

## Product Safety Assessment

### *n*-Butanol

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#### Names

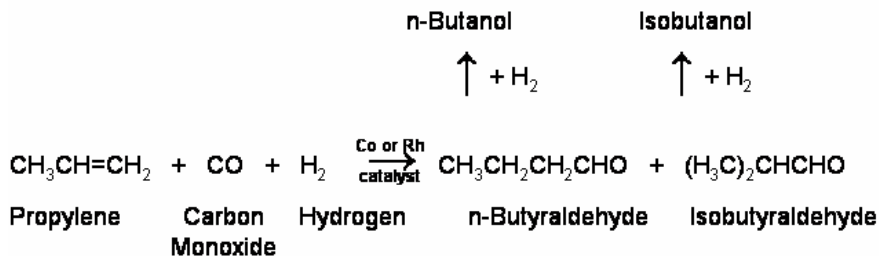
- |                   |                   |                   |
|-------------------|-------------------|-------------------|
| • CAS No. 71-36-3 | • Butanol         | • Butyl alcohol   |
| • n-Butanol       | • n-Butyl alcohol | • Butyric alcohol |
| • Normal butanol  | • Propyl carbinol | • Propylcarbinol  |
| • Butyl hydroxide | • Propylmethanol  | • Methylolpropane |
| • 1-Hydroxybutane | • 1-Butanol       |                   |

#### Product Overview

- n-Butanol (normal butanol) is a clear, colorless liquid that is flammable. It has a characteristic banana-like odor<sup>1</sup> and is used to produce other chemicals, as an ingredient in formulated products such as cosmetics, and as a solvent.<sup>2</sup> See Product Uses and Physical Hazard Information.
- n-Butanol demonstrates an overall low order of toxicity.<sup>3</sup> Acute (24 hours or less in duration) overexposures may cause irritation to the eyes and skin or can be harmful if inhaled. Prolonged (greater than 24 hours), excessive exposure to vapors may cause serious adverse effects, and even death. Birth defects have been observed in animals exposed to high concentrations of n-butanol which also caused serious adverse effects to the exposed mothers.<sup>4</sup> See Health Information.
- Occupational and consumer exposure is dependent upon the conditions under which n-butanol or the end-product is used. See Exposure Potential.
- n-Butanol is practically non-toxic to aquatic organisms and birds on an acute basis. The material is readily biodegradable.<sup>5</sup> See Environmental Information.

#### Manufacture of Product<sup>6</sup>

- **Capacity** – Dow<sup>7</sup> produces only the isomer n-butanol at two plants in the U.S. and purchases n-butanol from one of its joint ventures in Malaysia. Dow produces 9% of the world's capacity of plasticizer alcohols, such as n-butanol. Global consumption of n-butanol in 2002 was 10 billion pounds (5.1 million metric tons).
- **Process** – Dow first generates n-butyraldehyde using propylene, carbon monoxide (CO) and hydrogen gas (H<sub>2</sub>). By using low-pressure technology and a triphenylphosphine rhodium hydrocarbonyl catalyst, approximately eight to ten times more n-butyraldehyde is produced than isobutyraldehyde. The n-butyraldehyde is then reacted with H<sub>2</sub> to form n-butanol. Isobutanol is a byproduct of n-butanol production in Dow's process.



## Product Description

n-Butanol is a colorless, neutral liquid of medium volatility with a characteristic banana-like odor. It has restricted miscibility (about 7-8%) in water, but is freely miscible with all common solvents such as glycols, ketones, alcohol, aldehydes, ethers, and aromatic and aliphatic hydrocarbons.<sup>8</sup>

