# Ethylene glycol (Vapour and particulate)

| CAS number: | 107-21-1 |
| --- | --- |
| Synonyms: | 1,2-Dihydroxyethane, 1,2-Ethanediol,  ethylene alcohol, ethylene dihydrate, glycol,  glycol alcohol, monoethylene glycol, NCI-C00920 |
| Chemical formula: | C2H6O2 |

Workplace exposure standard (amended)

| TWA: | **20 ppm (52 mg/m3) (vapour)** |
| --- | --- |
| STEL: | **40 ppm (104 mg/m3) (vapour)**  **10 mg/m3 (particulate)** |
| Peak limitation: | — |
| Notations: | **Sk.** |
| IDLH: | — |
| **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 (52 mg/m3) as vapour is recommended to protect for upper respiratory tract (URT) and eye irritation in exposed workers.

A STEL of 40 ppm (104 mg/m3) for vapour and a STEL of 10 mg/m3 for particulate are recommended to protect for acute irritation effects in exposed workers.

## Discussion and conclusions

Ethylene glycol is used as antifreeze in heating and cooling systems. It is used in the production of esters and resinous products and frequently used for polyester fibres and resins.

Critical effects of exposure are respiratory tract irritation and cornea damage and conjunctiva in eyes.

No clinical symptoms reported in volunteers exposed at concentrations of 3 to 67 mg/m3 (1 to 26 ppm) by inhalation for 20 to 22 hours for 30 days, although, occasional complaints of irritation of the throat are reported. An increase in the concentration to 188 mg/m3 (73 ppm) is tolerated by volunteers for 15 minutes. Concentrations above 140 mg/m3 cause mucosal irritation in all exposed subjects. A NOAEC of 67 mg/m3 is established in this study, based on mucous membrane irritation (ACGIH, 2018; DFG, SCOEL, 1995). ACGIH (2018) recommend a STEL of 10 mg/m3 as aerosol to limit the amount of mist that is produced if the saturated vapour concentration is exceeded.

A NOAEC of 355 to 400 mg/m3 (140 to 160 ppm) based on renal toxicity is reported in rats and mice exposed for 16 weeks (ACGIH, 2018). ACGIH (2018) concludes that protection from concentrations causing respiratory irritation is likely to protect for systemic effects. Moderate to severe eye irritation in rabbits is reported following continuously exposure at 12 mg/m3 (4.7 ppm) for 90 days. It is concluded that continuous exposure may not provide opportunity for recovery to damage. Repeated application of one drop into the eye of rabbits produced appreciable irritation. No eye damage is reported in chimpanzees exposed at 265 mg/m3 over four weeks as aerosol (ACGIH, 2018).

The evidence from the controlled volunteer studies and studies in rodents supports retaining the TWA of 20 ppm (52 mg/m3) and STEL of 40 ppm (104 mg/m3) for vapours.

Ethylene glycol mist is expected to be irritating to mucous membranes based on evidence of eye irritation in rabbits. A STEL of 10 mg/m3 as inhalable particulate is recommended, as reported by the ACGIH (2018), to limit the amount of mist should vapour concentration become saturated.

## 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 suggesting dermal absorption and contribution to total body burden in animals. There is conflicting information between primary sources, especially about systemic toxicity as a result of dermal exposure. A review of additional sources on dermal exposure at the next scheduled review is recommended.

