# methyl formate

| CAS number: | 107-31-3 |
| --- | --- |
| Synonyms: | Formic acid methyl ester, methyl methanoate |
| Chemical formula: | C2H4O2 |
| Structural formula: | — |

Workplace exposure standard (amended)

| TWA: | **50 ppm (123 mg/m3)** |
| --- | --- |
| STEL: | **100 ppm (245 mg/m3)** |
| Peak limitation: | **—** |
| Notations: | **Sk.** |
| IDLH: | **4,500 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 50 ppm (123 mg/m3) is recommended to protect for upper respiratory tract irritation and eye damage in exposed workers.

A STEL of 100 ppm (245 mg/m3) is recommended to protect for acute sensory irritation and central nervous system (CNS) impairment in exposed workers.

## Discussion and conclusions

Methyl formate is used primarily as an insecticide (fumigant, larvicide), solvent, blowing agent and in organic synthesis.

Critical effects of exposure include respiratory and sensory irritation and eye damage caused by its metabolism into formic acid. Volunteers exposed at 100 ppm for eight hours and workers exposed at between 22 and 136 ppm combined with isopropanol showed no significant neurobehavioral effects (ACGIH 2018). In a two week rat inhalation study, a NOAEC of 100 ppm is established and is used to calculate an equivalent thirteen week NOAEC of 50 ppm based on analogy to formic acid (SCOEL 2004). Based on the potential for optic neuropathy caused by metabolism into formic acid, toxicokinetic modelling suggested a 50 ppm limit. A threshold response of 184 ppm for sensory irritation is predicted from mice studies (ACGIH, 2018).

Based on the evidence presented in humans and supported by the calculated NOAEC in animals, a TWA of 50 ppm (123 mg/m3) is recommended and consistent with the primary sources (ACGIH, 2018; DFG, 2013 and SCOEL, 2004). This TWA is considered protective of upper respiratory tract irritation and eye damage in exposed workers, and CNS impairment resulting from acute exposures. A STEL of 100 ppm (245 mg/m3) is recommended to prevent acute sensory irritation and CNS impairment.

## 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 potential dermal absorption and adverse systemic effects in humans and animals.

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA 1991 TWA: 100 ppm (246 mg/m3); STEL: 150 ppm (368 mg/m3) | |
|  |
| ACGIH 2015 TLV-TWA: 50 ppm (123 mg/m3); TLV-STEL: 100 ppm (245 mg/m3) |
| TLV-TWA recommended to minimise the risk of upper respiratory tract irritation, eye damage and CNS impairment in exposed workers.  Summary of data:  Methyl formate breaks down into methanol and formic acid. Formic acid is believed to cause optic neuropathy. Toxicokinetic modelling suggested a 50 ppm limit to minimise the risk of optic neuropathy caused by conversion of methyl formate to formic acid.  Human data:   * Volunteers exposed at 100 ppm (8 h) were tested for neurobehavioral performance, spirometry, vision, postural sway, mood and electromyography: * no significant differences were observed save for signs of an increase in fatigue * Workers exposed at ≈ 22–136 ppm (median 68 ppm) combined with ≈ 6-73 ppm isopropanol produced no significant neurobehavioral effects * Exposure at 1,500 ppm for one minute produced no observed adverse effects * Methyl formate is readily absorbed through human skin and cause systemic effects and fatality.   Animal data:   * LC50: 8,500 ppm (rats) * Guinea pigs exposed at 1,500–50,000 ppm (inhalation), 50,000 ppm proved fatal: * 10,000 ppm: retching in 6–15 min * 3,500 ppm (180 min): pulmonary irritation, liver and kidney hyperaemia and congestion of vessels and adrenal of the brain * NOAEL(RD0): 184 ppm (mice) for respiratory depression * LD50: 1,600 mg/kg (rabbits, oral) * LD50: >4,000 mg/kg (rats, dermal) staggering and irregular breathing indicate dermal absorption * Negative results in mutagenic assays.   A skin notation is recommended due to evidence of systemic effects in humans and animals after dermal exposure.  Insufficient data to recommend a sensitiser or carcinogen notation. |
| DFG 2013 MAK: 50 ppm (120 mg/m3) |
| As no neuropsychological changes observed at concentrations <50 ppm the provisional MAK has been retained. |
| SCOEL 2004 TWA: 50 ppm (125 mg/m3); STEL: 100 ppm (250 mg/m3) |
| Summary of additional data:   * NOAEC: 100 ppm (rats, 6 h/d, 5 d/wk, 2 wk, inhalation): * 500 ppm: slight nasal olfactory epithelium degeneration * 1,500 ppm: body weight changes, multifocal squamoid metaplasia of the olfactory epithelium and multifocal inflammatory cell infiltration * by analogy to formic acid studies a 13 wk NOAEC of 50 ppm estimated (no further information on extrapolation). |
| OARS/AIHA NA NA |
| No report. |
| HCOTN NA NA |
| No report. |

### Secondary source reports relied upon

NIL.

### 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 | NA |
| HCIS | NA |
| NICNAS | NA |
| EU Annex | NA |
| ECHA | NA |
| ACGIH | Skin |
| 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 |
| --- |
| |  |  |  |  | | --- | --- | --- | --- | | Adverse effects in human case study: | yes | 4.00 |  | | 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 |
| --- | --- |

## Additional information

| Molecular weight: | 60.06 |
| --- | --- |
| Conversion factors at 25°C and 101.3 kPa: | 1 ppm = Number mg/m3; 1 mg/m3 = 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*](http://www.acgih.org/tlv-bei-guidelines/policies-procedures-presentations) on the ACGIH website.

Deutsche Forschungsgemeinschaft (DFG) (2013) Formic acid methyl ester – MAK value documentation.

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (2004) Recommendation from the Scientific Committee on Occupational Exposure Limits for methyl formate. SCOEL/SUM/59.

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