

# FURFURYL ALCOHOL

**CAS number:** 98-00-0

**Synonyms:** 2-Furylmethanol, 2-hydroxymethylfuran, 2-furancarbinol

**Chemical formula:** C<sub>5</sub>H<sub>6</sub>O<sub>2</sub>

**Structural formula:** —

## Workplace exposure standard (amended)

**TWA:** 0.2 ppm (0.8 mg/m<sup>3</sup>)

**STEL:** —

**Peak limitation:** —

**Notations:** Carc. 2, Sk.

**IDLH:** 75 ppm

**Sampling and analysis:** The recommended value is quantifiable through available sampling and analysis techniques.

## Recommendation and basis for workplace exposure standard

A TWA of 0.2 ppm (0.8 mg/m<sup>3</sup>) is recommended to protect against upper respiratory tract and eye irritation in exposed workers.

The previous STEL of 15 ppm (60 mg/m<sup>3</sup>) is recommended to be withdrawn as there is lack of evidence for immediate acute toxicity within ten times of the recommended TWA.

## Discussion and conclusions

Furfuryl alcohol is commonly used as an industrial solvent and intermediate for the production of resins (ACGIH, 2018). Critical effects include upper respiratory tract and eye irritation and possible nasal cancer.

Epidemiological studies show that workers exposed (via inhalation) to furfuryl alcohol at 1.72 ppm with peaks of 10 ppm experienced symptoms such as throat irritation (ACGIH, 2018). Chronic two-year inhalation studies in rats and mice demonstrate that exposure at 2 ppm can result in irritation in nasal mucous membranes (ACGIH, 2018). ACGIH (2018) assign a TLV-TWA of 0.2 ppm based on animal studies reporting irritation at 2 ppm and seemingly applying an uncertainty factor of 10 to this concentration.

There are insufficient carcinogenicity data in humans, but available animal data suggests an increase in nasal epithelium adenomas and carcinomas and renal tubule adenomas or carcinomas following exposure (ACGIH, 2018).

A TWA of 0.2 ppm is recommended as assigned by ACGIH. There is insufficient evidence to warrant the recommendation of a STEL as the recommended TWA is considered adequately protective.

## **Recommendation for notations**

Classified as a category 2 carcinogen according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

Not classified as a skin sensitiser or respiratory sensitiser according to the GHS.

A skin notation has been recommended based on evidence suggesting potential dermal absorption and adverse systemic effects in animals.

