

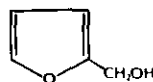
OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR FURFURYL ALCOHOL

INTRODUCTION

This guideline summarizes pertinent information about furfuryl alcohol for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- **Formula:** C₅H₆O₂
- **Structure:**



- **Synonyms:** 2-Furancarbinol, 2-furanmethanol, furfural alcohol, furyl alcohol, 2-furylcarbinol, 2-furylmethanol, 2-hydroxymethylfuran
- **Identifiers:** CAS 98-00-0; RTECS LU9100000; DOT 2874, label required: "St. Andrew's Cross (X)"
- **Appearance and odor:** Colorless to pale yellow, syrupy liquid with a mild odor

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**
 1. Molecular weight: 98.10
 2. Boiling point (at 760 mmHg): 170°C (338°F)
 3. Specific gravity (water = 1): 1.1351
 4. Vapor density (air = 1 at boiling point of furfuryl alcohol): 3.38
 5. Melting point: -14.63°C (5.7°F)
 6. Vapor pressure at 31.8°C (89°F): 1 mmHg
 7. Miscible with water
 8. Evaporation rate (butyl acetate = 1): Very slow
 9. Saturation concentration in air (approximate) at 31.8°C (89°F): 0.13% (1,300 ppm)
- **Reactivity**
 1. **Incompatibilities:** Contact with strong acids (including some organic acids) or acid catalysts may cause polymerization with

the liberation of heat and violent spattering. Avoid contact with strong oxidizers.

2. Hazardous decomposition products: Toxic vapors and gases (e.g., carbon monoxide) may be released in a fire involving furfuryl alcohol.

3. Caution: Furfuryl alcohol will attack some forms of plastics, coatings, and rubber.

- **Flammability**

1. Flash point: 77°C (170°F) (closed cup)
2. Autoignition temperature: 490°C (915°F)
3. Flammable limits in air, % by volume: Lower, 1.8; Upper, 16.3
4. Extinguishant: Alcohol foam, carbon dioxide, or dry chemical
5. Class IIIA Combustible Liquid (29 CFR 1910.106), Flammability Rating 2 (NFPA)

- **Warning properties**

1. Odor threshold: 7-8 ppm
2. Evaluation of warning properties for respirator selection: Because of its odor, furfuryl alcohol can be detected below the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL); thus, furfuryl alcohol is treated as a chemical with adequate warning properties.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for furfuryl alcohol is 50 parts of furfuryl alcohol per million parts of air (ppm) [200 milligrams of furfuryl alcohol per cubic meter of air (mg/m³)] as a time-weighted average (TWA) concentration over an 8-hour workshift. The NIOSH REL is 50 ppm (200 mg/m³) as a TWA for up to a 10-hour workshift, 40-hour workweek. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV[®]) is 10 ppm (40 mg/m³) (Skin) as a TWA for a normal 8-hour workday and a 40-hour workweek; and the ACGIH short-term exposure limit (STEL) is 15 ppm (60 mg/m³) (Skin). The notation "Skin" refers to the potential contribution to overall exposure by the cutaneous route including the mucous membranes and eyes (Table 1).

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

Table 1.—Occupational exposure limits for furfuryl alcohol

	Exposure limits	
	ppm	mg/m ³
OSHA PEL TWA	50	200
NIOSH REL TWA	50	200
ACGIH TLV® TWA (Skin)*	10	40
STEL (Skin)	15	60

* (Skin): Potential contribution to overall exposure by the cutaneous route including mucous membranes and eyes.

HEALTH HAZARD INFORMATION

• Routes of exposure

Furfuryl alcohol may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

• Summary of Toxicology

Effects on animals: Repeated daily exposure to mice, rats, or rabbits to furfuryl alcohol caused increased respiration, respiratory tract irritation, and vascular congestion, followed by decreased respiration, decreased force of cardiac contraction, decreased contractility of the gastrointestinal tract, drop in blood pressure, paralysis of sensory nerves, and death due to respiratory failure or possibly to cardiac arrest.

• Signs and symptoms of exposure

1. *Short-term (acute):* Exposure to furfuryl alcohol can cause excitement, drowsiness, nausea, vomiting, salivation, diarrhea, dizziness, shortness of breath, irregular breathing, and increased urination. Eye contact with furfuryl alcohol can cause redness, tearing, serious irritation, and corneal opacities; dermal contact can cause minor irritation.

