

N,N-Dimethylformamide

68-12-2

Hazard Summary

Dimethylformamide is used as an industrial solvent and in the production of fibers, films, and surface coatings. Acute (short-term) exposure to dimethylformamide has been observed to damage the liver in animals and in humans. Symptoms of acute exposure in humans include abdominal pain, nausea, vomiting, jaundice, alcohol intolerance, and rashes. Chronic (long-term) occupational exposure to dimethylformamide by inhalation has resulted in effects on the liver and digestive disturbances in workers. Human studies suggested a possible association between dimethylformamide exposure and testicular cancer, but further studies failed to confirm this relationship. EPA has not classified dimethylformamide with respect to its carcinogenicity.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) (4), which contains information on inhalation chronic toxicity of dimethylformamide and the [RfC](#), and EPA's Health and Environmental Effects Profile for N,N-Dimethylformamide. (2)

Uses

- Dimethylformamide is primarily used as an industrial solvent. Dimethylformamide solutions are used to process polymer fibers, films, and surface coatings; to permit easy spinning of acrylic fibers; to produce wire enamels, and as a crystallization medium in the pharmaceutical industry. (2)

Sources and Potential Exposure

- Individuals are most likely to be exposed to dimethylformamide in the workplace. (1) Dimethylformamide
- has been detected in the effluents from a sewage treatment plant and industrial plant. (2)

Assessing Personal Exposure

- The measurement of a metabolite of dimethylformamide, methyl formamide, in urine has been recommended as a guide to monitor exposure. (3)

Health Hazard Information

Acute Effects:

- Acute exposure to dimethylformamide has been observed to damage the liver in animal studies and in humans. (1,2,4)
- Symptoms of acute exposure in humans include abdominal pain, nausea, vomiting, jaundice, alcohol intolerance, and rashes. (1,4)
- Exposure to the skin may cause dermatitis in humans. (1)
- Damage to the liver, kidneys, and lungs has been observed in animals acutely exposed to dimethylformamide by inhalation. (3)
- Tests involving acute exposure of rats, mice, and rabbits have demonstrated dimethylformamide to have [moderate](#) acute toxicity from inhalation, oral, and dermal exposure. (5)

Chronic Effects (Noncancer):

- Chronic occupational exposure to dimethylformamide by inhalation has resulted in effects on the liver and digestive disturbances in workers. (4)
- Liver effects have also been reported in animals exposed by inhalation. (4)
- The Reference Concentration (RfC) for dimethylformamide is 0.03 milligrams per cubic meter (mg/m^3) based on digestive disturbances and minimal hepatic changes suggestive of liver abnormalities 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. (4)
- EPA has medium confidence in the study on which the RfC was based because, although it is a human study with the lowest LOAEL, the exposed population was large, well-defined, and compared with the controls, concentrations are not well characterized and the exposure duration is relatively short; medium confidence in the database because, although there are several inhalation developmental toxicity studies, there are no reproductive toxicity data; and, consequently, medium confidence in the RfC. (4)
- EPA has calculated a provisional Reference Dose (RfD) of 0.1 milligrams per kilogram body weight per day ($\text{mg}/\text{kg}/\text{d}$) for dimethylformamide based on liver effects in rats. The provisional RfD is a value that has had some form of Agency review, but it does not appear on IRIS. (6)

Reproductive/Developmental Effects:

- Only one study is available on the reproductive effects of dimethylformamide in humans. This study reported an increased rate of spontaneous abortion among pregnant women occupationally exposed to dimethylformamide. However, these results cannot be attributed solely to dimethylformamide, as these women were exposed to a number of additional chemicals. (2,4)
- Dimethylformamide is embryotoxic in animals; reduced implantation efficiency, decreased mean fetal weight, and increased abortions have been reported in rats exposed by inhalation. In rabbits exposed to dimethylformamide by gavage (experimentally placing the chemical in the stomach), decreased mean fetal weight and increased percentage of malformed live fetuses per litter and increased percentage of litters with malformed fetuses were observed in the high-dose group. (2,4)

Cancer Risk:

- Human studies suggested a possible association between dimethylformamide exposure and testicular cancer, but further studies failed to confirm this relationship. (9)
- Animal studies have not reported an increase in tumors from inhalation exposure to dimethylformamide. (9)
- EPA has not classified dimethylformamide with respect to its carcinogenicity. (4)

