

Occupational Health Guideline for Cyclohexane

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: C_6H_{12}
- Synonyms: Hexahydrobenzene; hexamethylene; benzene hexahydride
- Appearance and odor: Colorless liquid with mild, sweet odor resembling chloroform or benzene.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for cyclohexane is 300 parts of cyclohexane per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 1050 milligrams of cyclohexane per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

- Routes of exposure
Cyclohexane can affect the body if it is inhaled, is swallowed, or comes in contact with the eyes or skin.
- Effects of overexposure
 1. *Short-term Exposure:* Exposure to cyclohexane may cause dizziness and nausea. At higher levels of exposure, a person may become unconscious. Liquid splashes of cyclohexane may irritate the eyes.
 2. *Long-term Exposure:* Prolonged or repeated exposures can cause skin rash.
 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 cyclohexane.

- Recommended medical surveillance

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

1. *Initial Medical Screening:* Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from cyclohexane exposure.

—Skin disease: Cyclohexane 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.

—Kidney disease: Although cyclohexane 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 possible impairment of renal function.

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

—Liver disease: Although cyclohexane 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.

2. *Periodic Medical Examination:* Any employee developing the above-listed conditions should be referred for further medical examination.

- Summary of toxicology

Cyclohexane is primarily a local irritant and central nervous system depressant. The depressant effect is from exposure to concentrations above 12,000 ppm, while prolonged or repeated exposure to concentrations above 300 ppm produces a mild irritation of the eyes and upper respiratory tract. Aspiration causes a chemical pneumonitis.

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

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 84
2. Boiling point (760 mm Hg): 80 C (177 F)
3. Specific gravity (water = 1): 0.78
4. Vapor density (air = 1 at boiling point of cyclohexane): 2.98
5. Melting point: 6.5 C (44 F)
6. Vapor pressure at 20 C (68 F): 95 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Less than 0.01
8. Evaporation rate (butyl acetate = 1): Data not available

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with 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 cyclohexane.

4. Special precautions: None

• Flammability

1. Flash point: -20 C (-4 F) (closed cup)
2. Autoignition temperature: 245 C (473 F)
3. Flammable limits in air, % by volume: Lower: 1.31; Upper: 8.35
4. Extinguishant: Dry chemical, foam, or carbon dioxide

• Warning properties

1. Odor Threshold: May reports that the odor threshold of cyclohexane is 0.41 ppm. The Manufacturing Chemists Association (MCA) reports that "the sweetish odor of cyclohexane, which resembles that of chloroform, is not adequate warning against exposure to hazardous concentrations." The *AIHA Hygienic Guide* reports similar information.

2. Eye Irritation Level: The *Documentation of TLV's* reports that, according to Gerarde, a concentration of 300 ppm is somewhat irritating to the eyes. The MCA, however, states that even in high concentrations the vapor is not irritating to the eyes.

3. Evaluation of Warning Properties: Since the MCA and the *Hygienic Guide* both state that the odor of cyclohexane is not sufficient warning against exposure to hazardous concentrations, and since MCA states that even high concentrations of cyclohexane do not cause eye irritation, for the purposes of this guideline, cyclohexane is treated as a material with poor 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 cyclohexane 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 cyclohexane may be used.

An analytical method for cyclohexane is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 1, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00267-3).

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 cyclohexane.

• Clothing wet with liquid cyclohexane should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of cyclohexane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the cyclohexane, the person performing the operation should be informed of cyclohexane's hazardous properties.

• Any clothing which becomes wet with liquid cyclohexane should be removed immediately and not reworn until the cyclohexane is removed from the clothing.

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

SANITATION

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

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use as a solvent to dissolve cellulose ethers, resins, fats, waxes, oils, bitumin, and crude rubber; use in perfume manufacture; use during surface coating operations (lacquers)	Process enclosure; local exhaust ventilation; personal protective equipment
Use in synthesis of adipic acid for production of Nylon 66 and engineering plastics	Process enclosure; local exhaust ventilation; personal protective equipment
Use during synthesis of caprolactam in Nylon 6 production	Process enclosure; 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 cyclohexane gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If cyclohexane gets on the skin, promptly flush the contaminated skin with water. If cyclohexane soaks through the clothing, remove the clothing immediately and flush the skin with water. When there is skin irritation, get medical attention.

• Breathing

If a person breathes in large amounts of cyclohexane, 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 cyclohexane 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 cyclohexane 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. Combustion may be improved by mixing with a more flammable liquid. Cyclohexane liquid should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

- Waste disposal methods:

Cyclohexane may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.
2. By atomizing in a suitable combustion chamber. Combustion may be improved by mixing with a more flammable liquid.

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RESPIRATORY PROTECTION FOR CYCLOHEXANE

Condition	Minimum Respiratory Protection* Required Above 300 ppm
Vapor Concentration	
3000 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
10,000 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 10,000 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 organic vapors. Any escape self-contained breathing apparatus.

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