Department of Health and Human Services, September 2009, page 1.
- <sup>4</sup> *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Vol. 97* "1,3-Butadiene, Ethylene Oxide and Vinyl Halides (Vinyl Fluoride, Vinyl Chloride and Vinyl Bromide), World Health Organization International Agency on Research for Cancer, 2008, page 161: <http://monographs.iarc.fr/ENG/Monographs/vol97/mono97.pdf>.
- <sup>5</sup> *Butadiene Product Stewardship Guidance Manual*, American Chemistry Council, March 2002, pages II-1–II-2.
- <sup>6</sup> *Butadiene Material Safety Data Sheet*, The Dow Chemical Company, April 5, 2011, Section 2: Hazards Identification and Section 11: Toxicological Information.
- <sup>7</sup> *Butadiene Product Stewardship Guidance Manual*, American Chemistry Council, March 2002, page II-2.
- <sup>8</sup> *Butadiene Material Safety Data Sheet*, The Dow Chemical Company, April 5, 2011, Section 12: Ecological Information.
- <sup>9</sup> *Butadiene Material Safety Data Sheet*, The Dow Chemical Company, April 5, 2011, Section 2: Hazards Identification and Section 10: Stability and Reactivity.
- <sup>10</sup> *Butadiene Material Safety Data Sheet*, The Dow Chemical Company, April 5, 2011, Section 2: Hazards Identification and Section 9: Physical and Chemical Properties.
- <sup>11</sup> Davis, Sean, "Marketing Research Report: Butadiene," *Chemical Economics Handbook*, SRI Consulting, October 2009, pages 6 and 16–30.
- <sup>12</sup> "ToxFAQs for 1,3-Butadiene," Agency for Toxic Substances and Disease Registry (ATSDR), Public Health Service, U.S. Department of Health and Human Services, September 2009, page 1.
- <sup>13</sup> U.S. Environmental Protection Agency Technology Transfer Network, *2002 National-Scale Air Toxics Assessment*, 2002, web sites accessed January 16, 2012.
- <sup>14</sup> *Butadiene Product Stewardship Guidance Manual*, American Chemistry Council, March 2002, page IV-15.
- <sup>15</sup> U.S. Environmental Protection Agency Technology Transfer Network, *2002 National-Scale Air Toxics Assessment*, 2002, web sites accessed January 16, 2012.
- <sup>16</sup> *Butadiene Product Stewardship Guidance Manual*, American Chemistry Council, March 2002, page V-3.
- <sup>17</sup> *Butadiene Product Stewardship Guidance Manual*, American Chemistry Council, March 2002, page V-1.

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- <sup>18</sup> *Butadiene Material Safety Data Sheet*, The Dow Chemical Company, April 5, 2011, Section 2: Hazards Identification and Section 11: Toxicological Information.
- <sup>19</sup> *Butadiene Product Stewardship Guidance Manual*, American Chemistry Council, March 2002, pages II-1 to II-2.
- <sup>20</sup> "1,3-Butadiene," *Summary Risk Assessment Report*: European Commission Joint Research Centre, Institute for Health and Human Protection, European Chemicals Bureau, Special Publication I.02.110, 2002, pages 9–13 and 15–17.
- <sup>21</sup> *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Vol. 97* "1,3-Butadiene, Ethylene Oxide and Vinyl Halides (Vinyl Fluoride, Vinyl Chloride and Vinyl Bromide, World Health Organization International Agency on Research for Cancer, 2008, page 161: <http://monographs.iarc.fr/ENG/Monographs/vol97/mono97.pdf>.
- <sup>22</sup> "ToxFAQs for 1,3-Butadiene," Agency for Toxic Substances and Disease Registry (ATSDR), Public Health Service, U.S. Department of Health and Human Services, September 2009, page 1.
- <sup>23</sup> *Butadiene Product Stewardship Guidance Manual*, American Chemistry Council, March 2002, page II-2.
- <sup>24</sup> *Butadiene Material Safety Data Sheet*, The Dow Chemical Company, April 5, 2011, Section 12: Ecological Information.
- <sup>25</sup> *Butadiene Material Safety Data Sheet*, The Dow Chemical Company, April 5, 2011, Section 2: Hazards Identification and Section 10: Stability and Reactivity.
- <sup>26</sup> *Butadiene Product Stewardship Guidance Manual*, American Chemistry Council, March 2002, page V-1.

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### NOTICES

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