

TURPENTINE (WOOD)

CAS number: 8006-64-2

Synonyms: Wood turpentine, gum turpentine, sulfate turpentine, turpentine oil, oil of turpentine, rectifier, terpene

Chemical formula: C₁₀H₁₆

Workplace exposure standard (interim)

TWA: 20 ppm (112 mg/m³)

STEL: —

Peak limitation: —

Notations: Sk., DSEN

IDLH: 800 ppm (10% LEL)

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

Recommendation and basis for workplace exposure standard

A TWA of 20 ppm (112 mg/m³) is recommended to protect for irritation of the eyes, nose and throat in exposed workers.

Given the limited data available from the primary sources, it is recommended that a review of additional sources be conducted at the next scheduled review.

Discussion and conclusions

Turpentine is a mixture of monoterpenes, mainly α -pinene, β -pinene and Δ^3 -carene, predominately from resins in pine trees. It is used as a solvent, paint thinner, cleaner and antiseptic and is released as a vapour during wood processing.

The critical effects of exposure are eye, nose and throat irritation and dermal sensitisation.

Eye and upper respiratory irritation are reported in volunteers exposed acutely at 81 ppm during light exercise. These effects are not observed at 40 ppm under the same conditions (ACGIH, 2018; DFG, 2002). Turpentine's long elimination half-time of approximately 20 hours is also reported in these studies due to its accumulation in adipose tissue (ACGIH, 2018). Available workplace studies are limited by mixed exposures and small sample sizes. Average exposures at approximately 22 to 27 ppm are associated with self-reported irritation and slight decreases in pulmonary function in sawmill workers and carpenters (ACGIH, 2018; DFG, 2002). Positive dermal sensitisation reactions following occupational exposure are reported but limited by varying compositions of the substance and no other exposure details (ACGIH, 2018; DFG, 2002; NICNAS, 2018). An irritation threshold is not reported in the available animal studies. Systemic effects are observed as kidney toxicity at 25 ppm in rats. This endpoint is of unlikely relevance to humans due to species-specific metabolism of the substance (ECHA, 2020).

ACGIH (2018) recommended a TWA of 20 ppm based on several reports of irritation above 40 ppm in volunteers and limited occupational data. However, DFG (2002) consider the available database

insufficient to recommend a MAK due to a lack of repeat dose studies and confounded epidemiological data. In view of this uncertainty, relatively long elimination half-time and lack of reliable chronic exposure data, the TWA of 20 ppm by ACGIH (2018) is recommended in the interim and is expected to be protective of irritant effects.

Further assessment of additional sources regarding long-term exposure in humans and animals is recommended during subsequent reviews of the WES.

Recommendation for notations

Not classified as a carcinogen according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

Classified as a skin sensitiser and not a respiratory sensitiser according to the GHS. Occupational asthma is reported in a single study but no further details on this study are available in the available data sources (ACGIH, 2018). A review of the notation for respiratory sensation is recommended.

A skin notation is recommended as evidence indicates contact dermatitis in humans and reports of systemic availability in animals.

