

PHENOL

CAS number: 108-95-2

Synonyms: Carbolic acid, hydroxybenzene, oxybenzene, phenic acid, phenylic acid, phenyl hydroxide

Chemical formula: C₆H₆O

Structural formula: —

Workplace exposure standard (retained)

TWA: 1 ppm (4 mg/m³)

STEL: —

Peak limitation: —

Notations: Sk.

IDLH: 250 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 1 ppm (4 mg/m³) is recommended to protect for irritation and systemic toxicity in exposed workers.

Discussion and conclusions

Phenol is used commercially in adhesives, plastics and surface coatings and in the manufacturing of chemicals and pharmaceuticals.

The critical effects of exposure are eye and respiratory irritation, with some potential for systemic toxicity including cardiovascular, hepatic (liver), renal (kidney) and neurologic effects.

Phenol is an irritant to the eyes, mucous membranes and skin. It readily penetrates the skin with numerous reports of accidental skin exposure and absorption resulting in poisoning and adverse outcomes. No ill effects reported after male and female volunteers were exposed multiple times at up to 5.2 ppm for eight hours *via* inhalation only and at 6.8 ppm dermally *via* whole-body chamber and a fresh air mask. In a separate study, workers exposed up to 3.3 ppm (12.5 mg/m³) experienced no ill effects; no further details are provided. Animals exposed at 26 ppm for 28 to 88 days suffered adverse respiratory, cardiovascular, hepatic, renal and neurologic effects (ACGIH, 2018). A NOAEC of 5 ppm is determined in monkeys, rats and mice for systemic toxicity (NICNAS 2014; SCOEL, 2003).

Based on the available data, the TWA of 1 ppm (4 mg/m³) is recommended to be retained and is considered protective for irritation effects and systemic toxicity reported in animals.

Insufficient evidence is available to recommend a STEL.

Recommendation for notations

Not classified as a 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 is recommended based on evidence of dermal uptake and systemic effects in humans and animals.

DRAFT

APPENDIX

Primary sources with reports

Source	Year set	Standard
SWA	1991	TWA: 1 ppm (4 mg/m³)
ACGIH	2001	TLV-TWA: 5 ppm (19 mg/m³)
<p>TLV-TWA recommended to minimise the potential for eye and respiratory irritation and cardiovascular, hepatic, renal and neurologic toxicity.</p> <p>Summary of data:</p> <p>TLV-TWA based on evidence of workers and volunteers exposed ≤5.2 ppm experiencing no ill effects.</p> <p>Human data:</p> <ul style="list-style-type: none"> • Irritant of the eyes, mucous membranes and skin • Numerous reports of accidental skin exposure and absorption resulting in clinical and pathological outcomes and death • Readily penetrates skin with absorption efficiency ≈ inhalation rate • 7 males and 1 female exposed either <i>via</i> inhalation or dermally: <ul style="list-style-type: none"> ◦ exposed <i>via</i> a closed mask at 1.5–5.22 ppm (6–20 mg/m³) 11 times for 8 h with 2 x 0.2 h breaks; ◦ dermally exposed (3 x clothed and 1 x unclothed) to airborne concentrations of 1.3–6.8 ppm (5–26 mg/m³) in a whole-body chamber with fresh air supplied by a face mask to prevent inhalation of phenol; exposure duration was 6 h with 1 short break ◦ rates of excretion <i>via</i> urine similar <i>via</i> both routes of exposure ◦ no signs or symptoms of intoxication • Workers exposed at a range of 0–3.3 ppm (12.5 mg/m³) experienced no ill effects; no further details. <p>Animal data:</p> <ul style="list-style-type: none"> • Guinea pigs, rabbits and rats 26–52 ppm 7 h/d, 5 d/wk for 28–88 d; respiratory, cardiovascular, hepatic, renal and neurologic toxicity observed in all species: <ul style="list-style-type: none"> ◦ 5/12 guinea pigs died • Evidence of carcinogenicity in animal studies determined to be negative or inadequate. 		
DFG	2010	Not assigned
<p>Due to potential clastogenic and tumour-promoting effects and close metabolic linkage with benzene and hydroquinone, phenol is classified as carcinogenic and a MAK is not recommended.</p> <p>Summary of additional data:</p> <ul style="list-style-type: none"> • No suitable human studies available for assessment • No inhalation studies in animals reported • A LOAEL of 1.8 mg/kg/d reported in a 4 wk drinking water study in mice for neurochemical and haematological effects; lower doses were not examined. 		