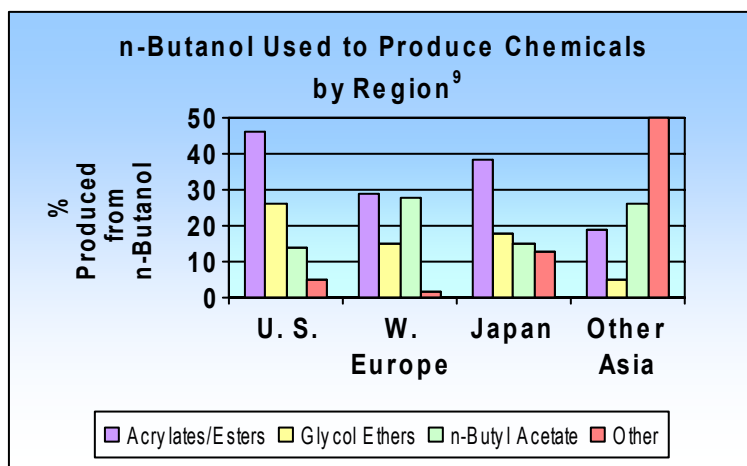
## Product Uses

Market literature classifies n-butanol as both an oxo-chemical derivative and a plasticizer alcohol for market purposes. The uses of n-butanol vary by geographic area, but in general it is used to make other chemicals, or used as a solvent or an ingredient in formulated products such as cosmetics. A partial list of chemicals in which it is used includes:<sup>9</sup>

- Acrylate/methacrylate esters
- Glycol ethers
- n-Butyl acetate
- Amino resins
- n-Butylamines

Applications, chemicals and products that use n-butanol include:<sup>10,11</sup>

- Solvents – for paints, coatings, varnishes, resins, gums, dyes, camphor, vegetable oils, fats, waxes, resins, shellac, rubbers and alkaloids
- Plasticizers – to improve how a plastic material processes
- Coatings – as a solvent for a variety of applications, such as curable lacquers and cross-linked baking finishes
- Chemical intermediate or raw material – for producing many other chemicals and plastics, including safety glass, hydraulic fluids and detergent formulations
- Textiles – as a swelling agent and manufacturing garments from coated fabric
- Flotation agents
- Cleaners
- Floor polishes
- Cosmetics – including eye makeup, foundations, lipsticks, nail care products, personal hygiene products and shaving products
- Drugs and antibiotics, hormones, and vitamins
- Gasoline (as an additive) and brake fluid (formulation component)



## Exposure Potential

n-Butanol is used in the production of consumer products such as cosmetic nail products, but is not sold directly for consumer use. Based on the uses for n-butanol, the public could be exposed through:

- **Workplace exposure** – Exposure can occur either in an n-butanol manufacturing facility or in the various industrial and consumer services facilities that use n-butanol. n-Butanol should be handled in a well-ventilated area or in completely closed systems. Each manufacturing, industrial and service facility should have appropriate work process and safety equipment policies in place to limit n-butanol exposure. Good industrial hygiene practices minimize the risk of exposure.
- **Consumer exposure to products containing n-butanol** – Although Dow does not sell n-butanol for consumer use, it is used as a component in some formulated consumer products such as cosmetics. n-Butanol is considered safe as a cosmetic ingredient by the Cosmetic Ingredient Review Expert Panel.<sup>12,13</sup> n-Butanol demonstrates an overall low order of human toxicity.<sup>14</sup> See Health Information.
- **Environmental releases** – In the event of a spill, the focus is on containing the spill to prevent contamination of soil, surface or ground water. If n-butanol does reach soil and water nearby, it can pose a flammability concern. All ignition sources should be removed from the area, proper grounding and bonding techniques used, and proper protective equipment worn. n-Butanol is readily biodegradable in water and readily decomposed in the air by photodegradation. It has a low order of toxicity to environmental organisms at all levels of the food chain.<sup>15</sup> See Environmental, Health and Physical Hazard Information.
- **Large release** – Industrial spills or releases are infrequent and are generally contained. If a large spill does occur, the material should be captured, collected and re-processed, or disposed of according to

applicable governmental requirements. Emergency personnel should wear proper protective equipment and follow emergency procedures carefully. Flammability is the primary concern. All ignition sources should be removed from the area, proper grounding and bonding techniques used and flammability concerns communicated to the community, when appropriate. See Environmental, Health and Physical Hazard information.

