

Occupational Health Guideline for Furfural

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: C_4H_6OCHO
- Synonyms: 2-Furaldehyde; furfuraldehyde; fural; 2-furancarboxaldehyde
- Appearance and odor: Colorless to light brown liquid that darkens on standing in light and air. Odor is like almonds.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for furfural is 5 parts of furfural per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 20 milligrams of furfural per cubic meter of air (mg/m^3). The American Conference of Governmental Industrial Hygienists has issued a Notice of Intended Changes of their recommended Threshold Limit Value for furfural from 5 ppm to 2 ppm with a skin notation.

HEALTH HAZARD INFORMATION

• Routes of exposure

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

• Effects of overexposure

1. *Short-term Exposure:* Furfural may cause irritation of the skin, eyes, and respiratory tract. It may also cause a person to become unconscious.

2. *Long-term Exposure:* Furfural may cause sensitization of the skin, loss of sense of taste, and numbness of the tongue.

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 furfural.

• Recommended medical surveillance

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

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

—Skin disease: Furfural can cause dermatitis on excessive exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Kidney disease: Although furfural 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.

—Liver disease: Although furfural 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.

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

• Summary of toxicology

Furfural vapor is irritating to the eyes, respiratory tract, and skin. It has been reported to be a central nervous system poison in large doses in some animals, causing hyper-reflexia and convulsions.

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: 96
2. Boiling point (760 mm Hg): 162 C (323 F)
3. Specific gravity (water = 1): 1.16
4. Vapor density (air = 1 at boiling point of furfural): 3.3
5. Melting point: -36.5 C (-33.7 F)
6. Vapor pressure at 20 C (68 F): 2 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 8.3
8. Evaporation rate (butyl acetate = 1): Very low

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong acids and oxidizing materials may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving furfural.
4. Special precautions: None

• Flammability

1. Flash point: 60 C (140 F) (closed cup)
2. Autoignition temperature: 316 C (600 F)
3. Flammable limits in air, % by volume: Lower: 2.1; Upper: 19.3
4. Extinguishant: Carbon dioxide, dry chemical, or alcohol foam

• Warning properties

1. Odor Threshold: The *AIHA Hygienic Guide* states that "although the odor threshold of furfural vapor has been reported to be 0.25 to 0.38 ppm, some industrial hygienists maintain that the odor becomes readily noticeable only near the TLV concentration of 5 ppm."

2. Eye Irritation Level: Grant states that "chronic exposure to the vapor at concentrations of 13.5 ppm or less in air is reported to cause reddening of the eyes, tearing, and irritation of the throat in workers." The *Hygienic Guide* states that the "irritating properties of furfural, which become uncomfortable at 20 to 50 ppm, probably preclude voluntary exposures which might lead to significant injury."

3. Nasal Irritation Level: The *Hygienic Guide* states that "nasal irritation would indicate that the TLV was being exceeded."

4. Evaluation of Warning Properties: Through its odor and irritant effects, furfural can be detected near the permissible exposure limit. For the purposes of this guideline, therefore, furfural 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

An analytical method for furfural 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 furfural.

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

• Non-impervious clothing which becomes contaminated with furfural should be removed promptly and not reworn until the furfural is removed from the clothing.

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

SANITATION

- Skin that becomes contaminated with furfural should be promptly washed or showered to remove any furfural.
- Employees who handle liquid furfural should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use during removal of industrial coatings in open-surface tanks	Local exhaust ventilation; personal protective equipment
Liberation during cold molding of abrasive grinding wheels	General dilution ventilation
Use in rubber of phenolic cement adhesives	General dilution ventilation; personal protective equipment
Liberation during molding of miscellaneous phenolic resin products	Local exhaust ventilation; general dilution ventilation
Use during molding of friction materials as brake linings, clutch facings, brake blocks, etc.	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use during manufacture of reinforced plastic products	General dilution ventilation; local exhaust ventilation; personal protective equipment
Liberation during coating of products with resins/varnishes as wire coating, food containers, paper, canvas, etc.	General dilution ventilation; process enclosure; local exhaust ventilation
Liberation during vulcanization of rubber in processes using furfural as an accelerator	General dilution ventilation; process enclosure; local exhaust ventilation
Liberation during manufacture of furfuryl alcohol	Process enclosure; general dilution ventilation

Liberation during use as a chemical intermediate in manufacture of furor, tetrahydrofuran, tetrahydrofuryl alcohol, hexamethylene diamene, and pyromucic acid

General dilution ventilation

Operation

Liberation during manufacture of phenolic-furfural resins; during dewaxing of oils, primarily lubricating oils; during decolorization of wood resins

Use during manufacture of surface coatings

Liberation during separation of butadiene, benzene, and miscellaneous compounds from C₄ hydrocarbons; during manufacture of some polyurethane elastomers

Use during in situ desludging and decarbonizing of internal combustion engines

Controls

Process enclosure; general dilution ventilation

General dilution ventilation; process enclosure; local exhaust ventilation

Process enclosure; general dilution 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 furfural 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 furfural gets on the skin, promptly flush the contaminated skin with water. If furfural soaks through the clothing, remove the clothing immediately and flush the skin with water. When there is skin irritation, get medical attention.

• Breathing

If a person breathes in large amounts of furfural, 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 furfural 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 furfural 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. For large quantities, cover with sodium bisulfite (NaHSO_3), add a small amount of water and mix. Then, after one hour, flush with large amounts of water and wash site with soap solution.

- **Waste disposal methods:**

Furfural 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. For small quantities, by absorbing it in vermiculite, dry sand, earth, or a similar material and disposing it in a suitable combustion chamber.

3. For large quantities, by mixing with a flammable liquid (such as acetone) and atomizing in a suitable combustion chamber.

REFERENCES

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RESPIRATORY PROTECTION FOR FURFURAL

Condition	Minimum Respiratory Protection* Required Above 5 ppm
Vapor Concentration	
250 ppm or less	<p>A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).</p> <p>A gas mask with a chin-style or a front- or back-mounted organic vapor canister.</p> <p>Any supplied-air respirator with a full facepiece, helmet, or hood.</p> <p>Any self-contained breathing apparatus with a full facepiece.</p>
Greater than 250 ppm or entry and escape from unknown concentrations	<p>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</p> <p>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.</p>
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	<p>Any gas mask providing protection against organic vapors.</p> <p>Any escape self-contained breathing apparatus.</p>

*Only NIOSH-approved or MSHA-approved equipment should be used.