http://www.epa.gov/ttn/atw/hlthef/manganes.html

Manganese Compounds

Hazard Summary-Created in April 1992; Revised in February 16,2010

Manganese is naturally ubiquitous in the environment. Manganese is essential for normal physiologic functioning in humans and animals, and exposure to low levels of manganese in the diet is considered to be nutritionally essential in humans. Chronic (long-term) exposure to high levels of manganese by inhalation in humans may result in central nervous system (CNS) effects. Visual reaction time, hand steadiness, and eye-hand coordination were affected in chronically-exposed workers. A syndrome named manganism may result from chronic exposure to higher levels; manganism is characterized by feelings of weakness and lethargy, tremors, a mask-like face, and psychological disturbances. Respiratory effects have also been noted in workers chronically exposed by inhalation. Impotence and loss of libido have been noted in male workers afflicted with manganism.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS), which contains information on inhalation chronic toxicity of manganese and the RfC, oral chronic toxicity and the RfD, and the Agency for Toxic Substances and Disease Registry's (ATSDR's) *Toxicological Profile for Manganese*.

Uses

- Metallic manganese is used primarily in steel production to improve hardness, stiffness, and strength. It is also used in carbon steel, stainless steel, and high-temperature steel, along with cast iron and superalloys. (1)
- Manganese compounds have a variety of uses. Manganese dioxide is used in the production of dry-cell batteries, matches, fireworks, and the production of other manganese compounds. (1)
- Manganese chloride is used as a catalyst in the chlorination of organic compounds, in animal feed, and in dry-cell batteries, while manganese sulfate is used as a fertilizer, livestock nutritional supplement, in glazes and varnishes, and in ceramics. (1)
- Potassium permanganate is used for water purification purposes in water and waste-treatment plants. (1)

Sources and Potential Exposure

- Manganese is a naturally occurring substance found in many types of rock and soil; it is ubiquitous in the environment and found in low levels in water air, soil, and food. (1)
- Manganese can also be released into the air by iron and steel production plants, power plants, and coke ovens. (1)
- The average manganese levels in various media are as follows: levels in drinking water are approximately 0.004 parts per million (ppm); average air levels are approximately 0.02 micrograms per cubic meter ($\mu g/m^3$); levels in soil range from 40 to 900 ppm; the average daily intake from food ranges from 1 to 5 milligrams per day (mg/d). (1)
- People who work in factories where manganese metal is produced from manganese ore or where manganese compounds are used to make steel or other products are most likely to be exposed through inhalation to higher than normal levels of manganese. (1)

Assessing Personal Exposure

- Several tests are available for measuring manganese in blood, urine, hair, or feces. As manganese is naturally present in the body, some manganese is always found in these materials. In addition, excess manganese is usually removed from the body within a few days, making it difficult to measure past exposure to manganese. (1)

Health Hazard Information

Acute Effects:

- No reports of effects in humans following acute (short-term) effects of exposure to manganese are available.
- Effects to the lung have been reported following acute exposure of rats to manganese via inhalation. (1)
- Manganese is considered to have moderate acute toxicity based on short-term tests in rats. However, other animal tests in which manganese has been given orally have indicated that manganese has low acute oral toxicity. (1)

Chronic Effects (Noncancer):

