

# OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR DIETHANOLAMINE

## INTRODUCTION

This guideline summarizes pertinent information about diethanolamine 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 Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

## SUBSTANCE IDENTIFICATION

### • Formula



### • Structure



### • Synonyms

N,N-Diethanolamine; iminodiethanol; diolamine; diethylolamine; 2,2'-dihydroxydiethylamine; DEA; bis(2-hydroxyethyl)amine; 2,2'iminobisethanol

### • Identifiers

1. CAS No.: 111-42-2
2. RTECS No.: KL2975000

3. DOT UN: None

4. DOT label: None

### • Appearance and odor

Diethanolamine is a combustible substance that can exist in the form of colorless crystals or a viscous liquid at room temperature. It has a mild, ammonia-like odor and is usually found in liquid form.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 105.14
2. Boiling point (760 mm Hg): 269°C (516.2°F) (decomposes)
3. Specific gravity (water = 1): 1.09 at 30°C (86°F)
4. Vapor density (air = 1 at boiling point of diethanolamine): 3.65
5. Melting point: 28°C (82.4°F)
6. Vapor pressure at 20°C (68°F): Less than or equal to 0.01 mm Hg
7. Solubility: Very soluble in water and alcohol; insoluble in ether and benzene; miscible with acetone and methanol.

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

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

8. Evaporation rate (ether = 1): Greater than 5,000

### Reactivity

1. Conditions contributing to instability: Heat, sparks, and open flame. Diethanolamine reacts with carbon dioxide in the air.
2. Incompatibilities: Contact of diethanolamine with oxidizing agents or acidic materials can cause fires or explosions.
3. Hazardous decomposition products: Toxic gases (such as carbon monoxide, carbon dioxide, and oxides of nitrogen) may be released in a fire involving diethanolamine.
4. Special precautions: Diethanolamine is corrosive to copper, copper alloys, zinc, and galvanized iron.

### Flammability

The National Fire Protection Association has assigned a flammability rating of 1 (slight fire hazard) to diethanolamine.

1. Flash point: 138°C (280°F) (open cup)
2. Autoignition temperature: 661.5°C (1,224°F)
3. Flammable limits in air (% by volume): Lower, 1.6; upper, 9.8
4. Extinguishant: Use dry chemical, carbon dioxide, alcohol foam, or water spray. A solid stream of water or foam directed into burning liquid diethanolamine may cause frothing. Use water spray to cool fire-exposed containers and to dilute liquid to a less flammable solution.

Fires involving diethanolamine should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving diethanolamine.

## EXPOSURE LIMITS

### OSHA PEL

The Occupational Safety and Health Administration

(OSHA) has not promulgated a permissible exposure limit (PEL) for diethanolamine [29 CFR 1910.1000, Table Z-1].

### • NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 3 ppm (15 mg/m<sup>3</sup>) as a TWA for up to 10-hr workday and a 40-hr workweek for diethanolamine [NIOSH 1992].

### • ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned diethanolamine a threshold limit value (TLV) of 3 ppm (13 mg/m<sup>3</sup>) as a TWA for a normal 8-hr workday and a 40-hr workweek [ACGIH 1993].

### • Rationale for limits

The NIOSH and ACGIH limits are based on the risk of eye and skin irritation associated with exposure to diethanolamine.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Exposure to diethanolamine can occur through inhalation, ingestion, and eye or skin contact.

### • Summary of toxicology

1. *Effects on Animals:* Diethanolamine is an irritant of the eyes and skin and, when administered orally or intraperitoneally, a kidney and liver toxin in animals. Applied to rabbit skin in a 10-percent solution, diethanolamine caused redness, and the application of more concentrated solutions caused a greater degree of injury [Clayton and Clayton 1981]. Instillation of the undiluted liquid or a 40-percent solution into rabbit eyes caused severe burns; whereas, 15 percent solution produces only minor damage [Clayton and Clayton 1981]. The dermal LD<sub>50</sub> in rabbits is 12.2 g/kg [NIOSH 1993]. The oral LD<sub>50</sub> is 710 mg/kg in rats, 3,300 mg/kg in mice, and 2,200 mg/kg in rabbits [NIOSH 1993]. Animals given large intraperitoneal doses lose the righting reflex, become uncoordinated and cyanotic, and die [Gosselin et al. 1984]. Rats administered 100 or 500 mg/kg

diethanolamine intraperitoneally were autopsied 4 or 24 hours after dosing and showed cytoplasmic vacuolization of the liver and kidneys and, at the higher dose, renal tubular degeneration [Hathaway et al. 1991]. At autopsy, rats fed 0.17 g/kg for 90 days showed cloudy swelling and degeneration of kidney tubules and fatty degeneration of the liver [Hathaway et al. 1991].

2. *Effects on Humans:* Diethanolamine causes irritation of the eyes, nose, and throat in humans, and contact of the skin with this substance can cause minor burns of the skin. Splashed into the eye, diethanolamine may cause severe burns [NJDH 1989].

• **Signs and symptoms of exposure**

1. *Acute exposure:* The signs and symptoms of acute exposure to diethanolamine may include redness, inflammation, and tearing of the eyes; inflamed eyelids; coughing; and sneezing. Splashed into the eye, this substance may cause severe eye burns, with corneal necrosis and permanent damage.

2. *Chronic exposure:* The signs and symptoms of repeated or prolonged skin contact with diethanolamine include dryness and cracking of the skin and minor burns.

