OCCUPATIONAL SAFETY AND HEALTH GUIDELINE

FOR n-BUTANE

INTRODUCTION

This guideline summarizes pertinent information about n-butane for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

- **Formula**

C_4H_{10}

- **Structure**

$CH_3CH_2CH_2CH_3$

- **Synonyms**

Butane, butyl hydride, diethyl, liquefied petroleum gas, methylethylmethane

- **Identifiers**

1. CAS No.: 106-97-8
2. RTECS No.: EJ4200000
3. DOT UN: 1011 22
4. DOT label: Flammable Gas

- **Appearance and odor**

n-Butane is a colorless gas with no odor, although an odorant is sometimes added to the gas to provide warning of its presence. This gas is commercially available in several grades of purity and in various mixtures (with the isobutane isomer, propane, and/or pentane). n-Butane is usually shipped under pressure as a liquefied gas and is one of the major ingredients in bottled gas.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 58.1
2. Boiling point (760 mm Hg): −0.5°C (31.1°F)
3. Specific gravity (water = 1): 0.5788 at 20°C (68°F)
4. Vapor density (air = 1 at boiling point of n-butane): 2.07
5. Melting point: −138.4°C (−217.1°F)
6. Vapor pressure at 20°C (68°F): 1,557 mm Hg
7. Solubility: Soluble in water; very soluble in alcohol, ether, and chloroform
8. Evaporation rate: Not applicable

- **Reactivity**

1. Conditions contributing to instability: Heat, sparks, and open flame
2. Incompatibilities: Fire and explosions may result from contact of n-butane with oxidizers. A mixture of n-butane and oxygen will explode on contact with nickel carbonyl in the 20° to 40°C (68° to 104°F) temperature range.
3. Hazardous decomposition products: Acrid smoke and fumes may be released when n-butane undergoes thermal oxidative decomposition.
4. Special precautions: Do not use n-butane around sparking motors or other nonexplosionproof equipment. Ground all lines and equipment used with n-butane.

- **Flammability**

The National Fire Protection Association has assigned a flammability rating of 4 (extreme fire hazard) to n-butane.

1. Flash point: −60°C (−76°F) (closed cup) (liquefied n-butane).
2. Autoignition temperature: 430°C (806°F)

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3. Flammable limits in air (% by volume): Lower, approximately 1.9; upper, approximately 8.4

4. Extinguishant: Stop flow of gas. Use water to keep fire-exposed containers cool and to protect persons effecting the shutoff. If a leak or spill has not ignited, water spray may be used to disperse the gas or vapor and to protect persons attempting to stop the leak.

Fires involving n-butane should be fought upwind and from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Vapor explosion and poison hazards may occur indoors, outdoors, or in sewers. Vapors may travel to a source of ignition and flash back. Containers of n-butane may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Personnel should withdraw immediately if they hear a rising sound from a venting safety device or if a container becomes discolored as a result of fire. Dikes should be used to contain fire-control water for later disposal. If a tank car or truck is involved in a fire, personnel should isolate an area of a half mile in all directions. Firefighters should wear a full set of protective clothing (including a self-contained breathing apparatus) when fighting fires involving n-butane.

EXPOSURE LIMITS

• OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for n-butane is 800 ppm (1,900 mg/m^3) as an 8-hr time-weighted average (TWA) [29 CFR 1910.1000, Table Z-1-A].

• NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) for n-butane of 800 ppm (1,900 mg/m^3) as an 8-hr TWA [NIOSH 1992].

• ACGIH TLV®

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned n-butane a threshold limit value (TLV) of 800 ppm (1,900 mg/m^3) as a TWA for a normal 8-hr workday and a 40-hr workweek [ACGIH 1991b].

• Rationale for limits

The limits are based on drowsiness and the risk of narcosis associated with exposure to n-butane.

HEALTH HAZARD INFORMATION

• Routes of exposure

Exposure to n-butane can occur through inhalation or eye and skin contact.