2. *Long-term (chronic):* Exposure to furfuryl alcohol can cause headache, eye irritation, and dermatitis.

RECOMMENDED MEDICAL PRACTICES

• Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evalu-

ated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to furfuryl alcohol, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, cardiovascular, nervous, and respiratory systems. Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to furfuryl alcohol at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include a history of chronic skin disease.

• Periodic medical screening and/or biologic monitoring

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to furfuryl alcohol. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physiologic function of the eyes, skin, and cardiovascular, nervous and respiratory systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following tests should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH and the ATS: standardized questionnaires and tests of lung function.

• Medical practices recommended at the time of job transfer or termination

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population.

• Sentinel health events

Acute SHE's include: Contact and/or allergic dermatitis.

MONITORING AND MEASUREMENT PROCEDURES

• TWA exposure evaluation

Measurements to determine worker exposure to furfuryl alcohol should be taken so that the TWA exposure is based on

a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• **Method**

Sampling and analysis may be performed by collecting furfuryl alcohol vapors with charcoal adsorption tubes followed by desorption with carbon disulfide and analysis by gas chromatography. Detector tubes or other direct-reading devices calibrated to measure furfuryl alcohol may also be used if available. A detailed sampling and analytical method for furfuryl alcohol may be found in the *NIOSH Manual of Analytical Methods* (method number S365).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, face shields (8-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with furfuryl alcohol.

Workers should be provided with and required to use splash-proof safety goggles where furfuryl alcohol may come in contact with the eyes.

SANITATION

Clothing which is contaminated with furfuryl alcohol should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of furfuryl alcohol from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of furfuryl alcohol's hazardous properties.

Change and shower rooms should be provided with separate locker facilities for street and work clothes.

Skin that becomes contaminated with furfuryl alcohol should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle furfuryl alcohol should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to furfuryl alcohol may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for furfuryl alcohol

Operations	Controls
During the manufacture of cements, molded high-density carbon, and graphite articles; during the preparation of furfuryl-dimethylol urea and furan resins	Local exhaust ventilation, general exhaust ventilation, personal protective equipment
During the synthesis and handling of furfuryl alcohol; during use as a solvent; during use in impregnation of wood	Local exhaust ventilation, general exhaust ventilation, personal protective equipment
During use in sand consolidation for oil and gas recovery operations	General dilution ventilation, personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• **Eye exposure**

Where there is any possibility of a worker's eyes being exposed to furfuryl alcohol, an eye-wash fountain should be provided within the immediate work area for emergency use.

If furfuryl alcohol gets into the eyes, flush them immediately with large amounts of water for 15 minutes, 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**

Where there is any possibility of a worker's body being exposed to furfuryl alcohol, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If furfuryl alcohol gets on the skin, wash it immediately with soap and water. If furfuryl alcohol penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

• **Rescue**

If a worker has been incapacitated, move the affected worker from the hazardous exposure. 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.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If furfuryl alcohol 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 of liquids containing furfuryl alcohol, absorb on paper towels and place in an appropriate container. Place towels in a safe place such as a fume hood for evaporation. Allow sufficient time for evaporation of the vapors so that the hood ductwork is free from furfuryl alcohol vapors. Burn the paper in a suitable location away from combustible materials.

4. Large quantities of liquids containing furfuryl alcohol may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container. Furfuryl alcohol should not be allowed to enter a confined space such as a sewer because of the possibility of an explosion.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

For each level of respiratory protection, only those respirators that have the minimum required protection factor and meet other use restrictions are listed. All respirators that have higher protection factors may also be used.

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Table 3.—Respiratory protection for furfuryl alcohol

Condition	Minimum respiratory protection*†
Concentration: Less than or equal to 250 ppm	Any powered air-purifying respirator with organic vapor cartridge(s) (substance reported to cause eye irritation or damage—may require eye protection) Any self-contained breathing apparatus (substance reported to cause eye irritation or damage—may require eye protection) Any supplied-air respirator (substance reported to cause eye irritation or damage—may require eye protection) Any chemical cartridge respirator with organic vapor cartridge(s) (substance reported to cause eye irritation or damage—may require eye protection)
Planned or emergency entry into environments containing unknown concentrations or levels above 250 ppm	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister Any appropriate escape-type self-contained breathing apparatus

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

† The respiratory protection listed for any given condition is the minimum required to meet the NIOSH REL of 50 ppm (200 mg/m³) (TWA).

