

FURFURAL

CAS number: 98-01-1

Synonyms: 2-Furaldehyde, 2-furancarboxyadehyde

Chemical formula: C₅H₄O₂

Structural formula: —

Workplace exposure standard (amended)

TWA: 0.2 ppm (0.8 mg/m³)

STEL: —

Peak limitation: —

Notations: Carc .2, Sk.

IDLH: 100 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/m³) is recommended to protect for upper respiratory tract and eye irritation in exposed workers.

Discussion and conclusions

Furfural is commonly used as a solvent and as an intermediate in the production of various domestic and commercial products (ACGIH, 2018). Critical effects include upper respiratory tract irritation, eye irritation and photophobia.

Workers exposed to furfural concentrations between 1.6 and 4.2 ppm reported headaches, nasal bleeding, burning sensation and irritation of eyes, nose and throat as well as shortness of breath (ACGIH, 2018). ACGIH (2018) assigned a TLV-TWA of 0.2 ppm based on human case studies.

Limited carcinogenicity data are available in humans, but available animal data suggests increased incidence of cancer following oral and inhalation exposures (ACGIH, 2018; DFG, 2002).

A TWA of 0.2 ppm is recommended as assigned by ACGIH to protect for irritant effects in exposed workers.

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.

APPENDIX

Primary sources with reports

Source	Year set	Standard
SWA	1991	TWA: 2 ppm (7.9 mg/m³)
ACGIH	2017	TLV-TWA: 0.2 ppm (0.8 mg/m³)
Summary of data: TLV-TWA of 0.2 ppm (0.8 mg/m³) recommended to minimise potential of upper respiratory tract and eye irritation in exposed workers. This value is based on human case studies, including studies which indicated that workers experienced nasal bleeding, burning sensation in eyes/nose/throat and shortness of breath or chest tightness, light sensitivity, among other complications, when exposed to concentrations between 1.6–4.2 ppm. No further explanation on derivation of TLV-TWA provided. Limited human carcinogenicity data exists, but animal studies suggest an increased incidence of tumours following oral and inhalation exposure, hence an A3 classification (confirmed animal carcinogen with unknown relevance to humans) was assigned. Insufficient information to recommend a STEL or SEN notation. Human data: - Workers exposed at concentrations between 5–16 ppm experienced eye and respiratory tract irritation, with some indicating nasal bleeding, throat dryness and sun sensitivity - Two NIOSH health hazard evaluations reported similar symptoms in workers exposed to concentrations between 1.6 and 4.2 ppm; and concentrations between 1.6 and 2.1 ppm - Genotoxicity testing involving human lymphocytes reported a strong induction of sister-chromatid exchange following exposure - No evidence of sensitisation in humans. Animal data: - LC₅₀ (rats, 1 h inhalation): 995 ppm (males), 1056 ppm (females) - LD₅₀: 50–127 mg/kg (rats, oral) - LD₅₀: 192 mg/kg (rats, dermal), which supports a skin notation - Eye and upper respiratory tract irritation reported in rats exposed to 38 ppm for 1 h/d, 5 d/wk for 7, 15 or 30 d. Hepatotoxicity was additionally reported at after 30 d exposure - Immunotoxic effects reported in rats exposed to 40 ppm for 1 h/d, 5 d/wk for 7, 15 or 30 d - NOAEL: <20 mg/m³ (5.1 ppm) based on rats exposed to concentrations (0–1,280 mg/m³, 3–6 h/d, 5 d/wk, 28 d); study findings indicated effects strongly linked to duration rather than concentration - Inhalation: Dose-dependent increase in nasal epithelium adenomas and carcinomas in rats and mice (2-yr inhalation study, 4 dose groups ranging from 0–32 ppm, 6 h/d, 5 d/wk for 105 wk); at 32 ppm, increase in renal tubule degeneration, adenomas or carcinomas in male mice; no liver lesions reported in either mice or rats - Both positive and negative genotoxicity test results have been presented, therefore the mutagenicity of furfural remains unclear.		



