

Methyl Isocyanate

624-83-9

Hazard Summary

Methyl isocyanate is used to produce carbamate pesticides. Methyl isocyanate is extremely toxic to humans from acute (short-term) exposure. In Bhopal, India, accidental acute inhalation exposure to methyl isocyanate resulted in the deaths of about 3,800 people and adverse health effects in greater than 170,000 survivors. Pulmonary edema was the probable cause of death in most cases, with many deaths resulting from secondary respiratory infections. Survivors continue to exhibit damage to the lungs and eyes. Reproductive effects and increased number of stillbirths and spontaneous abortions were noted in the survivors of the Bhopal, India accident. EPA has classified methyl isocyanate as a Group D, not classifiable as to human carcinogenicity.

Please Note: The main sources of information for this fact sheet are EPA's Health and Environmental Effects Profile for Methyl Isocyanate (1) and the California Environmental Protection Agency's (CalEPA's) Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. (4)

Uses

- Methyl isocyanate is used as a chemical intermediate for the production of carbamate insecticides and herbicides. (1)

Sources and Potential Exposure

- No information is available on the levels of methyl isocyanate in ambient air or water. (1)
- Occupational exposure to methyl isocyanate may occur for those workers who use insecticides and herbicides produced from methyl isocyanate. Few known exposures to the general public have occurred. (1,4)
- Methyl isocyanate has been detected in cigarette smoke. (1)

Assessing Personal Exposure

- No information is available on the assessment of personal exposure to methyl isocyanate.

Health Hazard Information

Acute Effects:

- In 1984, in Bhopal, India, an accidental Union Carbide gas leak of methyl isocyanate resulted in the deaths of more than 2,000 people and adverse health effects in greater than 170,000 survivors. Pulmonary edema was the cause of death in most cases, with many deaths resulting from secondary respiratory infections such as bronchitis and bronchial pneumonia. (1,2)
- Other effects noted from acute inhalation exposure to methyl isocyanate in humans are respiratory tract irritation, difficulty breathing, blindness, nausea, gastritis, sweating, fever, chills, and liver and kidney damage. Survivors continue to exhibit damage to the lungs (e.g., bronchoalveolar lesions and decreased lung function) and the eyes (e.g., loss of vision, loss of visual acuity, and cataracts). (1,2)

- Animal studies have reported pulmonary edema, upper respiratory tract irritation, respiratory lesions, and weight loss from acute inhalation exposure to methyl isocyanate. (1,2)
- Acute animal tests in rats have shown methyl isocyanate to have **extreme** acute toxicity from inhalation exposure and **high** acute toxicity from oral exposure. (3)

Chronic Effects (Noncancer):

- No information is available on the chronic (long-term) effects of methyl isocyanate in humans or animals.
- EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for methyl isocyanate.(5)
- CalEPA³ has calculated a chronic inhalation reference exposure level of 0.001 milligrams per cubic meter (mg/m³) based on lung and body weight effects in rats. The CalEPA reference exposure level is a concentration at or below which adverse health effects are not likely to occur. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At lifetime exposures increasingly greater than the reference exposure level, the potential for adverse health effects increases. (4)

Reproductive/Developmental Effects:

- After the Bhopal, India, accident, an unusually high percentage of survivors had disorders of the reproductive system, including leukorrhea, pelvic inflammatory disease, excessive menstrual bleeding, and suppression of lactation. Other adverse effects included increases in the number of stillbirths, spontaneous abortions, and increased infant mortality. (1,4)
- Animal studies have reported increased incidence of fetal deaths and decreased fertility, live litter size, fetal body weight, and neonatal survival following inhalation exposure to methyl isocyanate during pregnancy. (1,4)

Cancer Risk:

- No information is available on the carcinogenic effects of methyl isocyanate in humans.
- In a study in which animals were exposed once by inhalation, no tumors were significantly associated with methyl isocyanate exposure in mice and female rats; male rats had marginally increased rates of tumors of the pancreas. (2)
- EPA has classified methyl isocyanate as a Group D, not classifiable as to human carcinogenicity. (1)