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA 1991 TWA: 20 ppm (52 mg/m3) (Vapour);   STEL: 40 ppm (104 mg/m3) (Vapour);   TWA: 10 mg/m3 (Particulate) | |
|  |
| ACGIH 2017 TLV-TWA: 25 ppm (Vapour); TLV-STEL: 50 ppm (Vapour); TLV-STEL: 10 mg/m3 (Inhalable particulate matter, Aerosol) |
| TLV-TWA (vapour) and TLV-STEL (vapour) recommended to minimise respiratory and eye irritation.  TLV-STEL (aerosol) recommended to minimise respiratory and eye irritation when in aerosol and particulate form.  The TLV-STEL of 10 mg/m3 as an aerosol is reported to limit the amount of airborne mist if vapour concentration becomes saturated. Mist is expected to be irritating to mucous membranes based on surrogate evidence of eye irritation in rabbits.  Summary of data:   * Worker exposures are generally *via* skin and eyes with inhalation occurring when material is heated or as an aerosol * Vaporised chemical not significantly absorbed *via* the respiratory tract to cause systemic changes * ACGIH recommends applying the TLV for both vapour and aerosol separately when monitoring exposures and not to combine additive effects * A skin notation is not warranted due to low percutaneous absorption in controlled studies * Derivation of the OEL is not provided.   Human data:   * Not classified as a human carcinogen * Deaths from ingestion well documented following severe intoxication and metabolic acidosis and cranial nerve deficits * Volunteers exposed to aerosolised material (assumed vapour) for 20–22 h/d for 4 wk at 3–67 mg/m3 (1–26 ppm; average daily) and mean at 17–49 mg/m3 (6.6–19 ppm; mean weekly) reported: * complaints of irritation of upper respiratory tract more prevalent at 140 mg/m3 (55 ppm) * irritation at 188 mg/m3 (73 ppm) only tolerated for 15 min * irritation at 244 mg/m3 (620 ppm) only tolerated for 1–2 min * Protection for respiratory irritation effects is likely to protect for systemic effects * PBPK modelling demonstrates blood levels following inhalation exposure unlikely to produce renal effects reported in animals.   Animal data:   * LD50 of 9,530 mg/kg (rabbits, dermal) * LC50 (inhalation) of 10.9 mg/L (rats, 1 h) * Low irritation to rabbit skin when topically applied * Appreciable irritation in eye of rabbit with repeated application of 0.05 mL every 10 min for 6 h; 36 applications * No eye damage in chimpanzees exposed at 265 mg/m3 (4 wk) as aerosol * Cruzan *et al.* (2004) compared toxicity of ethylene glycol in Wistar and F344 rats and related effects; with both strains dosed at 0, 50, 150, 500 and 1,000 mg/kg/d for 16 wk: * differences in metabolism and clearance at 500 and 1000 mg/kg/d * incidence and severity of crystalline nephrology higher at the same dose level in Wistar rats; finding correlated with accumulation of calcium oxalate crystals in the kidney tubule * BMDL05 for kidney toxicity was 71.5 mg/kg/d (Wistar rats), 285 mg/kg/d (F344 rats) * No significant renal changes observed in rabbits, male dogs, rats, male squirrel monkeys and guinea pigs exposed at ≤57 mg/m3 (≤22 ppm) 8 h/d, 5 d/wk for 6 wk * Toxicological changes in the kidney and lower urinary tract reported at very high doses (route not identified): * less toxic when exposed by inhalation * Moderate to severe eye irritation in rabbits continuously exposed at 12 mg/m3 (4.7 ppm) for 90 d: * corneal damage and apparent blindness in 2/15 rats after 8 d exposure * continuous exposure may not provide opportunity for recovery for damage in animals * NOAEC of 355–400 mg/m3 (140–160 ppm) (rats and mice, 8 h/d, 16 wk); based on renal toxicity * No evidence of mutagenicity or genotoxicity. |
| DFG 1991 MAK: 10 ppm (26 mg/m3) |
| Vapours and aerosols severely irritating to mucous membranes of the URT and eyes including the cornea and conjunctiva.  MAK based on a volunteer aerosol exposure study identifying pronounced irritation associated with aerosol-vapour concentrations >140 mg/m3. Concluded that concentrations as low as 50 ppm (130 mg/m3) might still cause irritation. Therefore, the MAK value should be markedly lower. This study was also cited by ACGIH (2018). No further specific information on derivation is provided.  