• Summary of toxicology

1. *Effects on Animals*: Contact with liquid n-butane can cause frostbite. This gas is also an anesthetic and asphyxiant in animals at very high concentrations. Although n-butane was mildly to moderately irritating to rabbit skin, it did not produce ocular or respiratory tract irritation [NLM 1992]. However, direct tissue contact with liquid n-butane can cause frostbite [NLM 1992]. Anesthetized dogs concomitantly exposed to 5,000 ppm developed hemodynamic changes (decreased myocardial contractility, stroke volume, cardiac output, and left ventricular and aortic pressures) [Clayton and Clayton 1981]. Dogs exposed to 10,000 ppm for 2 hr or 200,000 ppm for 2 min were hypersensitized to epinephrine-induced ventricular fibrillation. Exposure of dogs to 150,000 to 900,000 ppm for 10 min also caused heart sensitization to epinephrine-induced arrhythmias [NLM 1992]. The anesthetic concentration for n-butane is 250,000 ppm in dogs [NLM 1992] and 220,000 ppm for 1 min or 130,000 ppm for 25 min in mice [Clayton and Clayton 1981]. The 30-min LC_{50} for mice is approximately 285,000 ppm, but the 15-min LC_{50} for rats is about 275,000 ppm [NLM 1992]. n-Butane was not mutagenic in the *Salmonella typhimurium* assay [NLM 1992].

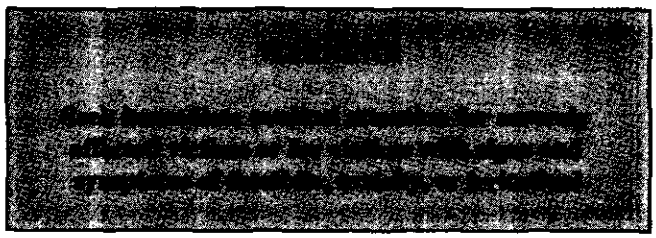
2. *Effects on Humans*: A transient blurring of vision resulted when n-butane was accidently sprayed into the eyes from a cigarette lighter [NLM 1992]. However, contact of the eyes or skin with n-butane gas does not normally cause irritation, but contact with the liquefied form may cause frostbite of the eyes or skin [Clayton and Clayton 1981; Genium 1990]. Exposure to 10,000 ppm for 10 min may lead to drowsiness but does not appear to cause systemic effects [Clayton and Clayton 1981]. A 2-year-old girl developed seizures, hypotension, and recurrent ventricular tachycardia following inhalation of an aerosol spray from a can containing a mixture of n-butane, isobutane, and propane [NLM 1992]. Progressive bilateral pulmonary infiltrates consistent with hydrocarbon pneumonitis developed in a "fire breather" following an inhalation of unignited fumes from a butane lighter. Exposure of volunteers to 1,000 ppm for 8 hr or 500 ppm for 8 hr/day, 5 days/week for 2 weeks did not induce toxicity [ACGIH 1991a]. Intentional inhalation abuse of n-butane for 1 year by a 16-year-old girl caused her to suffer from visual hallucinations, increased irritability, and social withdrawal [NLM 1992]. Exposure to n-butane at very high concentrations can affect the central nervous system, causing narcosis and asphyxiation [Clayton and Clayton 1981].

- **Signs and symptoms of exposure**

1. *Acute exposure*: Acute exposure to n-butane can cause central nervous system depression (drowsiness and lightheadedness), narcosis, and asphyxiation. Contact with liquefied n-butane can cause eye and skin burns (frostbite).

2. *Chronic exposure*: Visual hallucinations, irritability, and social withdrawal have been reported with chronic exposure. Cardiac sensitization may also be possible.

- **Emergency procedures**



Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure*: If tissue is frozen, seek medical attention ***immediately***; if tissue is not frozen, ***immediately and thoroughly*** flush the eyes with large amounts of water for at least 15 min, occasionally lifting the lower and upper eyelids. If irritation, pain, swelling, lacrimation, or photophobia persists, get medical attention as soon as possible.

