

Occupational Health Guideline for Morpholine

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_4H_8ON
- Synonyms: Tetrahydro-1,4-oxazine; diethyleneimide oxide
- Appearance and odor: Colorless liquid with a weak, ammonia-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for morpholine is 20 parts of morpholine per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 70 milligrams of morpholine per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

- Routes of exposure
Morpholine can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. It may enter the body through the skin.
- Effects of overexposure
 1. *Short-term Exposure:* Morpholine may cause irritation of the eyes, nose, throat, lungs, and skin.
 2. *Long-term Exposure:* Repeated or prolonged overexposure to morpholine may cause skin irritation.
 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 morpholine.

• Recommended medical surveillance

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

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

—Liver disease: Morpholine causes liver damage in animals. 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: Morpholine causes kidney damage in animals. The importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

—Eye disease: Morpholine is an eye irritant and has caused corneal edema in workers. Persons with pre-existing eye disorders may be more susceptible to the effects of this agent.

—Skin disease: Morpholine is a primary skin irritant and induces hypersensitive responses. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

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

• Summary of toxicology

Morpholine vapor is an irritant to the skin, eyes, mucous membranes, and the respiratory tract. Hypersensitivity is common. Repeated daily exposure of rats to 18,000 ppm was lethal to some animals; those dying during the third to fifth days of exposure revealed damage to lungs, liver, and kidneys. A human exposure

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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to 12,000 ppm for 1-½ minutes in a laboratory produced nose irritation and cough; mouth pipetting of the liquid caused a severe sore throat and reddened mucous membranes. The liquid dropped in the eye of a rabbit caused moderate injury with ulceration of the conjunctiva and corneal clouding. Workers exposed for several hours to low vapor concentrations complained of foggy vision with rings around lights, the result of corneal edema which cleared within 3 to 4 hours after cessation of exposure. The liquid is a severe skin irritant and may produce contact dermatitis. In industry, some instances of skin and respiratory tract irritation have been observed.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 87.1
2. Boiling point (760 mm Hg): 128 C (263 F)
3. Specific gravity (water = 1): 1.0
4. Vapor density (air = 1 at boiling point of morpholine): 3.0
5. Melting point: -4.8 C (23 F)
6. Vapor pressure at 20 C (68 F): 7 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Miscible in all proportions
8. Evaporation rate (butyl acetate = 1): Less than 1

• Reactivity

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

• Flammability

1. Flash point: 35 C (95 F) (closed cup)
2. Autoignition temperature: 310 C (590 F)
3. Flammable limits in air, % by volume: Lower: 1.8 (calculated); Upper: 11 (estimated)
4. Extinguishant: Carbon dioxide, dry chemical, alcohol foam

• Warning properties

1. Odor Threshold: Grant states that morpholine has a characteristic amine odor. No quantitative information is available concerning the odor threshold, however.
2. Eye Irritation Level: Grant reports that lacrimation has been observed among experimental animals and among industrial workers who have been exposed to high vapor concentrations. "At low concentrations in air, morpholine has been listed with its N-ethyl and N-methyl derivatives among the amines which have been observed to cause transient edema of the cornea and temporary foggy vision with haloes around lights in workers exposed to the vapors for many hours, the

symptoms usually coming on after work and clearing spontaneously by the next day."

Patty also reports that morpholine irritates the mucous membranes.

No quantitative information is available, however, concerning the threshold of eye irritation.

3. Other Information: Both Patty and Grant note that morpholine is a respiratory tract irritant, but no quantitative information is available concerning the threshold of this irritation.

4. Evaluation of Warning Properties: Since no quantitative information relating warning properties to air concentrations is available, morpholine is treated as a substance 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 morpholine in an adsorption tube containing silica gel, followed by desorption with sulfuric acid, and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure morpholine may be used. An analytical method for morpholine is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

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 any possibility of skin contact with liquid morpholine or solutions containing greater than 25% morpholine by weight and to prevent repeated or prolonged skin contact with solutions containing 25% or less of morpholine by weight.
- Clothing contaminated with morpholine should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of morpholine from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the morpholine, the person performing the operation should be informed of morpholine's hazardous properties.
- Where there is any possibility of exposure of an employee's body to liquid morpholine or solutions containing greater than 25% morpholine by weight, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Any clothing which becomes wet with liquid morpholine should be removed immediately and not reworn until the morpholine is removed from the clothing.
- Non-impervious clothing which becomes contaminated with morpholine should be removed promptly and not reworn until the morpholine is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid morpholine or solutions containing morpholine contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to liquid morpholine or solutions containing greater than 15% morpholine by weight, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with morpholine should be promptly washed or showered to remove any morpholine.
- Employees who handle liquid morpholine or solutions containing morpholine should wash their hands thoroughly before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

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

Operation

Use in manufacture of rubber chemicals for rubber accelerators, catalysts, plasticizers, curing agents, stabilizers of halogenated butyl rubber, and emulsifying agents

Use as a corrosion inhibitor in steam boiler systems, petroleum refining, sterilization autoclaves, and in natural gas processing; use in manufacture of optical brightening agents in bleaches and detergents

Use in compounding of waxes and polishes for commercial use as automobile waxes, rubless waxes and polishes, and water-resistant polishes

Use as a chemical intermediate for textile industry as lubricants, sizing emulsifiers, and softening agents; in pharmaceutical industry as bactericides, analgesics, anesthetics, anti-spasmodics, and anti-malarials; in chemical industry for alkyl morpholines, emulsifying agents, surface-active agents, cosmetics, and soap emulsifiers; in agriculture for protective coatings for fresh fruits and vegetables, pesticide emulsifiers, insecticides, fumigants, and herbicides

Use as a solvent for dyes, waxes, resins, and casein

Controls

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

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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 morpholine or solutions containing morpholine get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If liquid morpholine or solutions containing morpholine get on the skin, immediately flush the contaminated skin with water. If liquid morpholine or solutions containing morpholine soak through the clothing, remove the clothing immediately and flush the skin with water. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of morpholine, 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 morpholine has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. 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 morpholine 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 equipped with an appropriate effluent gas cleaning device. Morpholine should not be allowed

to enter a confined space, such as a sewer, because of the possibility of an explosion.

• Waste disposal method:

Morpholine may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

ADDITIONAL INFORMATION

To find additional information on morpholine, look up morpholine in the following documents:

- Medical Surveillance for Chemical Hazards
- Respiratory Protection for Chemical Hazards
- Personal Protection and Sanitation for Chemical Hazards

These documents are available through the NIOSH Division of Technical Services, 4676 Columbia Parkway, Cincinnati, Ohio 45226.

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RESPIRATORY PROTECTION FOR MORPHOLINE

Condition	Minimum Respiratory Protection* Required Above 20 ppm
Vapor Concentration	
1000 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
8000 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 8000 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.

