

Occupational Health Guideline for Acetaldehyde

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: CH_3CHO
- Synonyms: Ethanal; acetic aldehyde
- Appearance and odor: Colorless liquid or gas with a penetrating fruity odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for acetaldehyde is 200 parts of acetaldehyde per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 360 milligrams of acetaldehyde per cubic meter of air (mg/m^3). The American Conference of Governmental Industrial Hygienists has recommended for acetaldehyde a Threshold Limit Value of 100 ppm.

HEALTH HAZARD INFORMATION

• Routes of exposure

Acetaldehyde can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It may also affect the body if it is swallowed.

• Effects of overexposure

1. Short-term Exposure: Acetaldehyde vapors may cause irritation of the eyes, nose, and throat. Inhalation of high concentrations of acetaldehyde vapor may cause drowsiness, dizziness, and unconsciousness. The liquid splashed in the eyes may cause irritation and burning. Swallowing acetaldehyde may cause drowsiness, dizziness, unconsciousness, kidney damage, and

severe breathing difficulties which may be delayed in onset.

2. Long-term Exposure: Repeated or prolonged exposure to acetaldehyde may cause an irritation of the eyes and skin. An allergic skin rash may also result from repeated exposure.

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 acetaldehyde.

• Recommended medical surveillance

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

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

—Liver disease: Although acetaldehyde 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: Acetaldehyde ingestion has caused albuminuria in humans. The importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

—Skin disease: Acetaldehyde can cause dermatitis on prolonged exposure. 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.

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

• Summary of toxicology

Acetaldehyde vapor is an irritant of the eyes and mucous membranes and at high concentrations causes narcosis and delayed pulmonary edema. In rats the LC50 for 30 minutes was approximately 20,000 ppm; the animals developed pronounced excitement followed by an anesthesia-like state; the principal autopsy finding was pulmonary edema. Symptoms of narcosis occur in humans at very high exposure levels or by parenteral injection; the irritant effects of the vapor at lower concentrations, such as cough and a burning sensation in the nose, throat, and eyes, usually prevent sufficient exposure to cause narcosis. Human volunteers exposed for 15 minutes to 200 ppm had red eyes due to transient conjunctivitis, while at 50 ppm a majority had mild eye irritation. The liquid splashed in the eyes causes a burning sensation, lacrimation, and blurred vision. The liquid on the skin for a prolonged period causes erythema and burns; repeated contact may result in dermatitis, due either to primary irritation or to sensitization. Ingestion produces central nervous system depression, sometimes with pulmonary edema and albuminuria.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 44.05
2. Boiling point (760 mm Hg): 20.4 C (68.7 F)
3. Specific gravity (water = 1): 0.78
4. Vapor density (air = 1 at boiling point of acetaldehyde): 1.52
5. Melting point: -123.5 C (-190.3 F)
6. Vapor pressure at 20 C (68 F): 750 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): 49.1

• Reactivity

1. Conditions contributing to instability: Prolonged contact with air may cause formation of peroxides that may explode and burst container.

2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions. Contact with acids, bases, alcohols, ammonia and amines, phenols, ketones, hydrogen cyanide and hydrogen sulfide may cause violent reactions with liberation of much heat and bursting of containers.

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving acetaldehyde.

4. Special precautions: Liquid acetaldehyde will attack some forms of plastics, rubbers, and coatings.

• Flammability

1. Flash point: -37.8 C (-36 F) (closed cup)
2. Autoignition temperature: 175 C (347 F)
3. Flammable limits in air, % by volume: Lower: 4; Upper: 60
4. Extinguishant: Dry chemical, alcohol foam, carbon dioxide

• Warning properties

1. Odor Threshold: The AIHA *Hygienic Guide* reports an odor threshold of 2.3 ppm, May reports 0.031 ppm, and Stern reports 0.066 ppm.

2. Eye Irritation Level: Grant states that "irritation of the human eye is detectable at a concentration of 50 ppm in air and becomes excessive for chronic industrial exposure above 200 ppm. Higher concentration and extended exposure may injure the corneal epithelium, causing persistent lacrimation, photophobia, and foreign body sensation."

3. Evaluation of Warning Properties: Since the odor threshold for acetaldehyde is such a small fraction of the permissible exposure limit, odor is not considered a good warning of excessive exposures. Because of its irritant effects, however, acetaldehyde is judged to have adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• Eight-Hour Exposure Evaluation

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).

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of acetaldehyde. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method

An analytical method for acetaldehyde is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 5, 1979, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00349-1).

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 acetaldehyde.

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

- Any clothing which becomes wet with liquid acetaldehyde should be removed immediately and not reworn until the acetaldehyde 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 acetaldehyde contacting the eyes.

- Where there is any possibility that employees' eyes may be exposed to liquid acetaldehyde, an eye-wash facility should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes wet with liquid acetaldehyde should be promptly washed or showered to remove any acetaldehyde.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Production of intermediates during synthesis of acetic acid, acetic anhydride, aldol compounds.	Process enclosure; local exhaust ventilation; personal protective equipment
Use during manufacture of synthetic resins; synthesis of intermediates in production of pesticides and pharmaceuticals; synthesis of rubber processing chemicals	Process enclosure; local exhaust ventilation; personal protective equipment
Use in coating operations in the manufacture of mirrors	Process enclosure; local exhaust ventilation; personal protective equipment
Use as hardening agent in photography and in manufacture of gelatin, glue, casein products	Process enclosure; local exhaust ventilation; personal protective equipment
Use as preservative in food products and leather	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 liquid acetaldehyde gets 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 acetaldehyde gets on the skin, flush the contaminated skin with water. If acetaldehyde soaks 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 acetaldehyde, 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 acetaldehyde 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 uncon-

scious 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 acetaldehyde is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak to disperse gas.
3. If in gaseous form, stop flow of gas.
4. If in the liquid form, for small quantities absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for vapors to completely clear hood ductwork, then burn the paper in a location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber. Acetaldehyde should not be allowed to enter a confined space such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of acetaldehyde vapors are permitted.

- Waste disposal method:

Liquid acetaldehyde may be disposed of by atomizing in a suitable combustion chamber.

REFERENCES

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RESPIRATORY PROTECTION FOR ACETALDEHYDE

Condition	Minimum Respiratory Protection* Required Above 200 ppm
Gas or Vapor Concentration	
1000 ppm or less	A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).
5000 ppm or less	A gas mask with a chin-style organic vapor canister.
10,000 ppm or less	A gas mask with 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.
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.

**Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of acetaldehyde; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 10,000 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

