

Occupational Health Guideline for Acrylamide

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: $\text{CH}_2=\text{CHCONH}_2$
- Synonyms: Propenamide; acrylamide monomer; acrylic amide
- Appearance: Colorless solid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for acrylamide is 0.3 milligram of acrylamide per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. NIOSH has recommended a permissible exposure limit of 0.3 mg/m^3 averaged over a work shift of up to 10 hours per day, 40 hours per week. The NIOSH Criteria Document for Acrylamide should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

• Routes of exposure

Acrylamide 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: Exposure to acrylamide causes drowsiness, a tingling sensation, fatigue, weakness, a stumbling type of walking, slurred speech, and shaking. It may also cause irritation of the skin and eyes.

2. Long-term Exposure: Repeated or prolonged skin contact with acrylamide may cause irritation of the skin. It may also cause the legs to feel numb.

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 acrylamide.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to acrylamide 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 exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the skin, eyes, and central and peripheral nervous systems should be stressed. The skin should be examined for evidence of chronic disorders.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis. Emphasis should be placed on informing the employee to report any symptoms associated with acrylamide toxicity.

• Summary of toxicology

Acrylamide dust absorption produces severe neuropathy. Acrylamide poisoning has been studied in mice, rats, rabbits, cats, dogs, baboons, and monkeys. In chronic poisoning, symptoms appear with a latency depending on the severity of the poisoning. Muscular weakness develops and increases to paralysis, at first in the hind limbs, then in the forelimbs. Experiments have shown decreases in the amplitude and velocity of nerve action potentials, demyelination and degeneration of both sensory and motor nerve fibers, loss of tendon reflexes, and some indications of CNS involvement. Workers exposed to acrylamide have developed symptoms after one month to one year, exhibiting muscular weakness, ataxia, erythema, and excessive sweating of the hands and arms, cold fingers and hands, peeling of the skin, numbness and paresthesia, fatigue and signs of CNS involvement. Individual differences in susceptibility have been noted. When contact with acrylamide

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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ceases, recovery is good, often complete, but the rate of recovery depends upon the severity of the exposure. In these cases poor work practices had allowed excessive skin contact, and it was concluded that significant absorption had occurred through the skin. No cases were seen in work situations where care had been taken to avoid excessive skin contact. Aqueous solutions are mildly irritating to the eyes and skin.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 71.1
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 1.12
4. Vapor density (air = 1 at boiling point of acrylamide): 2.4
5. Melting point: 84 C (183 F)
6. Vapor pressure at 20 C (68 F): 0.007 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 216
8. Evaporation rate (butyl acetate = 1): Data not available

• Reactivity

1. Conditions contributing to instability: Acrylamide decomposes above 175 C (347 F). Violent polymerization may occur when heated.

2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.

3. Hazardous decomposition products: Toxic gases and vapors (such as ammonia, hydrogen, and carbon monoxide) may be released when acrylamide decomposes.

4. Special precautions: None

• Flammability

1. Flash point: Data not available
2. Autoignition temperature: Data not available
3. Flammable limits in air, % by volume: Data not available
4. Extinguishant: Foam, carbon dioxide, dry chemical

• Warning properties

1. Odor Threshold: No quantitative information is available concerning the odor threshold of acrylamide.

2. Eye Irritation Level: Grant reports that "acute testing of solutions of acrylamide on the eyes of rabbits has shown that a 10% aqueous solution causes immediate slight pain and conjunctival irritation, but no corneal injury, and the eyes are all normal in 24 hours. A 40% aqueous solution allowed to remain in contact for only 30 seconds caused more pain but no greater injury. When 40% solution was applied and not washed off, superficial corneal injury resulted but healed completely within 24 hours." Kirk and Othmer also note that acrylamide is an eye irritant.

No quantitative information is available concerning the air concentrations of acrylamide which produce eye irritation.

3. Evaluation of Warning Properties: Since no quan-

titative data are available relating warning properties to air concentrations of acrylamide, this substance is treated as a material with poor warning properties. The concentration of acrylamide in saturated air at 20 C could result in a significant exposure relative to the permissible exposure.

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

A detailed analytical method for acrylamide is suggested in the NIOSH Criteria Document for Acrylamide.

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 acrylamide or solutions containing acrylamide.

• If employees' clothing may have become contaminated with acrylamide or solutions containing acrylamide, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing contaminated with acrylamide should be placed in closed containers for storage until it can be

discarded or until provision is made for the removal of acrylamide from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the acrylamide, the person performing the operation should be informed of acrylamide's hazardous properties.

- Where exposure of an employee's body to acrylamide or solutions containing acrylamide may occur, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with acrylamide should be removed immediately and not reworn until the acrylamide is removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where acrylamide or solutions containing acrylamide may contact the eyes.

SANITATION

- Skin that becomes contaminated with acrylamide should be immediately washed or showered to remove any acrylamide.
- Workers subject to skin contact with acrylamide or solutions containing acrylamide should wash any areas of the body which may have contacted acrylamide at the end of each work day.
- Eating and smoking should not be permitted in areas where acrylamide or solutions containing acrylamide are handled, processed, or stored.
- Employees who handle acrylamide or solutions containing acrylamide 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 acrylamide may occur and control methods which may be effective in each case:

Operation	Controls
Use in manufacture of copolymers and polyacrylamides for use as flocculating and thickening agents in pulp and paper industries, oil production, mining, textile, surface coating, adhesives, dyes, photography, and water and waste treatment	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as a grouting material in drilling of oil well drill holes, basements, tunnels, mine shafts, caissons, and dams	General dilution ventilation; personal protective equipment

Operation

Use in miscellaneous processes of monomer acrylamide as curing agents and in organic synthesis

Controls

Process enclosure; 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 acrylamide or solutions containing acrylamide get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If acrylamide or solutions containing acrylamide get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If acrylamide or solutions containing acrylamide penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of acrylamide, 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 acrylamide has been swallowed and the person is conscious, 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 AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

- If acrylamide is spilled, the following steps should be taken:

1. Ventilate area of spill.

2. For small quantities, sweep onto paper or other suitable material, place in an appropriate container and burn in a safe place (such as a fume hood). Large quantities may be reclaimed; however, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

• Waste disposal methods:

Acrylamide may be disposed of:

1. By making packages of acrylamide in paper or other flammable material and burning in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

2. By dissolving acrylamide in a flammable solvent (such as alcohol) and atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

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RESPIRATORY PROTECTION FOR ACRYLAMIDE

Condition	Minimum Respiratory Protection* Required Above 0.3 mg/m ³
Particulate and Vapor Concentration	
15 mg/m ³ or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
600 mg/m ³ 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 600 mg/m ³ 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.