- Chronic exposure to manganese at low levels is nutritionally essential in humans. The recommended daily intake of manganese is 2 to 5 mg/d for adults and adolescents. (1)
- No cases of manganese deficiency have been observed in the general population. However, manganese deficiency in animals has been associated with impaired growth, skeletal abnormalities, impaired reproductive function in females, and testicular degeneration in males. (1)
- Chronic inhalation exposure of humans to manganese results primarily in effects on the nervous system. Slower visual reaction time, poorer hand steadiness, and impaired eye-hand coordination were reported in several studies of workers occupationally exposed to manganese dust in air. (1,3)
- Chronic inhalation exposure of humans to high levels may result in a syndrome called manganism and typically begins with feelings of weakness and lethargy and progresses to other symptoms such as gait disturbances, clumsiness, tremors, speech disturbances, a mask-like facial expression, and psychological disturbances. (1,3)
- Other chronic effects reported in humans from inhalation exposure to manganese are respiratory effects such as an increased incidence of cough, bronchitis, dyspnea during exercise, and an increased susceptibility to infectious lung disease. (1,3)
- The Reference Concentration (RfC) for manganese is 0.00005 mg/m^3 based on impairment of neurobehavioral function in humans. The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfC, the potential for adverse health effects increases. Lifetime exposure above the RfC does not imply that an adverse health effect would necessarily occur. (3)
- EPA has medium confidence in the RfC due to medium confidence in the principal studies on which the RfC was based and medium confidence in the database. Neither of the principal studies identified a no-observed-adverse-effect level (NOAEL) for neurobehavioral effects, nor did either study directly measure particle size or provide information on the particle size distribution. These limitations of the studies are mitigated by the fact that the principal studies found similar indications of neurobehavioral dysfunction, and these findings were consistent with the results of other human sudies. EPA has medium confidence in the database because the duration of exposure was relatively limited in the principal and supporting studies, the majority of studies did not specify the species of manganese, and the reproductive and developmental effects have not been adequately studied. (3)
- EPA has established a Reference Dose (RfD) for manganese of 0.14 milligrams per kilogram body weight per day (mg/kg/d) based on CNS effects in humans. The RfD is estimated to be an intake for the general population that is not associated with adverse health effects; this is not meant to imply that intakes above the RfD are necessarily associated with toxicity. Some individuals may, in fact, consume a diet that contributes more than 10 mg Mn/day without any cause for concern. When assessing risk from manganese in drinking water or soil, a modified RfD of 0.05 mg/kg/d is recommended. (3)
- EPA has medium confidence in the RfD due to (1) medium confidence in the studies on which the RfD for manganese was based; and (2) medium confidence in the database. (3)

Reproductive/Developmental Effects:

- Reproductive effects, such as impotence and loss of libido, have been noted in male workers afflicted with manganism attributed to occupational exposure to high levels of manganese by inhalation. No information is available on developmental effects of manganese in humans. (1,3)
- Animal studies have reported degenerative changes in the seminiferous tubules leading to sterility from intratracheal instillation of high doses of manganese (experimentally delivering the manganese directly to the trachea). In young animals exposed to manganese orally, decreased testosterone production and retarded growth of the testes were reported. (1)
- Decreased activity levels and a decrease in average pup weight have been noted in the offspring of mice exposed to manganese by inhalation. (1)

Cancer Risk:

- Oral human and animal studies on manganese are inadequate. Several animal studies reported an increased incidence of thyroid gland follicular cell adenomas and hyperplasia, or increased incidence of pancreatic tumors. (1,3)
- EPA has classified manganese as a Group D, not classifiable as to carcinogenicity in humans. (3)