• **Emergency procedures**

**WARNING!**

**Transport victims immediately to emergency medical facility!**

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. *Immediately* initiate the following emergency procedures, continuing them as appropriate en route to the emergency medical facility:

1. *Eye exposure:* Tissue destruction and blindness may result from exposure to concentrated solutions, vapors, mists, or aerosols of diethanolamine! *Immediately but gently* flush the eyes with large amounts of water for at least 15 min, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Severe burns and skin corrosion may result! *Immediately* remove all contaminated clothing! *Immediately, continuously, and gently* wash

skin for at least 15 min. Use soap and water if skin is intact; use only water if skin is not intact.

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. *Ingestion exposure:* Take the following steps if diethanolamine or any material containing it is ingested:

—Do *not* induce vomiting.

—Have the victim rinse the contaminated mouth cavity several times with a fluid such as water. Immediately after rinsing, have the victim drink one cup (8 oz) of fluid and *no more*.

—Do *not* permit the victim to drink milk or carbonated beverages!

—Do *not* permit the victim to drink any fluid if more than 60 min have passed since initial ingestion.

**NOTE:** These instructions must be followed exactly. Drinking a carbonated beverage or more than one cup of fluid could create enough pressure to perforate already damaged stomach tissue. The tissue-coating action of milk can sometimes impede medical assessment of tissue damage. Ingestion of any fluid more than 60 min after initial exposure could further weaken damaged tissue and result in perforation.

5. *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 diethanolamine and lead to worker exposures to this substance:

—Use as a liquid detergent in cleaners, polishes, textile specialties, paints, cutting oils, and shampoos

- Use as an absorbent for acid gases
- Use as an emulsifier and dispersing agent in various agricultural chemicals, cosmetics, and pharmaceuticals
- Manufacture of rubber chemicals, surface-active ingredients, and petroleum demulsifiers
- Use as a chemical intermediate in the manufacture of resins and plasticizers
- Use as a humectant and softening agent, in the production of lubricants for the textile industry, and in organic syntheses

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

- Process enclosure
- Local exhaust ventilation
- General dilution ventilation
- Personal protective equipment

Good sources of information on control methods are as follows:

1. ACGIH [1992]. *Industrial ventilation—a manual of recommended practice*. 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 surveil-

lance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, 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.

### • Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to diethanolamine, the licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, and respiratory tract. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society [ATS 1987].

A preplacement medical evaluation is recommended to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to diethanolamine at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with diseases of the eyes, skin, or respiratory tract.

### • Periodic medical examinations and biological monitoring

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recom-

mended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to diethanolamine exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of diethanolamine on the eyes, skin, or respiratory tract. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

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 diethanolamine.

- **Medical examinations recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination to determine the worker's medical status at the end of his or her employment. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

## **WORKPLACE MONITORING AND MEASUREMENT**

Determination of a worker's exposure to airborne diethanolamine is made using a coated XAD-2 tube (80/40 mg sections, 20/60 mesh); the coating is 10 percent 1-naphthylisothiocyanate (NITC). 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 dimethylformamide to extract the diethanolamine derivative. Analysis is conducted by high performance liquid chromatography using ultraviolet detection. This method is included in the OSHA Laboratory In-House Methods File [OSHA 1989].

## **PERSONAL HYGIENE**

If diethanolamine contacts the skin, workers should immediately wash the affected areas with soap and water.

Clothing contaminated with diethanolamine should be

removed immediately, and provisions should be made for the safe removal of the chemical from the clothing. Persons laundering the clothes should be informed of the hazardous properties of diethanolamine, particularly its potential to cause skin irritation.

A worker who handles diethanolamine should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, or applying cosmetics.

Workers should not eat, drink, use tobacco products, or apply cosmetics in areas where diethanolamine or a solution containing diethanolamine is handled, processed, or stored.

## **STORAGE**

Diethanolamine should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of diethanolamine should be protected from physical damage and should be stored separately from oxidizers, acidic materials, heat, sparks, and open flame. Because containers that formerly contained diethanolamine may still hold product residues, they should be handled appropriately.

## **SPILLS AND LEAKS**

In the event of a spill or leak involving diethanolamine, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup has been completed. The following steps should be undertaken following a spill or leak:

1. Do not touch the spilled material; stop the leak if it is possible to do so without risk.
2. Notify safety personnel.
3. Remove all sources of heat and ignition.
4. Ventilate potentially explosive atmospheres.
5. Mix with inert absorbent materials such as dry sand or vermiculite and place in appropriate containers for disposal.
6. Flush these residues with large quantities of water after neutralizing with sodium bisulfate.

7. Do not flush to sewers or open waterways.

## 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**

Diethanolamine 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 Part 355.40] to notify the National Response Center of an accidental release of diethanolamine; there is no reportable quantity for this substance.

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

Employers who own or operate facilities in SIC codes 20 to 39 that employ 10 or more workers and that manufacture 25,000 lb more or otherwise use 10,000 lb or more of diethanolamine per calendar year are required by EPA [40 CFR Part 372.30] to submit a Toxic Chemical Release Inventory form (Form R) to EPA reporting the amount of diethanolamine 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 diethanolamine 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 any 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 diethanolamine 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 1910.134]. 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, respirator 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 about the selection and use of respirators and about

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 clothing should be worn to prevent repeated or prolonged skin contact with diethanolamine. 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 recommended for use against permeation by diethanolamine and may provide protection for periods greater than 8 hours: butyl rubber, neoprene, nitrile rubber, polyvinyl chloride, and Viton®.

If diethanolamine is dissolved in water or an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which diethanolamine 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 diethanolamine. Contact lenses should not be worn if the potential exists for diethanolamine exposure.

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