APPENDIX

Primary sources with reports

Source	Year set	Standard
SWA	1995	TWA: 100 ppm (557 mg/m³)
ACGIH	2014	TLV-TWA: 20 ppm (112 mg/m³)
<p>Grouped assessment of α-pinene, β-pinene and Δ^3-carene, which are the main components of turpentine.</p> <p>TLV-TWA intended to protect for URT irritation and chronic respiratory impairment. TLV-STEL not recommended based on the available data.</p> <p>Summary of information:</p> <p>TLV-TWA based on weight of evidence of a workplace and volunteer chamber studies, from which URT irritation may be expected between 10 and 81 ppm; studies are limited by mixed exposures and short duration, respectively. In view of these limitations, the TLV-TWA of 20 ppm is expected to be protective of upper respiratory tract irritation.</p> <p>Human data:</p> <ul style="list-style-type: none"> α-Pinene absorbed through skin, maximum blood concentrations reached in 10 min Pulmonary uptake of 60–70% and elimination half-time of metabolites \approx20 h reported in several volunteer inhalation studies with exposure groups 0, 2, 40 and 81 ppm of turpentine or individual terpene components (n=8, 2 h, 50 W on bicycle ergometer, light exercise); cited articles note high substance affinity for adipose tissue: <ul style="list-style-type: none"> eye, nose and throat irritation and increased airway resistance at 81 ppm, no reports of CNS depression no irritation reported at 40 ppm 2 ppm of Δ^3-carene used as positive control for respiratory irritation Several reports of contact dermatitis following occupational dermal exposure Nose and throat irritation at 81 ppm in some subjects, throat irritation at 125 ppm and objectionable eye, nose and throat irritation in most subjects at 175 ppm in volunteer acute inhalation study (n=10/group, 3–5 min): <ul style="list-style-type: none"> cited study concludes 100 ppm highest tolerable exposure for 8 h shift Occupational asthma reported from inhaling oil mist with positive bronchial provocation test (no further details provided). It is unclear if these results meet the requirements for a respiratory sensitiser notation in accordance with the GHS Reduced forced expiratory second volume (FEV₁) and forced vital capacity (FVC) compared with controls reported in cross-sectional study of carpenters (n=38): <ul style="list-style-type: none"> personal exposures ranged from 1.6–38.5 ppm Decreased FEV₁ in sawmill workers (n=48) exposed at up to 99 ppm: <ul style="list-style-type: none"> follow-up study of 30 of the original 48 participants after introduction of improved ventilation at 2 facilities ventilation improvements led to mean exposure decreases from 24.7 to 6.3 ppm and from 44 to 8 ppm. Dust levels (particles sizes not provided) ranged from 0.1–1.1 mg/m³ (mean of 0.4 mg/m³) cited study concluded pulmonary function impairment only improved in the second sawmill (from 44 to 8 ppm reduction). Confounding by microorganisms, mould spores and dust not ruled out 		

Source	Year set	Standard
		<ul style="list-style-type: none"> Increased concentration of inflammation marker in nasal lavage fluid of volunteers (n=19, 5 h) exposed to sawmill atmosphere containing median dust concentration of 0.13 mg/m³ and terpene concentration ≈56 mg/m³ (10 ppm); cited authors conclude that exposure to sawmill atmosphere caused slight URT inflammation. <p>Animal data:</p> <ul style="list-style-type: none"> Median respiratory depression (RD₅₀) of α-pinene, β-pinene and Δ³-carene: 1,053, 1,279 and 1,345 ppm, respectively: <ul style="list-style-type: none"> basis of OEL recommendation of 34 ppm from cited study Carcinogenicity and chronic data limited to dermal application tumour promotion studies with co-application of tar or B[a]P, which produced equivocal results (mice, rats): <ul style="list-style-type: none"> ACGIH considered these studies inadequate for carcinogenicity classification d-limonene, a structurally related terpene, was carcinogenic in rats <i>via</i> species-specific metabolism in the kidney, which is not considered relevant to humans Genotoxicity data extremely limited; particleboard off-gasses, containing small amounts of pinene were mutagenic <i>in vitro</i> in bacteria, other compounds in the gas were benzene, formaldehyde and limonene: <ul style="list-style-type: none"> limonene alone was not mutagenic <i>in vitro</i> in bacteria and mammalian cells with or without metabolic activation. <p>Not classifiable as a human carcinogen (A4) based on inadequate human and animal exposure data.</p> <p>A skin notation is not recommended based on the absence of systemic effects following dermal absorption.</p> <p>A dermal sensitiser notation is recommended based on available data.</p> <p>Insufficient data to recommend a RSEN notation.</p>
DFG	2002	Not assigned
		<p>Summary of additional information:</p> <p>Critical effects are eye and upper respiratory tract irritation. Irritation threshold is below 100 ppm based on several volunteer inhalation studies (also reported by ACGIH, 2018) but no data for this endpoint regarding repeat exposures available. Previous MAK of 100 ppm therefore withdrawn; a new MAK is not established.</p> <p>Tumour promotion effect in mice (also reported in ACGIH, 2018) could be used to classify substance as category 4 carcinogen; mechanism of carcinogenicity is likely through chronic irritation. However, without a MAK/threshold for the irritative endpoint, category 3A provisionally assigned.</p> <p>Skin notation not recommended due to low acute dermal toxicity of the main constituent terpenes.</p> <p>Dermal sensitisation notation retained based on positive sensitisation in animals and humans.</p> <p>Human data:</p> <ul style="list-style-type: none"> Dizziness in exposed shoe polish workers; symptoms subsided after introduction of improved workplace ventilation. No effects associated with terpene air concentrations of 100–300 mg/m³ (≈18–53 ppm): <ul style="list-style-type: none"> shoe polish contained 65–70% turpentine, 7% white spirits, 23–24% paraffin wax study not considered for MAK evaluation due to lack of exposure data under unventilated conditions Reduced FEV₁ and FVC in workers exposed at 50–240 mg/m³ (9–43 ppm) mean 125 mg/m³ (22 ppm) for up to 37 yr, mean of 7.6 yr; coughing and throat irritation more common in workers exposed above 25 mg/m³ (4 ppm)

