OXALIC ACID

CAS number: 144-62-7

Synonyms: Dicarboxylic acid, ethanedioic acid

Chemical formula: $C_2H_2O_4$

Structural formula: —

Workplace exposure standard (retained)

TWA: **1 mg/m^3**

STEL: **2 mg/m^3**

Peak limitation: **—**

Notations: **—**

IDLH: **500 mg/m^3**

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 mg/m^3 is recommended to protect for irritation and hypocalcaemia in exposed workers.

A STEL of 2 mg/m^3 is recommended to protect for acute irritation and hypocalcaemia in exposed workers.

Discussion and conclusions

Oxalic acid is used for disinfection, rust removal and in dye and rubber manufacture.

Critical effects of exposure are irritation of the eyes and upper respiratory tract. Prolonged exposure may increase susceptibility to urinary stones. Acute exposure has caused hypocalcaemia and related heart and urinary complications in humans (ACGIH, 2018).

The toxicological database is limited and there are no human or animal inhalational data available. Duration-dependent symptoms, but no exposure data, relating to the critical effects are reported in a workplace study of railway cleaners (ACGIH, 2018; HCOTN, 2004). A NOAEL of 162 mg/kg/day in rats is reported from a sub-chronic reproductive feeding study (ACGIH, 2018). A NOAEL of 63 mg/kg/day for systemic effects of hypocalcaemia is reported from a separate sub-chronic feeding study in rats (ECHA, 2019). An equivalent air concentration of this NOAEL is approximately 78 mg/m^3 (ECHA, 2019).

The acidity of the compound, measured by its dissociation constant (pK_a), is considered the primary cause of irritation. The relationship of pK_a and TLV was modelled for various acidic irritants (ACGIH, 2018). Based on this relationship, ACGIH (2018) recommend TLV-TWA and TLV-STEL values, which are supported by analogy to phosphoric acid. In the absence of inhalational data regarding local irritant effects, the recommended TWA of 1 mg/m^3 and STEL of 2 mg/m^3 are adopted from ACGIH (2018). This combination of parameters is also considered sufficiently low to be protective of systemic effects reported in chronic animal feeding studies.

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.

There are insufficient data to recommend a skin notation.

APPENDIX

Primary sources with reports

Source	Year set	Standard
SWA	***1991***	***TWA: 1 mg/m^3; STEL: 2 mg/m^3***
ACGIH	***2015***	***TLV-TWA: 1 mg/m^3; TLV-STEL: 2 mg/m^3***

TLV-TWA intended to protect for irritation to the eyes, skin, respiratory tract. TLV-STEL intended to protect for nephrotoxicity and hypocalcaemia observed at higher exposures. No human or animal inhalational data are available for assessment; human exposure data primarily consist of oral overdoses and dietary studies.

Summary of data:

Acidity is considered primary cause of irritancy potential. Based on the relationship of the acidity (measured by the acid dissociation constant, pK_a) and TLVs of other acidic irritants a linear log-log relationship was established. From this model, the TLV-TWA is estimated at 1.05 mg/m^3 from a pK_a of 1.25 and is supported by the estimated TLV-TWA and TLV-STEL for phosphoric acid, which has comparable pK_a values.

Human data:

- 2.4% of ingested dietary oxalate absorbed; ≈20 mg/d in excreta of healthy volunteers
- Healthy volunteers (n=4) excreted less dietary oxalate than volunteers with kidney stones (n=6), 3.4% versus 10%, respectively; excretion was also higher in volunteers on low calcium diet
- 88–99% of iv dose excreted within 36 h; elimination half-life 90 min
- Severe poisoning by ingestion causes burning sensation in throat and stomach, oesophageal erosion, nausea, hypotension, headaches, convulsions, coma and death:
  - hypocalcaemia-induced cardiac effects likely cause of fatality in acute poisonings
- Increased incidence of kidney stones reported in survey of workers exposed during railway cleaning (n=393); high exposure (n=15, 3–4 h/d) associated with 53% incidence, low exposure (n=25, 1–8 h/wk): 32% and no exposure (n=353): 12% compared to local community: 0.2%; exposures were not measured (also cited in HCOTN, 2004):
  - pharyngeal irritation and coughing in workers involved in steam cleaning (n=7)
- Contact dermatitis in workers handling calcium oxalate crystals (needles) on plants.

