

Occupational Health Guideline for Hexane

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: $\text{CH}_3(\text{CH}_2)_4\text{CH}_3$
- Synonyms: *Hexyl hydride; normal hexane*
- Appearance and odor: Colorless liquid with a mild, gasoline-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for hexane is 500 parts of hexane per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 1800 milligrams of hexane per cubic meter of air (mg/m^3). NIOSH has recommended that the permissible exposure limit be reduced to 100 ppm ($350 \text{ mg}/\text{m}^3$) averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 510 ppm ($1,800 \text{ mg}/\text{m}^3$) averaged over a 15-minute period. The NIOSH Criteria Document for Alkanes should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

• Routes of exposure

Hexane can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed.

• Effects of overexposure

1. *Short-term Exposure:* Overexposure to hexane may cause lightheadedness, giddiness, nausea, and headache. It may also cause irritation of the eyes and nose. Greater exposure may cause unconsciousness and death.

2. *Long-term Exposure:* Prolonged overexposure to the liquid may cause irritation of the skin.

3. *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 hexane.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to hexane at potentially hazardous levels:

1. *Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the employee at increased risk, and to establish a baseline for future health monitoring. Examination of the central and peripheral nervous systems and the skin should be stressed.

—Skin disease: Hexane is a defatting agent and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of hexane might cause exacerbation of symptoms due to its irritant properties.

—Liver disease: Although hexane is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

—Kidney disease: Although hexane is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

2. *Periodic Medical Examination:* The aforementioned examinations should be performed on an annual basis.

• Summary of toxicology

Hexane vapor is a narcotic; it also is a mild upper respiratory irritant. Polyneuropathy has been reported to occur in Japanese workers exposed to hexane vapors. Effects appeared to be reversible. Concentrations of 30,000 ppm produced narcosis in mice within 30 to 60

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.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

minutes; convulsions and death occurred at 35,000 to 40,000 ppm; at 64,000 ppm respiratory arrest was produced in 2.5 to 4.5 minutes from the start of exposure. Concentrations up to 8000 ppm produced no anesthesia. In human subjects, 2000 ppm for 10 minutes produced no effects, but 5000 ppm resulted in dizziness and a sensation of giddiness. Other investigators reported slight nausea, headache, and irritation of the eyes and throat at 1400 to 1500 ppm. In industrial practice, mild narcotic symptoms such as dizziness have been observed when concentrations exceeded 1000 ppm, but not below 500 ppm. Chronic effects have rarely been reported. The liquid is a defatting agent, and prolonged exposure may cause irritation of the skin. Aspiration may cause a chemical pneumonia.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 86
2. Boiling point (760 mm Hg): 68.9 C (156 F)
3. Specific gravity (water = 1): 0.7
4. Vapor density (air = 1 at boiling point of hexane): 3.0
5. Melting point: -95 C (-139 F)
6. Vapor pressure at 20 C (68 F): 124 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.014
8. Evaporation rate (butyl acetate = 1): Data not available

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizing agents may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving hexane.
4. Special precautions: Hexane will attack some forms of plastics, rubber, and coatings.

• Flammability

1. Flash point: -21.7 C (-7 F) (closed cup)
2. Autoignition temperature: 225 C (437 F)
3. Flammable limits in air, % by volume: Lower: 1.1; Upper: 7.5
4. Extinguishant: Dry chemical, foam, carbon dioxide

• Warning properties

1. Odor Threshold: No quantitative information is available.
2. Irritation Levels: The *Documentation of TLV's* notes that "Drinker, Yaglou, and Warren found slight nausea, headache, and eye and throat irritation at 1400 to 1500 ppm. Nelson found no irritation at 500 ppm in unacclimated subjects."
3. Evaluation of Warning Properties: Since hexane can be detected at a concentration approximately 3 times the permissible exposure limit, it is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• Eight-Hour Exposure Evaluation

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).

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of hexane. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method

Sampling and analyses may be performed by collection of hexane 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 hexane may be used. An analytical method for hexane 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).

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 repeated or prolonged skin contact with liquid hexane.
- Any clothing which becomes wet with liquid hexane should be removed immediately and not reworn until the hexane is removed from the clothing.
- Clothing wet with liquid hexane should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of hexane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the hexane, the person performing the operation should be informed of hexane's hazardous properties.
- Employees should be provided with and required to use splash-proof safety goggles where liquid hexane may contact the eyes.
- Where there is any possibility that employees' eyes may be exposed to hexane, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes wet with liquid hexane should be promptly washed or showered with soap or mild detergent and water to remove any hexane.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use as an extractant of agricultural products	Process enclosure; general dilution ventilation
Use in manufacture of polyolefins and certain elastomers as a catalyst carrier and assist in controlling molecular weight by dropping polymer out of solution when a certain molecular weight is reached	Process enclosure; general dilution ventilation; personal protective equipment
Use as an extractant of animal fat	Process enclosure; general dilution ventilation; personal protective equipment

Operation

Use as a solvent in adhesives to control viscosity and reduce drying time

Use in pharmaceutical industry as a reaction medium, immiscible solvent, and extraction ergot

Use during compounding of adhesives as a diluent or vehicle solvent; use in compounding printing inks, lacquers, or stains; use as a laboratory reagent and general solvent; use in manufacture of low-temperature thermometers

Controls

General dilution ventilation; personal protective equipment

Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment

Local exhaust ventilation; general dilution 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 hexane 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 hexane gets on the skin, promptly wash the contaminated skin using soap or mild detergent. If hexane soaks through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of hexane, 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.

• Swallowing

If hexane has been swallowed, do not induce vomiting. Get medical attention immediately.

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

1. Remove all ignition sources.

2. Ventilate area of spill or leak.

3. 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. Hexane should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

- Waste disposal method:

Hexane may be disposed of by atomizing in a suitable combustion chamber.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Hexane," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- American Industrial Hygiene Association: "Hexane," *Hygienic Guide Series*, Detroit, Michigan, 1959.
- Charter Chemical Company: *Product Bulletin - Hexane*.
- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.
- Inoue, T., et al.: "Polyneuritis Caused by n-Hexane and the Maximum Allowable Concentration," presentation at XVI Congress on Occupational Health, Tokyo, Japan, September 22-27, 1969.
- National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare: *Criteria for a Recommended Standard Occupational Exposure to Alkanes*, HEW Publication No. (NIOSH) 77-151, GPO No. 017-033-00213-4, U.S. Government Printing Office, Washington, D.C., 1977.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.
- Sax, N. I.: *Dangerous Properties of Industrial Materials* (3rd ed.), Van Nostrand Reinhold, New York, 1968.
- Swann, H. E., Jr., et al.: "Acute Inhalation Toxicology of Volatile Hydrocarbons," *American Industrial Hygiene Association Journal*, 35:511-518, 1974.

RESPIRATORY PROTECTION FOR HEXANE

Condition	Minimum Respiratory Protection* Required Above 500 ppm
Vapor Concentration	
1000 ppm or less	Any chemical cartridge respirator with an organic vapor cartridge(s). Any supplied-air respirator. Any self-contained breathing apparatus.
5000 ppm or less	A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 5000 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 organic vapors. Any escape self-contained breathing apparatus.

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

