

Occupational Health Guideline for Ethyl Formate

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: HCOOC_2H_5
- Synonyms: Ethyl methanoate; formic acid ethyl ester
- Appearance and odor: Colorless liquid with a fruity odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for ethyl formate is 100 parts of ethyl formate per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 300 milligrams of ethyl formate per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

• Routes of exposure

Ethyl formate can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed.

• Effects of overexposure

1. Short-term Exposure: Overexposure to ethyl formate may cause irritation of the eyes, nose, throat, and skin. At high concentrations it may cause drowsiness and unconsciousness.

2. Long-term Exposure: Long-term overexposure to ethyl formate may cause irritation of the skin.

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 ethyl formate.

• Recommended medical surveillance

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

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

—Skin disease: This substance is a defatting agent and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Liver disease: Although ethyl formate 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: Although ethyl formate is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with possible impairment of renal function.

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

• Summary of toxicology

Ethyl formate is irritating to the eyes and nose at concentrations of 330 ppm. Narcosis occurs in animals, but only at exposure levels near the lethal concentration of 10,000 ppm. Dogs exposed to this very high concentration died of pulmonary edema. Rats survived at 4000 ppm. Application to the skin caused only slight irritation; when dropped into the eye, it caused moderate injury to the cornea. No chronic systemic effects have been reported in humans.

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

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 74
2. Boiling point (760 mm Hg): 54.5 C (130 F)
3. Specific gravity (water = 1): 0.92
4. Vapor density (air = 1 at boiling point of ethyl formate): 2.6
5. Melting point: -79 C (-110 F)
6. Vapor pressure at 20 C (68 F): 194 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 13.6
8. Evaporation rate (butyl acetate = 1): Data not available

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with nitrates, strong oxidizers, strong alkalis, and strong acids may cause fires and explosions.

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

4. Special precautions: None

• Flammability

1. Flash point: -20 C (-4 F) (closed cup)
2. Autoignition temperature: 455 C (851 F)
3. Flammable limits in air, % by volume: Lower: 2.8; Upper: 16
4. Extinguishant: Alcohol foam, dry chemical, carbon dioxide

• Warning properties

1. Odor Threshold: No information is available concerning the odor threshold of ethyl formate.
2. Eye Irritation Level: According to the *Documentation of TLV's*, "in man, a concentration of 330 ppm produced a slight irritation of the eyes and a rapidly increasing nasal irritation . . . A threshold limit of 100 ppm is recommended to prevent eye and nasal irritation."
3. Evaluation of Warning Properties: Since eye and nasal irritation occur at a concentration which is approximately only three times the permissible exposure limit, ethyl formate is treated as a material with good 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 ethyl formate vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure ethyl formate may be used. An analytical method for ethyl formate is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

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 ethyl formate.

• Any clothing which becomes wet with liquid ethyl formate should be removed immediately and not reworn until the ethyl formate is removed from the clothing.

• Employees should be provided with and required to use splash-proof safety goggles where liquid ethyl formate may contact the eyes.

SANITATION

• Skin that becomes wet with liquid ethyl formate should be promptly washed or showered to remove any ethyl formate.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use during spray, brush, or dip applications of lacquers	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as a solvent for cellulose acetate in artificial silk manufacture	General dilution ventilation; personal protective equipment
Use in shoe industry to dissolve celluloid heel coverings; use as a solvent in manufacture of artificial leather	General dilution ventilation; personal protective equipment
Use in manufacture of safety glass	General dilution ventilation
Use as a fumigant and larvacide for tobacco, cereals, and dried fruits	Personal protective equipment
Liberation during use as an intermediate in organic synthesis	General dilution ventilation
Liberation during formulation of synthetic flavors	General dilution ventilation

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 ethyl formate gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If ethyl formate gets on the skin, immediately flush the contaminated skin with water. If ethyl formate soaks through the clothing, remove the clothing immediately and flush the skin with water. If there is skin irritation, get medical attention.

• Breathing

If a person breathes in large amounts of ethyl formate, 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 ethyl formate has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

• 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 ethyl formate 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. Ethyl formate should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

• Waste disposal methods:

Ethyl formate 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.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Ethyl Formate," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- Browning, E.: *Toxicity and Metabolism of Industrial Solvents*, Elsevier, New York, 1965.
- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.
- International Labour Office: *Encyclopedia of Occupational Health and Safety*, McGraw-Hill, New York, 1971.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.
- Sax, N. I.: *Dangerous Properties of Industrial Materials* (3rd ed.), Van Nostrand Reinhold, New York, 1968.
- Smyth, H. F., et al.: "Range-Finding Toxicity Data, List V," *Archives of Industrial Hygiene and Occupational Medicine*, 10:61, July 1954.
- Union Carbide Corporation, Industrial Medicine and Toxicology Department: *Toxicology Studies - Ethyl Formate*, New York, 1968.

RESPIRATORY PROTECTION FOR ETHYL FORMATE

Condition	Minimum Respiratory Protection* Required Above 100 ppm
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 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.
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.