Animal data:

- Oral LD_{50}: 375–475 mg/kg (rats); administered as 5% aqueous solution
- Decreased thyroid weight, iodine uptake and dose-dependent severity of kidney lesions at 5,000 mg/kg in repeat feeding study with exposure groups 0, 2,000 and 5,000 mg/kg (rats, 70 d)
- Mildly irritating to skin (rabbits); redness but no ulceration when applied as 9% aqueous solution for 5 min
- Binds to calcium under physiological conditions, which leads to kidney stones, hypocalcaemia and hypotension affecting heart and central nervous system (CNS) function
- Negative Ames test results with and without metabolic activation; negative chromosomal aberration test with hamster fibroblast cells
- Increased kidney weights and abnormal sperm counts in F1 generation and decreased live foetuses and female pups in F2 generation in 2-generation reproductive feeding study at

Source	Year set	Standard
	275 mg/kg/d (rats, 18 wk); only reduced water consumption noted at 89 and 162 mg/kg/d compared to controls; NOAEL: 162 mg/kg/d. Insufficient data to recommend notations for carcinogenicity, skin absorption or sensitisation.	
DFG	***NA***	***NA***
No report.		
SCOEL	***NA***	***NA***
No report.		
OARS/AIHA	***NA***	***NA***
No report.		
HCOTN	***2004***	***TWA 8 hours: 1 mg/m^3***
Summary of additional data: Critical effects are irritation of the upper respiratory tract, eyes and skin. No data on thresholds for these endpoints were available for the agency's assessment; therefore, no comment can be made on the suitability of the current administrative OEL in protecting for these critical effects. However, based on the reproductive NOAEL of 162 mg/kg/d in rats (also cited in ACGIH, 2018), the current administrative OEL of 1 mg/m^3 is considered protective of systemic effects. Human data: • Inhalational exposure causes irritation to eyes, nose and throat, breathing difficulties and loss of consciousness (no further details provided) • 54% positive sensitisation reactions in patients with eczema (n=26) when applied to eczema on the feet • Respiratory tract irritation and increased and painful urination were reported in railroad workers exposed to contaminated steam from cleaning (n=7) (also cited in ACGIH, 2018). Animal data: • Dermal LD_{50} >20,000 mg/kg (rabbits) • Increased mortality, changes in bw and organ weight, decreased oestrus cycle and kidney lesions at 1,780/1,980 mg/kg (males/females) in repeat feeding study (rats, 70 d) • Non-mutagenic *in vitro* in *Salmonella typhimurium* strains with or without metabolic activation, positive for potential DNA damage in *Escherichia coli*, no *in vivo* mutagenicity data available.		

Secondary source reports relied upon

Source		Year	Additional information
NICNAS	✓	2014	• No inhalational data available • Non-sensitising in guinea pig maximisation test and OECD-compliant local lymph node assay (LLNA) test; positive results reported in other; Sensitiser classification is not warranted • Prolonged exposure may lead to urinary stones and therefore, likely to injurious due to cumulative exposure.
ECHA	✓	2019	• No inhalational data available

Source		Year	Additional information

			• Local effects not assessed
			• Long-term DNEL based on results of sub-chronic feeding study with exposure groups 0, ≈16, 32 and 63 mg/kg/d (rats, 90 d);
			  ○ no adverse effects on body weight, haematology or urine and clinical biochemical parameters at highest tested dose
			  ○ NOAEL 63 mg/kg/d ≡77.7 mg/m^3 following conversion to inhalational dose
			  ○ overall assessment factor of 25 applied to account for differences in exposure duration, inter- and intraspecies differences to arrive at DNEL of 3 mg/m^3.

US NIOSH	✓	1994	• IDLH based on acute oral toxicity data in humans and animals.

Carcinogenicity — non-threshold based genotoxic carcinogens

Is the chemical mutagenic? No

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

Notations

Source	Notations
SWA	—
HCIS	—
NICNAS	—
EU Annex	NA
ECHA	—
ACGIH	—
DFG	NA
SCOEL	NA
HCOTN	—
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
Insufficient data to assign a skin notation

IDLH

Is there a suitable IDLH value available?	Yes

Additional information

Molecular weight:	90.04
Conversion factors at 25°C and 101.3 kPa:	1 ppm = Number mg/m^3; 1 mg/m^3 = Number 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
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.

European Chemicals Agency (ECHA) (2019) Oxalic acid – REACH assessment.

Health Council of the Netherlands (HCOTN) (2004) Oxalic acid. Health-based Reassessment of Administrative Occupational Exposure Limits. The Hague: Health Council of the Netherlands; publication no. 2000/15OSH/106.

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

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