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## APPENDIX

### Primary sources with reports

Source	Year set	Standard
<b>SWA</b>	<b>1991</b>	<b>TWA: 10 ppm (40 mg/m<sup>3</sup>); STEL: 15 ppm (60 mg/m<sup>3</sup>)</b>
<b>ACGIH</b>	<b>2017</b>	<b>TLV-TWA: 0.2 ppm (0.8 mg/m<sup>3</sup>)</b>
<p>TLV-TWA of 0.2 ppm (0.8 mg/m<sup>3</sup>) recommended to minimise potential against upper respiratory and eye irritation in exposed workers. The TLV-TWA is based on a 2-yr inhalation study in which irritation of nasal mucous membranes were reported at 2 ppm in rats and mice; no further information on TLV-TWA calculation.</p> <p>Limited human carcinogenicity data exists, but experimental animal studies suggest increased cancer incidence, thus, an A3 carcinogenicity classification is assigned.</p> <p>Summary of data:</p> <p>Human data:</p> <ul style="list-style-type: none"> <li>Workers exposed at an average of 7 mg/m<sup>3</sup> (1.72 ppm) over 8 hours, with peak values &gt;40 mg/m<sup>3</sup> (&gt;10 ppm), reported throat irritation</li> <li>No symptoms reported by workers exposed at &lt;10.8 ppm; severe lacrimation reported in workers exposed to 15.8 ppm. Despite direct skin contact with furfuryl alcohol, no irritation or any other symptoms reported</li> <li>NIOSH health hazard evaluation indicated workers exposed to peak levels up to 16.5 ppm did not report any symptoms including irritation, headache or dizziness.</li> </ul> <p>Animal data:</p> <ul style="list-style-type: none"> <li>LD<sub>50</sub>: 177 mg/kg (rats, oral)</li> <li>LC<sub>50</sub>: 592 ppm (rats, 1h inhalation)</li> <li>Dermal LD<sub>50</sub>: 3,825 mg/kg (rats), 400 mg/kg (rabbits). Dermal application between 400–1,100 mg/kg led to dose-related mortality in rabbits</li> <li>Available animal studies insufficient to assign furfuryl alcohol as a respiratory sensitiser</li> <li>Decrease in brain protein synthesis in exposed rats to 100 ppm at 16 wk; (inhalation study, 4 per group, 4 dose group ranging from 0–100 ppm, 6 h/d, 5 d/wk, 4–16 wk)</li> <li>No signs of significant nervous system effects were observed at 25 ppm for 16 weeks</li> <li>Significant increase in adenomas and carcinomas in male rats (nasal epithelium adenoma, carcinoma or squamous cell carcinoma) and male mice (renal tubule adenomas or carcinomas) at 32 ppm (2-yr inhalation study)</li> <li>LOAEL of 2 ppm identified for significant increase of non-neoplastic olfactory epithelium effects in both male and female rats and mice</li> <li>Majority of genotoxicity studies reported negative results; found mutagenic in one strain of <i>Salmonella typhimurium</i></li> <li>Insufficient evidence exists with respect to reproductive/developmental effects.</li> </ul>		
<b>DFG</b>	<b>2008</b>	<b>Not assigned</b>
<p>No MAK recommended since a NOAEL not established.</p> <p>A former MAK value of 10 ppm has been withdrawn as evidence of adverse effects in humans and animals at or below 2 ppm exist.</p> <p>Summary of additional data:</p>		



Source	Year set	Standard
<p>Human data:</p> <ul style="list-style-type: none"> <li>No additional human toxicity data is available.</li> </ul> <p>Animal data:</p> <ul style="list-style-type: none"> <li>Reduced body weight gains up to 15% based on 16-d whole-body inhalation study in rats exposed to <math>\geq 31</math> ppm (for males) and <math>\geq 125</math> ppm (for females)</li> <li>Concentrations <math>\geq 63</math> ppm resulted in dyspnoea, hypoactivity and nasal and ocular discharge</li> <li>All exposed animals developed inflammation of the nasal cavity and damage to the respiratory epithelium</li> <li>Concentrations <math>\geq 2</math> ppm resulted in significant increase in irritation of the nasal mucosa, including degeneration and metaplasia in the olfactory epithelium of mice and rats</li> <li>Renal tubule degeneration was observed in animals exposed at <math>\geq 32</math> ppm.</li> </ul>		
<b>SCOEL</b>	<b>2011</b>	<b>Not assigned</b>
<p>TWA not assigned as it was not possible to identify a value without adverse effects. Additionally, no NOAEL for inhalation exposure established.</p> <p>Summary of additional data:</p> <p>Human data:</p> <ul style="list-style-type: none"> <li>Threshold for eye irritation reported between 100–122 mg/m<sup>3</sup> (25–31 ppm).</li> </ul> <p>Animal data:</p> <ul style="list-style-type: none"> <li>Heart weights of male mice significantly reduced following exposure to 131 mg/m<sup>3</sup>. Dose-related increase in severity of lesions of the respiratory and olfactory epithelium also observed and a LOAEL of 8 mg/m<sup>3</sup> established.</li> </ul>		
<b>OARS/AIHA</b>	<b>NA</b>	<b>NA</b>
No report.		
<b>HCOTN</b>	<b>NA</b>	<b>NA</b>
No report.		