Source	Year set	Standard
SCOEL	2003	TWA: 2 ppm (8 mg/m³); STEL: 4 ppm (16 mg/m³)
TWA recommended to protect for systemic toxicity and potential upper respiratory tract irritation. STEL recommended to protect for upper respiratory irritation. Summary of additional data: <ul style="list-style-type: none"> • RD₅₀: 166 ppm (mice) • Exposure of rhesus monkeys, rats and mice at 5 ppm for 90 d resulted in no significant pathological effects; no significant systemic toxicity; no further details Exposure of rabbits, guinea pigs and rats for 7 h/d, 5 d/wk for 74 d at 26–52 ppm (100–200 mg/m ³) resulted in severe degeneration and necrosis in lung, liver, kidney and heart in rabbits after 63 exposures and guinea pigs after 29 exposures; no effects seen in rats after 53 exposures <ul style="list-style-type: none"> • TWA of 2 ppm based on effects in monkeys, rats and mice at 5 ppm; UF of 2 applied to account for absence of human data and rounding according to SCOEL methodology • No derivation of STEL at 4 ppm provided; reported to be based on animal data; no further details. 		
OARS/AIHA	NA	NA
No report.		
HCOTN	NA	NA
No report.		

Secondary source reports relied upon

Source	Year	Additional information
NICNAS	✓ 2014	<ul style="list-style-type: none"> • Well absorbed in animals and humans following oral, dermal and inhalation exposure • LD₅₀: 660–707 mg/kg (dermal) • Rats exposed by 10 nose-only exposures for 5 d/wk, 6 h/d at concentrations up to 25 ppm (96 mg/m³); local and systemic NOAEC of 25 ppm determined.
ECHA	✓ 2019	<ul style="list-style-type: none"> • NOAEC of 5 ppm (20 mg/m³) in monkeys (cited by SCOEL, 2003).

Carcinogenicity — non-threshold based genotoxic carcinogens

Is the chemical mutagenic? Insufficient data

Is the chemical carcinogenic with a mutagenic mechanism of action? No

The chemical is not a non-threshold based genotoxic carcinogen.

Notations

Source	Notations
SWA	Skin



Source	Notations
HCIS	—
NICNAS	—
EU Annex	NA
ECHA	—
ACGIH	Carcinogenicity – A4, Skin
DFG	Carcinogenicity – 3B, H(Skin)
SCOEL	Skin
HCOTN	NA
IARC	Carcinogenicity – Group 3
US NIOSH	SK:SYS

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:
 Dermal LD₅₀ ≤ 1000 mg/kg:
 Dermal repeat-dose NOAEL ≤ 200 mg/kg:
 Dermal LD₅₀/Inhalation LD₅₀ < 10:
In vivo dermal absorption rate > 10%:
 Estimated dermal exposure at WES > 10%:

yes

yes

a skin notation is warranted

IDLH

Is there a suitable IDLH value available? Yes

Additional information

Molecular weight:	94.11
Conversion factors at 25°C and 101.3 kPa:	1 ppm = 3.84 mg/m ³ ; 1 mg/m ³ = 0.260 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:	✓ ACGIH ✓ DFG <input type="checkbox"/> SCOEL

Workplace exposure standard history

Year	Standard
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) (2010) Phenol – MAK value documentation.

European Chemicals Agency (ECHA) (2019) Phenol – REACH assessment.

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (2003) Recommendation from the Scientific Committee on Occupational Exposure Limits for Phenol. SCOEL/SUM/16.

International Agency for Research on Cancer (IARC) (1999) Phenol. IARC Monographs on the evaluation of the carcinogenic risk to humans.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2014) Phenol: Human health tier II assessment – IMAP report.

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

US National Institute for Occupational Safety and Health (NIOSH) (2011) NIOSH Skin Notation Profiles: Phenol.