2. *Skin exposure*: If frostbite has occurred, seek medical attention ***immediately***; do ***not*** rub the affected areas or flush them with water. If frostbite has ***not*** occurred, ***immediately and thoroughly*** wash contaminated skin with soap and water.

3. *Inhalation exposure*: Move the victim to fresh air ***immediately***.

If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Rescue*: Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve n-butane and may result in worker exposures to this substance:

—Use of n-butane as a raw material in the production of motor and aviation fuels

—Use of n-butane as a household fuel, solvent, refrigerant, standby and enricher gas, and propellant in aerosols

—Use of pure grades of n-butane in calibrating instruments

—Use of n-butane as a food additive

—Manufacture of ethylene and butadiene

—Use of n-butane as a special motor fuel for in-plant trucking, where the presence of gasoline vapors is undesirable

The following methods are effective in controlling worker exposures to n-butane, depending on the feasibility of implementation:

—Process enclosure

—Local exhaust ventilation

—General dilution ventilation

—Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. Industrial ventilation—a manual of recommended practice. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

2. Burton DJ [1986]. Industrial ventilation—a self study companion. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. Design of industrial ventilation systems. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. Engineering design for control of workplace hazards. New York, NY: McGraw-Hill.

5. Plog BA [1988]. Fundamentals of industrial hygiene. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety or health, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To

place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for n-butane.

WORKPLACE MONITORING AND MEASUREMENT

A worker's exposure to airborne n-butane is determined by using two charcoal tubes in series (100/50-mg sections, 20/40 mesh). Samples are collected at a maximum flow rate of 0.1 liter/min until a maximum air volume of 10 liters is collected. The sample is then treated with carbon disulfide to extract the n-butane. Analysis is conducted by gas chromatography using a flame ionization detector. This method is included in the OSHA In-House Methods File [OSHA 1989].

PERSONAL HYGIENE

If liquefied n-butane contacts the skin, workers should flush the affected areas immediately with plenty of water for 15 min and should not rub the affected areas.

Workers should not eat, drink, or use tobacco products in areas where n-butane is handled, processed, or stored.

Workers should wash their hands after handling liquefied n-butane.

STORAGE

n-Butane should be stored in a cool, dry, well-ventilated, low-fire-risk area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of n-butane should be protected from physical damage and should be stored separately from oxidizers (including cylinders of oxygen or chlorine), nickel carbonyl, heat, sparks, and open flame. All equipment used with n-butane should be electrically bonded and grounded. Because containers that formerly contained n-butane may still hold product residues, they should be handled appropriately.

LEAKS

In the event of a leak involving n-butane, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a leak:

1. Notify safety personnel.
2. Remove all sources of heat and ignition.
3. Ventilate potentially explosive atmospheres; supply optimum explosionproof ventilation to disperse the gas.
4. Use self-contained breathing apparatus and protection against contact with the cold liquid to avoid frostbite when attempting to stop the leak.
5. Stop the leak or remove the leaky cylinder or tank to a safe, open area and vent it slowly to empty the container.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

- **Emergency planning requirements**

n-Butane is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

- **Reportable quantity requirements for hazardous releases**

Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the National Response Center of an accidental release of n-butane; there is no reportable quantity for this substance.

- **Community right-to-know requirements**

Employers are not required by Section 313 of SARA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of n-butane emitted or released from their facility annually.

- **Hazardous waste management requirements**

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although n-butane is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are

conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

- **Conditions for respirator use**

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of n-butane exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

- **Respiratory protection program**

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1900.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective gloves and clothing should be worn to prevent skin contact with n-butane. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. The following materials have been shown to provide resistance to liquefied n-butane: neoprene rubber, the combination of nitrile and polyvinyl chloride, and Viton®. Natural rubber, nitrile, and polyvinyl chloride have demonstrated poor resistance to n-butane.

Safety glasses, goggles, or face shields should be worn during operations in which n-butane might contact the eyes (e.g., through splashes of solution). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with n-butane. Contact lenses should not be worn if the potential exists for exposure to liquefied n-butane.

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