

Occupational Health Guideline for Cyclohexanol

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: $C_6H_{11}OH$
- Synonyms: Hexalin; hydroxycyclohexane; hydralin; anol; hexahydrophenol; cyclohexyl alcohol
- Appearance and odor: Colorless, viscous liquid or sticky solid with a faint, camphor-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for cyclohexanol is 50 parts of cyclohexanol per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 200 milligrams of cyclohexanol per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

- Routes of exposure
Cyclohexanol can affect the body if it is swallowed, inhaled, or comes in contact with the skin or eyes.
- Effects of overexposure
 1. *Short-term Exposure:* Overexposure to cyclohexanol may cause headache and irritation of the eyes, nose, and throat.
 2. *Long-term Exposure:* Repeated exposure to cyclohexanol 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 cyclohexanol.

- Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to cyclohexanol 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 cyclohexanol exposure.

—Skin disease: Cyclohexanol 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.

—Liver disease: Although cyclohexanol 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 cyclohexanol 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.

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

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

- Summary of toxicology

Cyclohexanol vapor has a narcotic effect at high concentrations and causes irritation of the eyes, nose, and throat. Prolonged exposure at 145 ppm resulted in minimal changes in the liver and kidneys of rabbits. Lethargy occurs in the monkey at 700 ppm, and narcosis in rabbits at 1000 ppm. The liquid defats the skin and may produce dermatitis upon prolonged or frequent contact. No chronic systemic effects have been reported in humans.

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: 100
2. Boiling point (760 mm Hg): 161 C (322 F)
3. Specific gravity (water = 1): 0.96
4. Vapor density (air = 1 at boiling point of cyclohexanol): 3.5
5. Melting point: 23.6 C (75 F)
6. Vapor pressure at 20 C (68 F): 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 3.6
8. Evaporation rate (butyl acetate = 1): 0.08

• Reactivity

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

• Flammability

1. Flash point: 67.8 C (154 F (closed cup)
2. Autoignition temperature: 300 C (572 F)
3. Flammable limits in air, % by volume: Lower: 2.4 (calculated at flash point)
4. Extinguishant: Alcohol foam, carbon dioxide, dry chemical

• Warning properties

1. Odor Threshold: No quantitative information is available.
2. Irritation Levels: The *Documentation of TLV's* states that "Nelson and his associates found 100 ppm of cyclohexanol to be objectionable to the ten persons subjected to this concentration in a study of sensory response to a number of solvent vapors. In this study the individuals classified the effect of the vapor on the eyes, nose, and throat after 3 to 5 minutes' exposure as objectionable. The limit of 50 ppm was chosen to reduce objectionable irritation."
3. Evaluation of Warning Properties: Since cyclohexanol is known to produce eye, nose, and throat irritation at a concentration only twice the permissible exposure limit, it is treated as a substance 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 cyclohexanol vapors using an adsorption tube with subsequent desorption with 2-propanol in 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 cyclohexanol may be used. An analytical method for cyclohexanol 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 solid or liquid cyclohexanol.
- Clothing wet with liquid cyclohexanol should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of cyclohexanol from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the cyclohexanol, the person performing the operation should be informed of cyclohexanol's hazardous properties.
- Non-impervious clothing which becomes contaminated with solid or liquid cyclohexanol should be removed promptly and not reworn until the cyclohexanol is removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where liquid or solid cyclohexanol may contact the eyes.

SANITATION

- Skin that becomes contaminated with liquid or solid cyclohexanol should be promptly washed or showered with soap or mild detergent and water to remove any cyclohexanol.
- Employees who handle liquid or solid cyclohexanol should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use during synthesis of adipic acid, primarily in production of Nylon 66	General dilution ventilation; personal protective equipment
Liberation during synthesis of caprolactam	General dilution ventilation
Use during application of surface coatings of natural and synthetic textile dyes, cotton mercerizers, paints, varnishes, lacquers, and shellacs	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use in cleaning and degreasing operations	Local exhaust ventilation; personal protective equipment
Use in production of dicyclohexyl phthalate, other cyclohexyl esters, soaps, synthetic detergents, and rubber cement	Local exhaust ventilation

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

• Breathing

If a person breathes in large amounts of cyclohexanol, 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

When cyclohexanol has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

• 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 cyclohexanol 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, mixed with ethyl alcohol, and atomized in a suitable combustion chamber.

- Waste disposal methods:

Cyclohexanol 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 mixing with ethyl alcohol and atomizing in a suitable combustion chamber.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Cyclohexanol," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.

- Browning, E.: *Toxicity and Metabolism of Industrial Solvents*, Elsevier, New York, 1965.
- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.

- International Labour Office: *Encyclopedia of Occupational Health and Safety*, McGraw-Hill, New York, 1971.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.

RESPIRATORY PROTECTION FOR CYCLOHEXANOL

Condition	Minimum Respiratory Protection* Required Above 50 ppm
Vapor Concentration	
1000 ppm or less	Any chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).
2500 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.
3500 ppm or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 3500 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.