### Health Information

n-Butanol shows a low order of toxicity in single-dose exposures to laboratory animals.<sup>16</sup> For safety, however, avoid contact with eyes, skin and clothing. Avoid breathing vapor. Do not swallow. Use only with adequate ventilation, keep containers closed and wash thoroughly after using.<sup>17</sup>

Prolonged excessive exposure may cause serious adverse effects, and even death. To identify acceptable exposure limits and proper protective equipment, please consult the Safety Data Sheet (SDS). Exposure may cause severe eye irritation and moderate skin irritation. Repeated skin contact may aggravate preexisting dermatitis and result in absorption of harmful amounts through the skin.<sup>18</sup> In most cases, n-butanol is quickly metabolized to carbon dioxide (CO<sub>2</sub>).<sup>19</sup>

Short-term exposure (acute) or repeated overexposure to n-butanol can result in depression of the central nervous system, as is often observed with other short-chain aliphatic alcohols. This effect is usually transient (goes away after the exposure is removed and the body recovers/metabolizes the material).<sup>20</sup>

According to the European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC), there is no evidence that n-butanol exhibits genotoxicity (causes damage to the DNA or cancer).

There is a report of fetotoxicity (birth defects or malformations) in rats when the exposures are great enough to cause significant toxicity to the mother.<sup>21,22</sup> In a rat study without detailed information, n-butanol has caused birth defects at doses reported to be nontoxic to the mother.<sup>23</sup> The dose levels producing these effects in both studies were many times higher than any dose levels expected from exposure due to use of n-butanol. In fact, a newer study utilizing current protocols has shown no evidence of fetotoxicity at high levels that are toxic to the mother.<sup>24</sup>

For more information on the health hazards of n-butanol and recommended protective equipment, view the Safety Data Sheet (SDS).

### Environmental Information

n-Butanol is considered a volatile organic compound (VOC) and is emitted by natural sources such as plants (rape, rye and grass), trees (beech, birch and hornbeam), animal waste, microbes and insects.

n-Butanol enters the environment from either natural sources or, to a small extent, during its production, transport, storage and use as a chemical intermediate and a solvent. The primary route for entering the environment is the release to the atmosphere when used as a solvent. n-Butanol is readily degradable in water and readily decomposed in the air by photodegradation. It does adsorb on soil, and favors partitioning to water versus air (80% to 15-20%). Because the degradation and decomposition is rapid, bioaccumulation or bioconcentration is unlikely.<sup>25</sup>

n-Butanol is practically non-toxic to aquatic organisms and birds on an acute basis.<sup>26</sup>

### Physical Hazard Information<sup>27</sup>

n-Butanol has a flash point of 35°C (95°F) and as such is considered a flammable liquid. When mixed with air at room temperature, n-butanol can form a flammable mixture. Every precaution should be taken to prevent exposure to ignition sources, including:

- Keep containers closed.
- Proper grounding and bonding procedures should be followed to minimize the risk of ignition through static build up, heat, sparks or flame. Never use air pressure for transferring the product.
- Vapors are heavier than air and may travel a long distance and accumulate in low lying areas. Ignition and/or flash back may occur.
- Ventilation can control airborne levels to minimize exposure and flammability risks.
- Violent steam generation or eruption may occur when applying a direct water stream to hot liquids.
- Containers, even those that are "empty," can contain vapors. Do not cut, drill, grind, weld, or perform similar operations on or near empty containers.

n-Butanol is thermally stable at typical use temperatures, but elevated temperatures can lead to decomposition. Avoid contact with halogens, strong acids and strong oxidizers.

Additional physical property information for n-butanol is available on the Safety Data Sheet.

### Regulatory Information

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

### Additional Information

- Safety Data Sheet  
(<http://www.dow.com/webapps/msds/msdssearch.asp>)
- Dow's Oxygenated Solvents website  
(<http://www.dow.com/oxysolvents/index.htm>)
- Product Information Sheet  
([http://www.dow.com/PublishedLiterature/dh\\_041e/09002f138041e1e4.pdf](http://www.dow.com/PublishedLiterature/dh_041e/09002f138041e1e4.pdf))
- *Working with Modern Hydrocarbon and Oxygenated Solvents: A Guide to Flammability* brochure  
([http://www.americansolventscouncil.org/resources/pdfs/Flammability\\_Guide.pdf](http://www.americansolventscouncil.org/resources/pdfs/Flammability_Guide.pdf))

For more business information about n-butanol, visit Dow's Oxygenated Solvents web site, listed above.