Summary of additional data:   * In a controlled inhalation study, 20 male volunteers exposed 20–22 h/d for 30 d, to average concentrations which varied markedly from day to day between 3 and 67 mg/m3 reported occasional complaints of irritation of the throat and of headaches and back pains: * increase in concentration to 188 mg/m3 (day 27) tolerated by volunteers for 15 min; 244 mg/m3 (day 26) for 1–2 min; 305 mg/m3 (day 26) for only a few breaths * exposure at >140 mg/m3 caused mucosal irritation in all exposed * Fetotoxic and embryotoxic following ingestion of high oral doses or inhalation of high concentrations of the aerosol * In a study of reproductive toxicity in CD rats (15 pregnant animals/dose group, 18 in control group) doses administered by gavage from GD 6 to 20 in doses of 0, 250, 1,250 or 2,250 mg/kg/d; from day 1 post-partum, pups reared by untreated dam: * NOAEL at 250 mg/mg/d * 1,250 and 2,250 mg/kg/d doses resulted in longer pregnancies and microscopically visible renal damage * in the 2250 mg/kg/d group, bw gain of the dams and progeny and the survival of the pups during days 1–4 post-partum reduced * Embryotoxic and teratogenic effects observed in an exposure chamber inhalation study in pregnant CD rats and CD1 mice (groups of 20–25 animals of each species) exposed at 0, 150, 1,000 or 2,500 mg/m3: * ethylene glycol condensed on the fur of the animals; a large proportion of the dose taken in dermally and orally during grooming * symptoms of minimal maternal toxicity in rats (increased liver weights, gross pathology of kidneys normal) seen only in the 2,500 mg/m3 group * ossification slightly delayed at doses of 1,000 mg/m3 in fetuses * in mice, implantation losses and incidence of malformations increased at concentrations of 1,000 and 2,500 mg/m3 * Embryotoxic or fetotoxic effects not expect at MAK of 10 ppm (26 mg/m3) in humans * Mutagenic and carcinogenic activity not observed * Skin absorption possible in toxic doses and assigned skin notation * Insufficient evidence for classification of sensitising effects.   Human data:   * Preliminary study NOAEL (aerosol): 3.6–75 mg/m3 in 4 volunteers exposed over 7 d (no further information). |
| SCOEL 1995 TWA: 20 ppm (52 mg/m3); STEL: 40 ppm (104 mg/m3) |
| The critical effect is irritation of the mucous membranes.  Summary of additional data:  Skin notation recommended as dermal absorption could contribute substantially to the total body burden.  No differentiation between vapours and aerosol exposure values.  Human data:   * Liquid strongly irritating to eyes, no significant evidence to classify as sensitising * Accidental exposure into worker eyes caused conjunctival congestion, oedema, reduced light reflex and severe keratitis which healed after 4 wk * Volunteers exposed to aerosolised material for 20–22 h/d for 4 wk at 3–67 mg/m3 (1–26 ppm; daily average) and at 17–49 mg/m3 (6.6–19 ppm; mean weekly): * NOAEC established at 67 mg/m3 from this study * study also cited by ACGIH (2018) * The reported NOAEC of 67 mg/m3 is used as the basis for SCOEL TWA: * UF of 2 applied as the study had extended exposure (20–22 h/d), to allow for interindividual variation and for the absence of long-term human studies * TWA of 20 ppm (52 mg/m3) is calculated by rounding the resultant value down * No effects in eyes of rabbits and rats exposed at 10 mg/m3 (3.9 ppm) and 57 mg/m3 (22 ppm) 8 h/d, 5 d/wk for 6 wk (cited by ACGIH, 2018): * basis for STEL not provided.   Animal data   * Not genotoxic in bacterial or mammalian cells *in vitro* * Reported evidence of dose-related developmental toxicity in rats and mice following oral dosing and inhalation: * no effect levels were 250 mg/kg (oral), 150 mg/m3 whole body exposure and 1,000 mg/m3 nose-only exposure (no further information). |
| OARS/AIHA NA NA |
| No report. |
| HCOTN NA NA |
| No report. |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| NICNAS |  | 2016 | * Systemic toxicity attributed to glycolic acid and oxalic acid, which are major metabolites * Low acute toxicity. |
| US EPA |  | 1987 | * Oral assessment only. |
| OECD |  | 2004 | * Chemical is a candidate for further risk assessment work. |

### 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 | Skin |
| HCIS | — |
| NICNAS | — |
| EU Annex | NA |
| ECHA | NA |
| ACGIH | Carcinogenicity – A4 |
| DFG | H (skin) |
| SCOEL | Skin |
| 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 |
| --- |
| Insufficient data to assign a skin notation. |

### IDLH

| Is there a suitable IDLH value available? | No |
| --- | --- |

## Additional information

| Molecular weight: | 62.07 |
| --- | --- |
| Conversion factors at 25°C and 101.3 kPa: | 1 ppm = 2.54 mg/m3; 1 mg/m3 = 39 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*](http://www.acgih.org/tlv-bei-guidelines/policies-procedures-presentations) on the ACGIH website.

Deutsche Forschungsgemeinschaft (DFG) (2000) Ethylenglykol – MAK value documentation.

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (1995) Recommendation from the Scientific Committee on Occupational Exposure Limits for Ethylene glycol. SCOEL/SUM/40.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2016) 1,2-Ethanediol: Human health tier II assessment – IMAP report.

Organisation for Economic Cooperation and Development (OECD) (2004) SIDS initial assessment profile – Ethylene glycol.