## Secondary source reports relied upon

Source	Year	Additional information
NICNAS	✓ 2016	<ul style="list-style-type: none"> <li>Several local lymph node assays determined that furfuryl alcohol considered to be a skin sensitiser.</li> </ul>
IARC	✓ 2019	<ul style="list-style-type: none"> <li>Group 2B (<i>possibly carcinogenic to humans</i>) classification based on inadequate evidence for carcinogenicity in humans, but sufficient evidence in experimental animals.</li> </ul>
US NIOSH	✓ 1994	<ul style="list-style-type: none"> <li>IDLH of 75 ppm, based on acute inhalation toxicity data in animals.</li> </ul>

## Carcinogenicity — non-threshold based genotoxic carcinogens

Is the chemical mutagenic? Insufficient data

Is the chemical carcinogenic with a mutagenic mechanism of action? Insufficient data

**Insufficient data are available to determine if the chemical is a non-threshold based genotoxic carcinogen.**

## Notations

Source	Notations
SWA	Carc. 2, Skin
HCIS	Carcinogenicity – category 2, Skin sensitisation – category 1
NICNAS	Carc. Cat 3, Skin sensitisation
EU Annex	Carcinogenicity – category 2
ECHA	Carc. 2
ACGIH	Carcinogenicity – A3, Skin
DFG	Carcinogenicity – 3B, H (skin)
SCOEL	Skin
HCOTN	NA
IARC	Carcinogenicity – Group 2B
US NIOSH	—

NA = not applicable (a recommendation has not been made by this Agency); — = the Agency has assessed available data for this chemical but has not recommended any notations

## Skin notation assessment

Calculation	
Adverse effects in human case study:	<i>Insufficient Data</i>
Dermal LD <sub>50</sub> ≤ 1000 mg/kg:	Yes
Dermal repeat-dose NOAEL ≤ 200 mg/kg:	<i>Insufficient Data</i>
Dermal LD <sub>50</sub> /Inhalation LD <sub>50</sub> < 10:	Yes
<i>In vivo</i> dermal absorption rate > 10%:	<i>No data</i>
Estimated dermal exposure at WES > 10%:	<i>No data</i>
<b>Consider assigning a skin notation</b>	

## IDLH

Is there a suitable IDLH value available? Yes

## Additional information

Molecular weight:	98.1
Conversion factors at 25°C and 101.3 kPa:	1 ppm = 4.01 mg/m <sup>3</sup> ; 1 mg/m <sup>3</sup> = 0.25 ppm
This chemical is used as a pesticide:	<input type="checkbox"/>
This chemical is a biological product:	<input type="checkbox"/>
This chemical is a by-product of a process:	<input type="checkbox"/>
A biological exposure index has been recommended by these agencies:	<input type="checkbox"/> ACGIH <input type="checkbox"/> DFG <input type="checkbox"/> SCOEL

## Workplace exposure standard history

Year	Standard
1991	TWA 10 ppm (40 mg/m <sup>3</sup> ) ; STEL 15 ppm (60 mg/m <sup>3</sup> )

## References

American Conference of Industrial Hygienists (ACGIH®) (2018) TLVs® and BEIs® with 7<sup>th</sup> Edition Documentation, CD-ROM, Single User Version. Copyright 2018. Reprinted with permission. See the [TLVs® and BEIs® Guidelines section](#) on the ACGIH website.

Deutsche Forschungsgemeinschaft (DFG) (2008) Furfuryl alcohol – MAK value documentation.

European Chemicals Agency (ECHA) (2016) furfuryl alcohol – REACH assessment. Tenth Adaptation to Technical Progress Commission Regulation (EU) No 2017/776 amending, for the purposes of its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures (the CLP Regulation).

International Agency for Research on Cancer (IARC) (2019) Furfuryl alcohol. IARC Monographs on the evaluation of the carcinogenic risk to humans.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2016) 2-Furanmethanol: Human health tier II assessment – IMAP report.

Scientific Committee on Occupational Exposure Limits (SCOEL) (2011) Recommendation from the Scientific Committee on Occupational Exposure Limits for Furfuryl Alcohol. SCOEL/SUM/129.

Tenth Adaptation to Technical Progress Commission Regulation (EU Annex) No 2017/776 amending, for the purposes of its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures (the CLP Regulation).

US National Institute for Occupational Safety and Health (NIOSH) (1994) Immediately dangerous to life or health concentrations – Furfuryl alcohol.