### References

- <sup>1</sup> *n-Butanol Product Information*, The Dow Chemical Company, Form No. 327-00014-1001, page 1.
  - <sup>2</sup> *n-Butyl Alcohol*, CIR Expert Panel Meeting, June 13-14, 2005, pages 4, 6 and 7.
  - <sup>3</sup> *n-Butyl Alcohol*, CIR Expert Panel Meeting, June 13-14, 2005, page 8.
  - <sup>4</sup> *Dow n-Butanol Safety Data Sheet*, No. 758, August 26, 2004, page 3.
  - <sup>5</sup> *Dow n-Butanol Safety Data Sheet*, No. 758, August 26, 2004, page 11.
  - <sup>6</sup> *Chemical Economics Handbook Report Plasticizer Alcohols*, SRI International, May 2002, pages 12-15.
  - <sup>7</sup> Dow refers to The Dow Chemical Company and its consolidated subsidiaries.
  - <sup>8</sup> *n-Butanol Product Information*, The Dow Chemical Company, Form No. 327-00014-1001, pages 1-2.
  - <sup>9</sup> *Chemical Economics Handbook Report Plasticizer Alcohols*, SRI International, May 2002, pages 8-9 and 27.
  - <sup>10</sup> *n-Butanol Product Information*, The Dow Chemical Company, Form No. 327-00014-1001, page 2.
  - <sup>11</sup> *Safety Assessment of n-Butyl Alcohol*, Cosmetic Ingredient Review Expert Panel Meeting, June 13-14, 2005, pages 7-8.
  - <sup>12</sup> *Addendum to the Safety Assessment of n-Butyl Alcohol*, Cosmetic Ingredient Review Expert Panel Meeting, August 5, 2005, page 31.
  - <sup>13</sup> <http://www.cir-safety.org/info.shtml>
  - <sup>14</sup> *n-Butyl Alcohol*, CIR Expert Panel Meeting, June 13-14, 2005, page 8.
  - <sup>15</sup> *ECETOC JACC No. 41 n-Butanol (CAS No. 71-36-3)*, European Centre for Ecotoxicology and Toxicology of Chemicals, Brussels, December 2003, page 3.
  - <sup>16</sup> *ECETOC JACC No. 41 n-Butanol (CAS No. 71-36-3)*, European Centre for Ecotoxicology and Toxicology of Chemicals, Brussels, December 2003, pages 3-4.
  - <sup>17</sup> *Dow n-Butanol Safety Data Sheet*, No. 758, August 26, 2004, page 3.
  - <sup>18</sup> *Dow n-Butanol Safety Data Sheet*, No. 758, August 26, 2004, page 3.
  - <sup>19</sup> *ECETOC JACC No. 41 n-Butanol (CAS No. 71-36-3)*, European Centre for Ecotoxicology and Toxicology of Chemicals, Brussels, December 2003, page 1.
  - <sup>20</sup> *ECETOC JACC No. 41 n-Butanol (CAS No. 71-36-3)*, European Centre for Ecotoxicology and Toxicology of Chemicals, Brussels, December 2003, pages 3-4.
  - <sup>21</sup> *ECETOC JACC No. 41 n-Butanol (CAS No. 71-36-3)*, European Centre for Ecotoxicology and Toxicology of Chemicals, Brussels, December 2003, pages 3-4.
  - <sup>22</sup> Nelson, B.K., et al., *Fundamental & Applied Toxicology*, No. 12, 1989, pages 469-479.
  - <sup>23</sup> Sitarek, K., et al., "Assessment of the Effect of Butanol Given to Female Rats in Drinking Water on Fertility," *International Journal of Occupational Medicine & Environmental Health*, No. 7, 1994, pages 365-370.
  - <sup>24</sup> Ema, M., et al., "Evaluation of Developmental Toxicity of 1-butanol Given to Rats in Drinking Water throughout Pregnancy," *Food and Chemical Toxicology*, No. 43, 2005, pages 325-331.
  - <sup>25</sup> *n-Butanol*, European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC), JACC No. 41, pages 11-16.
  - <sup>26</sup> *Dow n-Butanol Safety Data Sheet*, No. 758, August 26, 2004, pages 11-12.
  - <sup>27</sup> *Dow n-Butanol Safety Data Sheet*, No. 758, August 26, 2004, pages 2-9.
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