Physical Properties

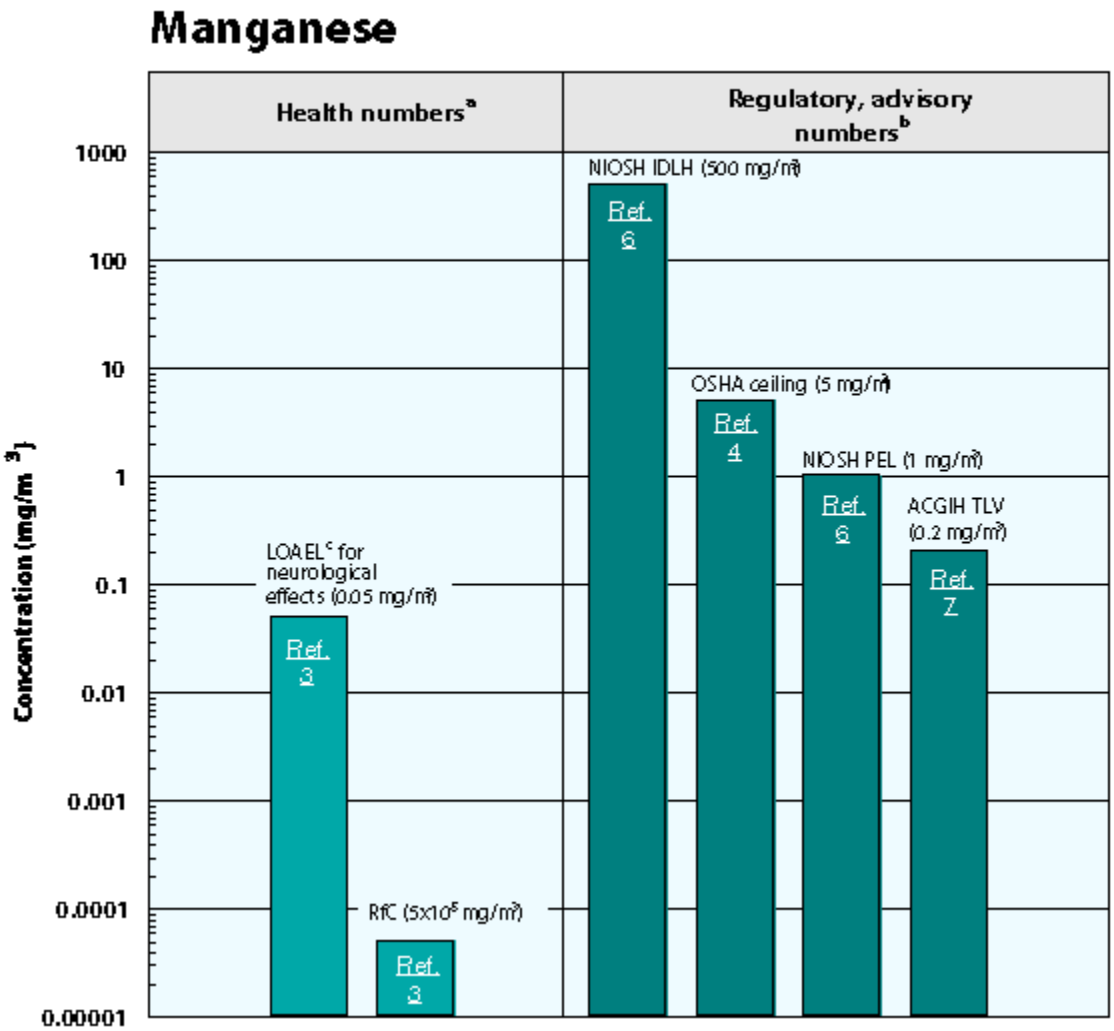
- Manganese is a silver-colored metal that forms compounds in the environment with chemicals such as oxygen, sulfur, and chlorine. (1)

- Manganese compounds are solids that do not evaporate; however, small dust particles can become suspended in air. (1)
- Manganese can dissolve in water. (1)
- The chemical symbol for manganese is Mn, and elemental manganese has an atomic weight of 54.94 g/mol. (1)
- Some manganese compounds are: manganese dioxide (MnO_2), manganese tetraoxide (Mn_3O_4), manganese salts (chloride, sulfate, carbonate, and nitrate), manganese silicate, and potassium permanganate ($KMnO_4$).

Conversion Factors:

To convert concentrations in air (at 25°C) from ppm to mg/m^3: mg/m^3 = (ppm) × (molecular weight of the compound)/(24.45). For manganese: 1 ppm = 2.25 mg/m^3. To convert concentrations in air from µg/m^3 to mg/m^3: mg/m^3 = (µg/m^3) × (1 mg/1,000 µg).

Health Data from Inhalation Exposure



ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.
LOAEL--Lowest-observed-adverse-effect level.
NIOSH REL--National Institute of Occupational Safety and Health's recommended exposure limit; NIOSH-recommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.
NIOSH IDLH -- NIOSH's immediately dangerous to life or health concentration; NIOSH recommended exposure limit to ensure that a worker can escape from an exposure condition that is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from the environment.

OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.
OSHA ceiling--OSHA's short-term exposure limit; 15-min time-weighted-average exposure that should not be exceeded at any time during a workday even if the 8-h time-weighted-average is within the threshold limit value.

The health and regulatory values cited in this factsheet were obtained in December 1999.

[a] Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.
[b] Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH and ACGIH numbers are advisory.
[c] This LOAEL is from the critical study used as the basis for the EPA RfC.

References

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