

# Occupational Health Guideline for Acetic Anhydride

## 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:  $(\text{CH}_3\text{CO})_2\text{O}$
- Synonyms: Ethanoic anhydride; acetic acid anhydride; acetyl oxide
- Appearance and odor: Colorless liquid with a characteristic sharp odor.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for acetic anhydride is 5 parts of acetic anhydride per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 20 milligrams of acetic anhydride per cubic meter of air ( $\text{mg}/\text{m}^3$ ). The American Conference of Governmental Industrial Hygienists has recommended for acetic anhydride a Threshold Limit Value of 5 ppm as a ceiling value.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

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

### • Effects of overexposure

**1. Short-term Exposure:** Exposure to the vapors of acetic anhydride may cause irritation of the nose and throat and coughing. Exposure to high concentrations of the vapor can result in severe damage to the lungs. Delayed breathing difficulties may occur. Acetic anhydride liquid does not cause a severe burning sensation when it comes in contact with the skin. If it is not

removed by washing, the skin may become reddened and later turn white and wrinkled but may not be painful. Skin burns may appear later. Contact with the liquid or vapor may produce a serious eye burn. Immediately after contact, a burning sensation of the eyes with tearing occurs. This may be followed later by impairment of vision. After exposure to acetic anhydride, there may be a delay in the appearance of the severe eye burns.

**2. Long-term Exposure:** Repeated and prolonged exposure to acetic anhydride may cause irritation of the skin and chronic eye irritation. Allergic sensitization of the skin may occur.

**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 acetic anhydride.

### • Recommended medical surveillance

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

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

—Skin disease: Acetic anhydride is a primary skin irritant. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Eye disease: Acetic anhydride is a severe eye irritant and may cause tissue damage. Those with pre-existing eye problems may be at increased risk from exposure.

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

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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

Acetic anhydride vapor is a severe irritant of the eyes, mucous membranes, and skin. Rats exposed to 2000 ppm for 4 hours died, but 1000 ppm for 4 hours was not lethal. Humans exposed to undetermined but high vapor concentrations complained immediately of severe conjunctival and naso-pharyngeal irritation, harsh cough, and dyspnea. Workmen exposed to vapors from a boiling mixture complained of severe eye irritation and lacrimation. The immediate effect of exposure to vapor concentrations above 5 ppm is acute irritation of the eyes and upper respiratory tract; inhalation of high vapor concentrations may produce ulceration of the nasal mucosa and, in some instances, bronchospasm. In the rabbit eye, direct application of the liquid caused severe injury. Both the liquid and the vapor can cause severe damage to the human eye; this is characterized by immediate burning, followed some hours later by an increasing severity of reaction, with corneal and conjunctival edema. Interstitial corneal opacity may develop over a period of several days due to progression of tissue infiltration; in mild cases, this condition is reversible, but permanent opacification with loss of vision may also occur. Workmen exposed to acetic anhydride vapor may show evidence of conjunctivitis with associated photophobia. Severe burns and vesiculation of human skin have been reported from liquid splashes; concentrated vapor produces primary irritation. Generalized skin reactions in guinea pigs sensitized to acetic anhydride have been demonstrated, and skin sensitivity in humans has been reported. While ingestion of the liquid is unlikely in ordinary industrial use, the highly corrosive nature of the substance may be expected to produce serious mucous-membrane burns of the mouth and esophagus.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 102.1
2. Boiling point (760 mm Hg): 140 C (284 F)
3. Specific gravity (water = 1): 1.08
4. Vapor density (air = 1 at boiling point of acetic anhydride): 3.52
5. Melting point: -73 C (-99 F)
6. Vapor pressure at 20 C (68 F): 4 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 12, then reacts slowly
8. Evaporation rate (butyl acetate = 1): 0.46

### • Reactivity

1. Conditions contributing to instability: Water, particularly if the heat liberated by the slow reaction with water cannot escape so that the reaction becomes progressively more violent.
2. Incompatibilities: Contact with water, alcohols, strong oxidizers (especially chromic acid) or amines may cause violent reaction. Contact with strong caustics will cause violent reaction and spattering.
3. Hazardous decomposition products: Toxic gases

and vapors (such as acetic acid and carbon monoxide) may be released in a fire involving acetic anhydride.