Source	Year set	Standard
DFG	2002	Not assigned
No MAK recommended for furfural due to evidence it can contribute to carcinogenic risk and a genotoxic mechanism cannot be disregarded. Summary of additional data: Human data: - Negative results for sister-chromatid exchange on human lymphocytes. Animal data: - LC₅₀: 175 ppm (rats, 6 h) - LD₅₀: 125 mg/kg (rats and mice, oral) - Hamsters exposed to concentrations of 552 ppm (2,208 mg/m³) displayed eye and nose irritation, liver damage and significant weight loss - Rats exposed to 40 ppm (160 mg/m³) for 1 h, 5 d/wk, 6 wk showed irritation in eyes and nose, and damage to type II pneumocytes - Carcinogenic studies demonstrated an increase in the incidence of liver tumours in mice given 175 mg/kg.		
SCOEL	NA	NA
No report.		
OARS/AIHA	NA	NA
No report.		
HCOTN	NA	NA
No report.		

Secondary source reports relied upon

Source	Year	Additional information
NICNAS	✓ 2013	- LOAEL: 20 mg/m³ (rats, repeat dose inhalation) for respiratory tract effects - NOAEL: 8 mg/m³ (rats, inhalation) - Most <i>in vitro</i> genotoxicity studies produced positive results, whilst most <i>in vivo</i> studies had negative results - Studies did not show evidence of reproductive or developmental toxicity.
IARC	✓ 1995	Classified as Group 3 (not classifiable as to its carcinogenicity) based on limited evidence in animals.
US EPA	✓ 1988	Oral RfD (0.003 mg/kg/d) based on LOAEL (11 mg/kg/d) for mild hepatocellular vacuolization (rat, oral sub-chronic study).
OECD	✓ 2008	NOAEL and LOAEL of 77 and 448 mg/m³, respectively (hamsters, inhalation).
US NIOSH	✓ 1994	- TWA: 2 ppm (8 mg/m³) - IDLH based on acute inhalation toxicity data in humans.

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	Skin
HCIS	Carcinogenicity – category 2
NICNAS	Carc. Cat 3, Skin
EU Annex	Carcinogenicity – category 2
ECHA	Carc. 2
ACGIH	Carcinogenicity – A3, Skin
DFG	H (skin)
SCOEL	NA
HCOTN	NA
IARC	Carcinogenicity – Group 3
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 ₅₀ ≤ 1000 mg/kg:	Yes
Dermal repeat-dose NOAEL ≤ 200 mg/kg:	<i>Insufficient Data</i>
Dermal LD ₅₀ /Inhalation LD ₅₀ < 10:	Yes
<i>In vivo</i> dermal absorption rate > 10%:	<i>No data</i>
Estimated dermal exposure at WES > 10%:	<i>No data</i>
Consider assigning a skin notation	

IDLH

Is there a suitable IDLH value available? Yes

Additional information

Molecular weight:	96.09
Conversion factors at 25°C and 101.3 kPa:	1 ppm = 3.93 mg/m ³ ; 1 mg/m ³ = 0.255 ppm
This chemical is used as a pesticide:	☐
This chemical is a biological product:	☐
This chemical is a by-product of a process:	☐
A biological exposure index has been recommended by these agencies:	☒ ACGIH ☐ DFG ☐ SCOEL

Workplace exposure standard history

Year	Standard
1991	TWA: 2 ppm (7.9 mg/m ³)

References

American Conference of Industrial Hygienists (ACGIH®) (2018) TLVs® and BEIs® with 7th 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) (2002) Furfural – MAK value documentation.

European Chemicals Agency (ECHA) (2016) Furfural – 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) (1995) Furfural. IARC Monographs on the evaluation of the carcinogenic risk to humans.

Organization for Economic Co-operation and Development (OECD) (2008) SIDS Initial Assessment Profile. SIAM 26, 16-18.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2013) 2-Furancarboxaldehyde: Human health tier II assessment – IMAP report.

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US Environmental Protection Agency (US EPA) (1988) Integrated Risk Information System (IRIS), Furfural; CASRN 98-01-1.

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