# Manganese fume, dust & compounds (as Mn)

| CAS number: | 7439-96-5 |
| --- | --- |
| Synonyms: | — |
| Chemical formula: | Mn |
| Structural formula: | — |

Workplace exposure standard (amended)

| TWA: | **0.02 mg/m3 (respirable) 0.1 mg/m3 (inhalable)** |
| --- | --- |
| STEL: | **—** |
| Peak limitation: | **—** |
| Notations: | **—** |
| IDLH: | **500 mg/m3** |
| **Sampling and analysis:** The recommended value is quantifiable through available sampling and analysis techniques. | |

## Recommendation and basis for workplace exposure standard

A TWA of 0.02 mg/m3 (respirable particulates) and 0.1 mg/m3 (inhalable particulates) is recommended to protect for adverse neuro-physiological and neuro-psychological effects in exposed workers.

A STEL is not recommended as the TWAs are considered adequately protective for acute exposure to manganese fume.

## Discussion and conclusions

Manganese (Mn) is an essential human trace element and important co-factor in many enzymes processes. Raw material is used extensively for alloy production in combination with other metals in steel production. It is also used in production of dry-cell batteries, fireworks, glass production or as a fungicide. Inorganic compounds of manganese are used as process catalyst and found in animal feed. Manganese fume generation is associated with welding manganese containing alloys.

The critical effects of exposure are extrapyramidal motor system effects (including fine tremors) which may lead to disorders clinically resembling Parkinson’s disease. Following inhalation, most manganese is absorbed in the alveoli, gas-exchanging regions of the lungs, as respirable dust. The fine respirable fraction (less than 4 μm) is considered of greatest concern (ACGIH, 2018).

A LOAEC of 0.3 mg/m3 (inhalable fraction) is identified in humans based on postural tremor functions (DFG, 2011). A LOAEC of approximately 0.10 mg/m3 (total dust) is reported in humans based on neuro-behavioural deficit over an average exposure of 11.5 years (ACGIH, 2018).

A TWA of 0.02 mg/m3 (respirable dust) and 0.1 mg/m3 (inhalable dust) are recommended to protect for neurotoxicity affecting motor and cognitive functions in workers (ACGIH, 2018). A STEL is not warranted as the recommended TWAs are considered adequately protective for acute exposure to manganese fume.