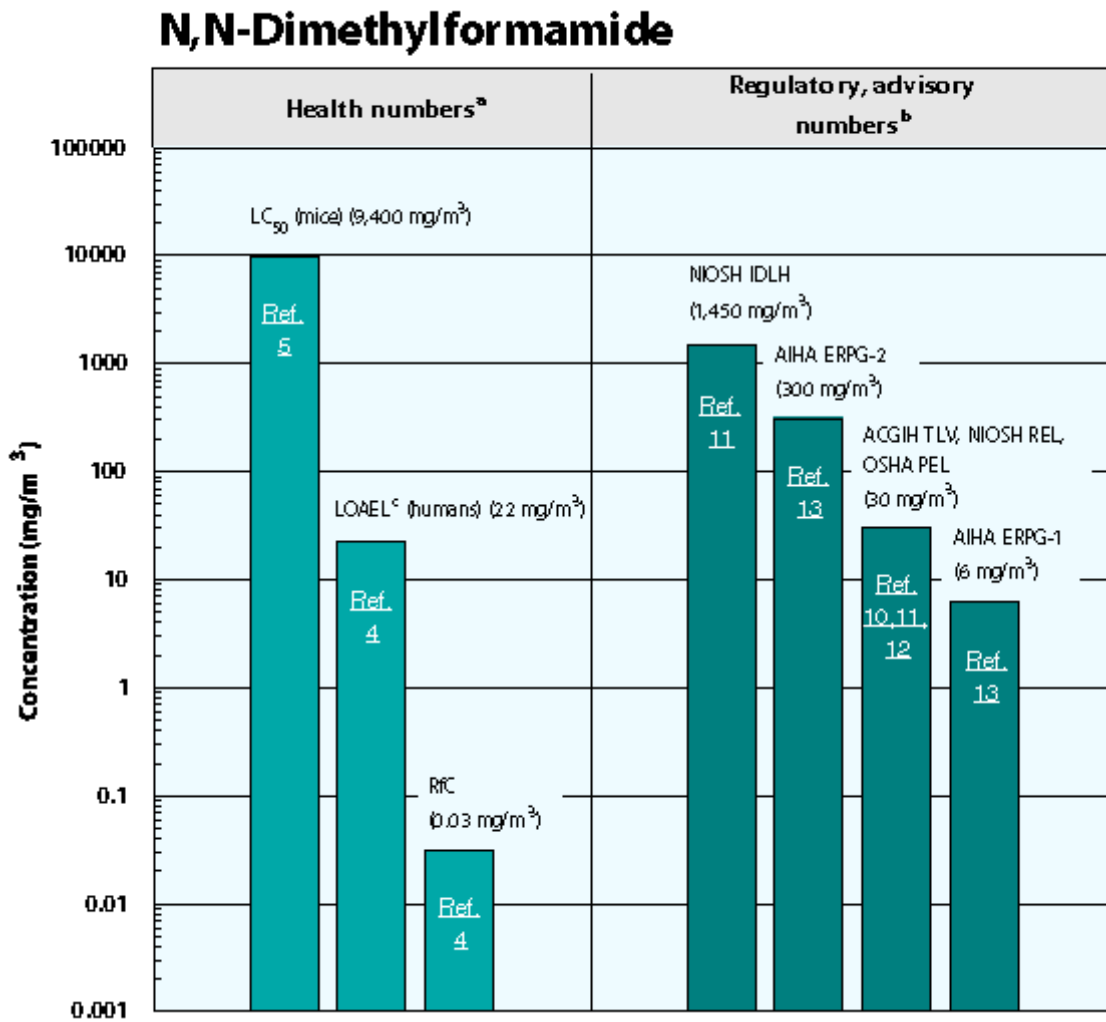
Physical Properties

- The chemical formula for dimethylformamide is $\text{C}_2\text{H}_5\text{NO}$, and its molecular weight is 73.09 g/mol. (2,7)
 - Dimethylformamide occurs as a colorless to slightly yellow hygroscopic liquid that is miscible with water. (4,7)
 - Dimethylformamide has a fishy, unpleasant odor with an odor threshold of 2.2 parts per million (ppm) ($6.6 \text{ mg}/\text{m}^3$). (1,8)
 - The vapor pressure for dimethylformamide is 3.7 mm Hg at 25 °C, and its log octanol/water partition coefficient ($\log K_{ow}$) is -1.01. (2)
-

Conversion Factors:

To convert concentrations in air (at 25 °C) from ppm to mg/m^3 : $\text{mg}/\text{m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$. For dimethylformamide: 1 ppm = 2.9 mg/m^3 .

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.

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.

LOAEL--Lowest-observed-adverse-effect level.

NIOSH IDLH --National Institute of Occupational Safety and Health's immediately dangerous to life or health limit; 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.

NIOSH REL--NIOSH's recommended exposure limit; NIOSH-recommended exposure limit for an 8- or 10-h time-

weighted-average exposure and/or ceiling.

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 This LOAEL is from the critical study used as the basis for the EPA RfC.

References

Summary created in April 1992, updated in January 2000

1. M. Sittig. Handbook of Toxic and Hazardous Chemicals and Carcinogens. 2nd ed. Noyes Publications, Park Ridge, NJ. 1985.
2. U.S. Environmental Protection Agency. Health and Environmental Effects Profile for N,N-Dimethylformamide. EPA/600/x-86/141. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1986.
3. 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.
4. U.S. Environmental Protection Agency. [Integrated Risk Information System \(IRIS\) on N,N-Dimethylformamide](#). National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999.
5. 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.
6. U.S. Environmental Protection Agency. Health Effects Assessment Summary Tables. FY 1997 Update. Solid Waste and Emergency Response, Office of Emergency and Remedial Response, Cincinnati, OH. EPA/540/R-97-036. 1997.
7. The Merck Index. An Encyclopedia of Chemicals, Drugs, and Biologicals. 11th ed. Ed. S. Budavari. Merck and Co. Inc., Rahway, NJ. 1989.
8. 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.
9. International Agency for Research on Cancer. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 71. World Health Organization. Geneva, Switzerland. 1999.
10. 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.
11. 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.
12. Occupational Safety and Health Administration (OSHA). Occupational Safety and Health Standards, Toxic and Hazardous Substances. Code of Federal Regulations. 29 CFR 1910.1000. 1998.
13. American Industrial Hygiene Association (AIHA). The AIHA 1998 Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook. 1998.