Physical Properties

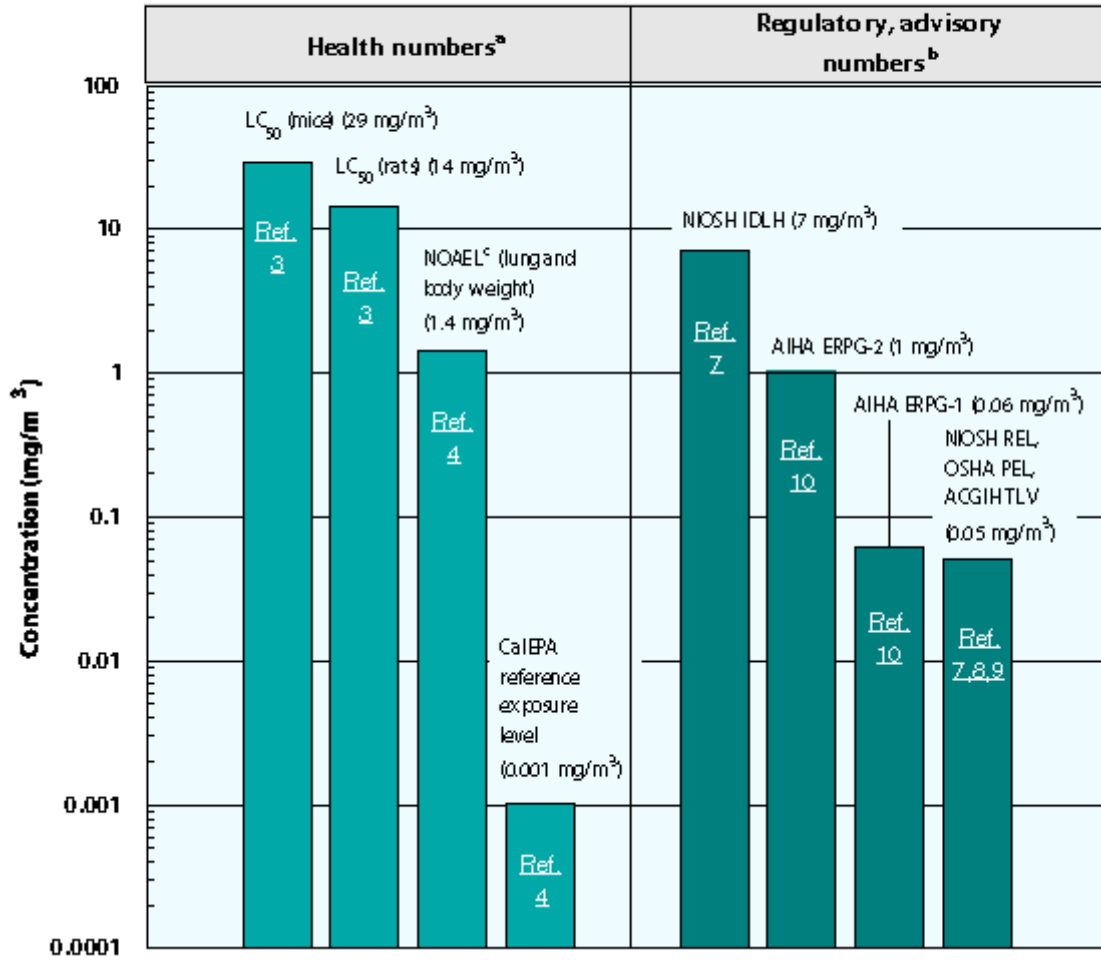
- Methyl isocyanate is a colorless liquid that has a sharp odor. (1)
- The odor threshold for methyl isocyanate is 2.1 parts per million (ppm). (6)
- The chemical formula for methyl isocyanate is C₂H₃NO, and the molecular weight is 57.05 g/mol. (1)
- The vapor pressure for methyl isocyanate is 348 mm Hg at 20 °C. (1)

Conversion Factors:

To convert concentrations in air (at 25 °C) from ppm to mg/m³: $\text{mg/m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$. For methyl isocyanate: 1 ppm = 2.34 mg/m³.

Health Data from Inhalation Exposure

Methyl Isocyanate



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.

AIHA ERPG--American Industrial Hygiene Association's emergency response planning guidelines. ERPG 1 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor; ERPG 2 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing or developing irreversible or other serious health effects that could impair their abilities to take protective action.

LC₅₀ (Lethal Concentration₅₀)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

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.

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, ACGIH, and AIHA numbers are advisory.

^c The NOAEL is from the critical study used as the basis for the CalEPA chronic inhalation reference exposure level.

References

Summary created in April 1992, updated January 2000

1. U.S. Environmental Protection Agency. Health and Environmental Effects Profile for Methyl Isocyanate. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1986.
2. U.S. Department of Health and Human Services. Hazardous Substances Data Bank (HSDB, [online database](#)). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
3. U.S. Department of Health and Human Services. Registry of Toxic Effects of Chemical Substances (RTECS, [online database](#)). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
4. California Environmental Protection Agency (CalEPA). Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. Draft for Public Comment. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1997.
5. U.S. Environmental Protection Agency. [Integrated Risk Information System \(IRIS\) on Methyl Isocyanate](#). National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999.
6. J.E. Amore and E. Hautala. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatilities for 214 industrial chemicals in air and water dilution. *Journal of Applied Toxicology*, 3(6):272–290. 1983.
7. National Institute for Occupational Safety and Health (NIOSH). [Pocket Guide to Chemical Hazards](#). U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. Cincinnati, OH. 1997.
8. Occupational Safety and Health Administration (OSHA). Occupational Safety and Health Standards, Toxic and Hazardous Substances. Code of Federal Regulations 29 CFR 1910.1000. 1998.
9. American Conference of Governmental Industrial Hygienists (ACGIH). 1999 TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents. Biological Exposure Indices. Cincinnati, OH. 1999.
10. American Industrial Hygiene Association (AIHA). The AIHA 1998 Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook. 1998.
11. Environ Health Perspective's article: Personal exposure and long-term health effects in survivors of the union carbide disaster in bhopal. Dhara VR, et al. 2002 110:487–500