Source	Year set	Standard
<ul style="list-style-type: none"> No changes in lung function parameters in carpenters (n=38) and sawmill workers (n=48) exposed on average at 150 mg/m³ (27 ppm) in 2 epidemiological studies (also reported by ACGIH, 2018): <ul style="list-style-type: none"> 10/48 sawmill workers self-reported eye irritation slight decrease in lung diffusion capacity in 12 sawmill workers and not in 26 other workers both exposed at 50 mg/m³ (9 ppm) wood dust concentrations measured between 0.1–1.1 mg/m³ DFG considers clinical relevance of these results questionable due to the mildness of the symptoms and small number of subjects; results not used to inform MAK due to mixed exposures to wood dust Contact dermatitis reported in several cases, especially with Δ^3-carene-rich turpentine. <p>Animal data:</p> <ul style="list-style-type: none"> LD₅₀: >5,000 mg/kg (rabbits, dermal) as constituent terpenes. 		
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	✓ 2018	<ul style="list-style-type: none"> Critical effects are skin sensitisation and eye and URT irritation: <ul style="list-style-type: none"> high acute exposures may cause CNS depression Several cases of dermal sensitisation reported in humans; however unknown composition of the substance complicates definitive assessment: <ul style="list-style-type: none"> erythema in 18/25 volunteers at challenge site using 20% solution in petrolatum 48 h after induction with 50% solution allergy in 14/24 pottery workers 6 mo following substitution of Portuguese (78% α-pinene, <0.7% Δ^3-carene) for Indonesian turpentine (85% α-pinene, >15% Δ^3-carene), no details on exposure provided Negative mutagenicity <i>in vitro</i> in bacteria and mammalian cells in the presence or absence of metabolic activation Negative results for chromosomal aberration with human lymphocyte cells Weak association between respiratory cancers and occupational exposure reported in epidemiological study of Finnish woodworkers Association between incidence of neuroblastoma in offspring and paternal exposure.

Source	Year	Additional information
ECHA	✓ 2020	<ul style="list-style-type: none"> Granular casts and hyaline droplets in kidney at 25 ppm reported in sub-chronic inhalation study with dose groups 0, 25, 50, 100, 200 and 400 ppm (rats, 6 h/d, 5 d/wk, 90 d): <ul style="list-style-type: none"> LOAEC of 25 ppm kidney toxicity associated with species-specific metabolism; not considered relevant to humans by SCHA NOAEC of 200 ppm for decreased body weight gain considered relevant to human systemic toxicity by ECHA.
US NIOSH	✓ 1994	<ul style="list-style-type: none"> IDLH based on acute toxicity data in humans and animals; it is also 10% of the LEL.

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	Sen
HCIS	Skin sensitisation – category 1
NICNAS	—
EU Annex	Skin sensitisation – category 1
ECHA	NA
ACGIH	Carcinogenicity – A4, DSEN
DFG	Carcinogenicity – 3A, Sh (dermal sensitiser)
SCOEL	NA
HCOTN	NA
IARC	NA
US NIOSH	NA

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: yes
Dermal LD₅₀ ≤1000 mg/kg: no
Dermal repeat-dose NOAEL ≤200 mg/kg:
Dermal LD₅₀/Inhalation LD₅₀ <10:
In vivo dermal absorption rate >10%:
Estimated dermal exposure at WES >10%:

a skin notation is warranted

IDLH

Is there a suitable IDLH value available? Yes, based on LEL

Additional information

Molecular weight: 136 (approximately)

Conversion factors at 25°C and 101.3 kPa: 1 ppm = 5.56 mg/m³; 1 mg/m³ = 0.18 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
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[Click here to enter year](#)

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) Turpentine – MAK value documentation.

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).

European Chemicals Agency (ECHA) (2020) Turpentine, oil – REACH assessment.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2018) Turpentine: Human health tier II assessment – IMAF report.

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

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