

Occupational Health Guideline for Butadiene

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $\text{CH}_2 = \text{CHCH} = \text{CH}_2$
- Synonyms: 1,3-Butadiene; divinyl; butadiene-1,3; biethylene; erythrene
- Appearance and odor: Colorless gas with a mildly aromatic odor at temperatures above -4.7 C (23.5 F). Below -4.7 C (23.5 F) butadiene is a colorless liquid with a mildly aromatic odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for butadiene is 1000 parts of butadiene per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 2200 milligrams of butadiene per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

- **Routes of exposure**
Butadiene can affect the body if it is inhaled or if the liquid comes in contact with the eyes or skin.
- **Effects of overexposure**
Overexposure to butadiene may cause irritation of the eyes, nose, and throat. It may also cause drowsiness and lightheadedness. Exposure to very high concentrations may cause unconsciousness and death. Spilled on the skin, it may cause frostbite and irritation.
- **Reporting signs and symptoms**
A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to butadiene.

- **Recommended medical surveillance**

Routine medical examinations should be provided to each employee who is exposed to butadiene at potentially hazardous levels.

- **Summary of toxicology**

Butadiene vapor is a narcotic at very high concentrations, with mild irritant properties. Deep anesthesia was induced in rabbits in 8 to 10 minutes at 200,000 to 250,000 ppm, although death occurred in 23 minutes at 250,000 ppm. Recovery from brief periods of anesthesia occurred within 2 minutes of terminating the exposure; no tissue changes were detectable microscopically after daily induction of anesthesia as many as 34 times. Daily exposure of various small animal species at 6700 ppm over 8 months resulted in no significant chronic effects. Human subjects tolerated 8000 ppm for 8 hours without apparent effect, other than slight irritation of the eyes and upper respiratory tract. No cases of serious illness arising from its industrial use have been reported. Contact of liquid butadiene with the skin causes a freezing burn.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 54.1
2. Boiling point (760 mm Hg): -4.7 C (23.5 F)
3. Specific gravity (water = 1): 0.62
4. Vapor density (air = 1 at boiling point of butadiene): 1.87
5. Melting point: -108.9 C (-164 F)
6. Vapor pressure at 20 C (68 F): 910 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.05
8. Evaporation rate (butyl acetate = 1): Greater than 25

- **Reactivity**

1. Conditions contributing to instability: Heat. Peroxides are formed when inhibitor concentration is not maintained at proper level. At elevated temperatures, such as in fire conditions, polymerization may take

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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place.

2. **Incompatibilities:** Contact with strong oxidizing agents may cause fires and explosions. Contact with copper and copper alloys may cause formation of explosive copper compounds.

3. **Hazardous decomposition products:** Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving butadiene.

4. **Special precautions:** Butadiene will attack some forms of plastics, rubber, and coatings. Butadiene in storage should be checked for proper inhibitor content, for self-polymerization, and for formation of peroxides that form when in contact with air and iron. Piping carrying butadiene may become plugged by formation of rubbery polymer.

• **Flammability**

1. **Flash point:** Not applicable (considered a gas for fire purposes)

2. **Autoignition temperature:** 450 C (842 F)

3. **Flammable limits in air, % by volume:** Lower: 2.0; Upper: 11.5

4. **Extinguishant:** Stop flow of gas.

• **Warning properties**

1. **Odor Threshold:** May reports an odor threshold of 0.16 ppm.

2. **Eye Irritation Level:** Grant states that "allegedly workmen exposed to vapors of butadiene (concentration or purity unspecified) have complained of irritation of eyes, nasal passages, throat, and lungs. However, a precise quantitative study has shown that even a concentration of 8000 ppm in air produces no symptoms in human beings. Dogs and rabbits exposed experimentally to as much as 6700 ppm 7-½ hours a day for 8 months have developed no histologically demonstrable abnormality in any part of the eyes."

3. **Evaluation of Warning Properties:** Since the odor threshold of butadiene is well below the permissible exposure limit, it is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

Sampling and analyses may be performed by collection of butadiene vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure butadiene may be

used. An analytical method for butadiene is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6). Methods for Set G" (order number PB 265 026).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent the skin from becoming frozen from contact with liquid butadiene or from contact with vessels containing liquid butadiene.

• Any clothing which becomes wet with liquid butadiene should be removed immediately and not reworn until the butadiene has evaporated.

• Employees should be provided with and required to use splash-proof safety goggles where liquid butadiene may contact the eyes.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to butadiene may occur and control methods which may be effective in each case:

Operation

Controls

Liberation during molding and vulcanizing operations in processing of rubber products from styrene-butadiene (SBR) elastomer; polybutadiene elastomer into rubber products; manufacture of high-impact polystyrene containing SBR/polybutadiene elastomer and manufacture of SBR foams; processing into products of ABS resins and styrene-butadiene copolymer resins; processing of neoprene elastomers into rubber products; processing of nitrile elastomer into nitrile latexes and rubbers; processing of nitrile elastomer and PVC-nitrile polyblends into rubber products and calendered plastic products

General dilution ventilation; local exhaust ventilation

Use in manufacture of SBR elastomer, polybutadiene elastomer, neoprene elastomer, nitrile elastomer, and SB copolymer and ABS resins

General dilution; local exhaust ventilation; personal protective equipment

Use in manufacture of adiponitrile, cycloolefins, 1,4-hexadiene tetramethylene sulfone, and tetrahydrophthalic anhydride

General dilution; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If liquid butadiene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If liquid butadiene gets on the skin, immediately flush the contaminated skin with water. If liquid butadiene soaks through the clothing, remove the clothing immediately and flush the skin with water. Do not use hot water for flushing. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of butadiene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If butadiene is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. If in liquid form, for small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber.
4. If in gaseous form, stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air and repair the leak or allow the cylinder to empty.

• Waste disposal methods:

Butadiene may be disposed of:

1. If in liquid form, by atomizing in a suitable combustion chamber.
2. If in gaseous form, by burning in a safe location or in a suitable combustion chamber.

REFERENCES

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RESPIRATORY PROTECTION FOR BUTADIENE

Condition	Minimum Respiratory Protection* Required Above 1000 ppm
Vapor Concentration	
5000 ppm or less	A gas mask with a chin-style canister providing protection against butadiene.
8000 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
20,000 ppm or less	A gas mask with a front- or back-mounted canister providing protection against butadiene. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 20,000 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against butadiene. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.