4. Special precautions: Liquid acetic anhydride will attack some forms of plastics, rubber, and coatings.

### • Flammability

1. Flash point: 49 C (120 F) (closed cup)
2. Autoignition temperature: 390 C (734 F)
3. Flammable limits in air, % by volume: Lower: 2.9; Upper: 10.3
4. Extinguishant: Carbon dioxide, dry chemical, alcohol foam

### • Warning properties

1. Odor Threshold: The Coast Guard's *CHRIS Hazard Chemical Data Handbook* reports an odor threshold for acetic anhydride of 0.14 ppm.

2. Eye Irritation Level: The AIHA *Hygienic Guide* reports that "the immediate effect of exposure to vapor concentrations above 5 ppm is that of acute irritation of the eyes and the mucous membranes of the respiratory tract. Conjunctivitis, photophobia, lacrimation, and irritation of the nose and throat may occur."

3. Evaluation of Warning Properties: Through its odor and irritant effects, acetic anhydride can be detected at concentrations below and at the permissible exposure limit. Acetic anhydride, therefore, has good 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 acetic anhydride. 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

Sampling and analyses may be performed by collection of acetic anhydride in a bubbler containing hydroxyl amine, followed by reaction with ferric chloride, and colorimetric analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure acetic anhydride may be used. An analytical method for acetic anhydride is in

## 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 skin contact with liquid acetic anhydride, where skin contact may occur.
- Clothing contaminated with acetic anhydride should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of acetic anhydride from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the acetic anhydride, the person performing the operation should be informed of acetic anhydride's hazardous properties.
- Where exposure of an employee's body to liquid acetic anhydride 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 acetic anhydride should be removed immediately and not reworn until the acetic anhydride 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 acetic anhydride or solutions containing acetic anhydride contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to liquid acetic anhydride or solutions containing more than 1% acetic anhydride by weight, an eye-wash fountain should be provided within the immediate work area for emergency use.

## SANITATION

- Skin that becomes contaminated with acetic anhydride should be immediately washed or showered to remove any acetic anhydride.
- Employees who handle liquid acetic anhydride 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 acetic anhydride may occur and control methods which may be effective in each case:

Operation	Controls
Use in manufacture of cellulose esters and in manufacture of fibers, plastics, lacquers, protective coating solutions, photographic films, cigarette filters, magnetic tape, and thermoplastic molding compositions	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of pharmaceuticals and pharmaceutical intermediates	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in organic synthesis as an acetylating agent, bleaching agent, and dehydrating agent; use in synthesis of perfume chemicals, explosives, and weed killers; use in acetylation of animal and vegetable oils; acetylating agent and dehydrating agent in textile dyeing, chemical treatment of paper, and chemical analysis	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 acetic anhydride 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 acetic anhydride gets on the skin, immediately flush the contaminated skin with water. If acetic anhydride soaks through the clothing, remove the clothing immediately and flush the skin with water. Get medical attention immediately.

#### • Breathing

If a person breathes in large amounts of acetic anhydride, 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

If acetic anhydride has been swallowed and the person is conscious, give him large quantities of water immediately to dilute the acetic anhydride. Do not attempt to make the exposed 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 acetic anhydride 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. Acetic anhydride should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

• Waste disposal methods:

Acetic anhydride 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 atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

## REFERENCES

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## RESPIRATORY PROTECTION FOR ACETIC ANHYDRIDE

Condition	Minimum Respiratory Protection* Required Above 5 ppm
Vapor Concentration	
250 ppm or less	Any chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s). 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.
1000 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 1000 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 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.