## 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 not recommended based on the available evidence.

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA 1995 TWA: 1 mg/m3 (dust, compounds and fume, as Mn);  STEL: 3 mg/m3 (fume) | |
|  |
| ACGIH 2013 TLV-TWA: 0.02 mg/m3 (Respirable particulate matter, as Mn), 0.1 mg/m3 (Inhalable particulate matter, as Mn) |
| TLV-TWA (respirable particulates) recommended to reduce potential for preclinical adverse neuro-physiological and neuro-psychological effects.  Summary of data:  Manganism is a severe adverse effect of chronic Mn exposure primarily affecting the CNS. Extrapyramidal motor system effects may lead to disorders clinically resembling Parkinson’s Disease.  Welding processes generating metal fumes from Mn containing alloys recognized as a source of exposure to fine manganese particles with high concentrations of MnO2 present in the fume.  Majority of Mn absorbed in the fine, gas-exchanging regions of the lungs (alveoli). The particles of greatest concern are the fine respirable fraction (<4 μm).  Additional TLV-TWA (inhalable particulates) is recommended for particles >4 μm. The inhalable aerosol limit provides additional protection for intestinal absorption secondary to inhalation exposure, and possibly for soluble particles deposited in the nasopharynx.  No studies identified regarding carcinogenic effects on humans or animals from inhalation exposure.  Human data:   * Extensive evidence of systemic effects of inhalation and oral exposures * LOAEL ~0.10 mg/m3 (total dust) for neuro-behavioural deficit (average exposure - 11.5 yr) * Neurological behaviour changes in workers exposed at 0.01–0.04 mg/m3 (respirable aerosol) * Clinical disease symptoms of manganism observed in worker exposures <5 mg/m3 (total dust).   Animal data:   * Extensive data of effects; however, based on analysis of toxicity dose response, there is limited relevance for chronic low level exposures compared to humans * Not mutagenic for several *S. typhimurium* strains * No adverse reproductive effects observed in rats exposed at 232 mg/kg/d or in mice exposed at 731 mg/kg/d.   Insufficient data available to recommend a STEL value.  Insufficient data available to recommend a Skin or RSEN and DSEN notations. |
| DFG 2011 TLV: 0.02 mg/m3 (Respirable fraction), 0.2 mg/m3 (Inhalable fraction) |
| Most sensitive endpoint for manganese is preclinical neurotoxic effects of inhalation. Associated effects on motor and cognitive performance are early indicators of structural or functional damage in the CNS.  Neurotoxicity affecting human motor or cognitive functions not expected at 0.2 mg/m3 (inhalable fraction) based on LOAEC of 0.3 mg/m3 (Postural tremor functions; Bast-Pettersen and Ellingsen 2005).  MAK (respirable fraction) is derived based on same data and rounding according to DFG methodology.  Summary of additional data:  An essential trace element and important cofactor in many enzymes processes.  Manganese and its inorganic compounds not classified as carcinogens or germ cell mutagens.  Human data:   * Difficult to determine NOAEC or LOAEC values for determining exposure effects * Majority of studies indicated average NOAEC is at or above 0.2 mg/m3 supporting the inhalation fraction recommendation: * variety of study sizes and measurement indicators makes comparison difficult * complications with causal relationships in some studies * No data available on the dermal absorption and toxicity * Poor water solubility and evidence of low gastrointestinal absorption reduces likelihood of dermal absorption * Suggestions of patch test sensitisation with limited evidence of allergic reactions.   Animal data:   * No studies provide indication of contact sensitisation. |
| SCOEL 2011 TLV: 0.05 mg/m3 (Respirable fraction), 0.2 mg/m3 (Inhalable fraction) |
| Critical effects associated with “contemporary (low)” occupational exposure are neurological with respirable fraction considered to be the best indicator of systemic availability.  No single “critical study” best for basis to set the IOELV. Three major studies (Bast-Pettersen *et al.* 2004, Ellingsen *et al.* 2008 and Lucchini *et al.* 1999) identified adverse neurological effects and point-of-departure (POD) in the dose-effect/response relationship.  Summary of additional data:  Respirable manganese readily taken up in lungs, with larger particles both directly taken up (respiratory tract) and some transported upward in the lung by muco-ciliary movement, swallowed and absorbed in the intestine.  A short-term exposure limit (STEL) is not required.  Human data:   * Varied heterogeneity of the data noted (i.e. different types of industry, different compounds and particle sizes, study designs and different neurofunctional measurements) * Changes reported in studies are subtle early neurofunctional effects which may not be clinical in nature and are only detected at a statistical level between groups of workers. |
| OARS/AIHA NA NA |
| No report. |
| HCOTN 2001 Not assigned |
| Additional data:   * Classification of manganese and its compounds for Compounds Toxic to Reproduction.   No human data concerning developmental effects were identified. |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| NICNAS |  | 2018 | * Human health tier II assessment * Low acute toxicity based from animal data following inhalation exposures * LC50: >5.14 mg/L (rats, 4 h) exposure to dust * Toxic concentration (TCLo) 2,300 µg/m3 (inhalation exposure) * Dermal exposure not considered an important route of potential systemic toxicity and does not produce skin sensitisation * Not considered genotoxic. |
| US EPA |  | 1993 | * Critical effect - impairment of neuro-behavioural functions * LOAEL 0.05 mg/m3. |
| ECHA |  | 2019 | * DNEL 10.1 µg/m³ (repeated dose toxicity) * LD50: 2,000 mg/kg bw (rat, oral) * LC50: 5,000 mg/m3 (rat, inhalation). |

### 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 | NA |
| HCIS | NA |
| NICNAS | NA |
| EU Annex | NA |
| ECHA | NA |
| ACGIH | Carcinogenicity – A4 |
| DFG | NA |
| 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 |
| --- |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Conclusion:** |  |  |  |  |  | |  |  | Adverse effects in human case study: | no |  |  | |  |  | 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 not warranted** | |  |  |  |  |  |  | |

### IDLH

| Is there a suitable IDLH value available? | Yes |
| --- | --- |

## Additional information

| Molecular weight: | 54.9 |
| --- | --- |
| 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) (2011) Manganese and its inorganic compounds – MAK value documentation.

European Chemicals Agency Regulation (ECHA) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (2011) Recommendation from the Scientific Committee on Occupational Exposure Limits for manganese and inorganic manganese compounds. SCOEL/SUM/127.

Health Council of the Netherlands (HCOTN) (2001) Manganese and its compounds. Evaluation of the effects on reproduction, recommendation for classification. The Hague: Health Council of the Netherlands; publication no. 2001/02OSH.

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

US Environmental Protection Authority (US EPA) (1998) Integrated Risk Information System (IRIS) Chemical Assessment Summary – Manganese.