

Caprolactam

105-60-2

Hazard Summary

Caprolactam is used in the manufacture of synthetic fibers. Acute (short-term) exposure to caprolactam may result in irritation and burning of the eyes, nose, throat, and skin in humans. Headaches, malaise, confusion, and nervous irritation have been observed in workers exposed to caprolactam by inhalation. Chronic (long-term) exposure of workers to caprolactam has been observed to cause peeling of the hands and some eye, nose, and throat irritation, but no other effects on general health. EPA has not classified caprolactam for carcinogenicity.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) (5), which contains information on oral chronic toxicity of caprolactam and the RfD, and EPA's Health and Environmental Effects Document for Caprolactam (2).

Uses

- Caprolactam is primarily used in the manufacture of synthetic fibers (especially Nylon 6). (1,2)
- Caprolactam is also used in brush bristles, textile stiffeners, film coatings, synthetic leather, plastics, plasticizers, paint vehicles, cross-linking for polyurethanes, and in the synthesis of lysine. (1,2)

Sources and Potential Exposure

- The most probable routes of exposure to caprolactam are by dermal contact and inhalation of workers involved in the manufacture and use of this compound. (1)
- Caprolactam may be released to the environment in emissions and effluents from its manufacturing and use facilities. (1)
- Caprolactam has been detected in water. Small segments of the general population may be exposed by the ingestion of contaminated drinking water. (1,2)

Assessing Personal Exposure

- No information was found regarding the measurement of personal exposure to caprolactam.

Health Hazard Information

Acute Effects:

- Acute exposure to caprolactam may result in irritation and burning of the eyes, nose, throat, and skin in humans. (2,3)
- Headaches, malaise, confusion, and nervous irritation have been observed in workers exposed to caprolactam by inhalation. (1)
- Dermatitis, fever, and grand mal seizures were reported in a man exposed to high levels of caprolactam for 3 days; no CNS abnormalities were detected. (2)
- Tests involving acute exposure of rats, mice, and rabbits have demonstrated caprolactam to have high acute toxicity from inhalation and dermal exposure and moderate acute toxicity from ingestion.

(4)

Chronic Effects (Noncancer):

- Chronic exposure of workers to caprolactam has been observed to cause peeling of the hands and some eye, nose, and throat irritation, but no other effects on general health. (2)
- Neurological, gastrointestinal, and cardiovascular effects and dermatological and immunological changes were reported in workers chronically exposed to caprolactam, among other chemicals. High noise levels, temperature, and humidity were noted and may have also affected the workers. (2)
- Weight gain depression and increased liver and kidney weights have been observed in rats chronically exposed to caprolactam in their diet. (2)
- EPA has not established a Reference Concentration (RfC) for caprolactam. (5)
- The Reference Dose (RfD) for caprolactam is 0.5 milligrams per kilogram body weight per day (mg/kg/d) based on reduced offspring body weight in rats. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral 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 RfD, the potential for adverse health effects increases. Lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur. (5)
- EPA has high confidence in the RfD based on: high confidence in the principal study because the threshold for the most sensitive reproductive effect, reduced body weight of offspring, was clearly identified, and high confidence in the database because subchronic and chronic dietary studies identified no-effect levels for kidney effects in rats, another critical effect in the most sensitive species, and the carcinogenicity and developmental and reproductive toxicity have been adequately studied. (5)

Reproductive/Developmental Effects:

- Alterations in ovarian-menstrual functions and condition have been reported in female workers exposed to caprolactam vapors/dusts. (5)
- Depressed fetal body weights have been observed in the offspring of rats and mice exposed to caprolactam in their diet and in rabbits exposed by gavage. An increased incidence of fetal resorptions was reported in rats exposed by gavage. (2,5)
- Adverse effects on spermatogenesis have been observed in rats following inhalation exposure. (1)

Cancer Risk:

- No information is available on the carcinogenic effects of caprolactam in humans.
- No significant increase in tumor incidence was reported in rats and mice exposed to caprolactam in their diet at the maximum tolerated dose. (2)

Physical Properties

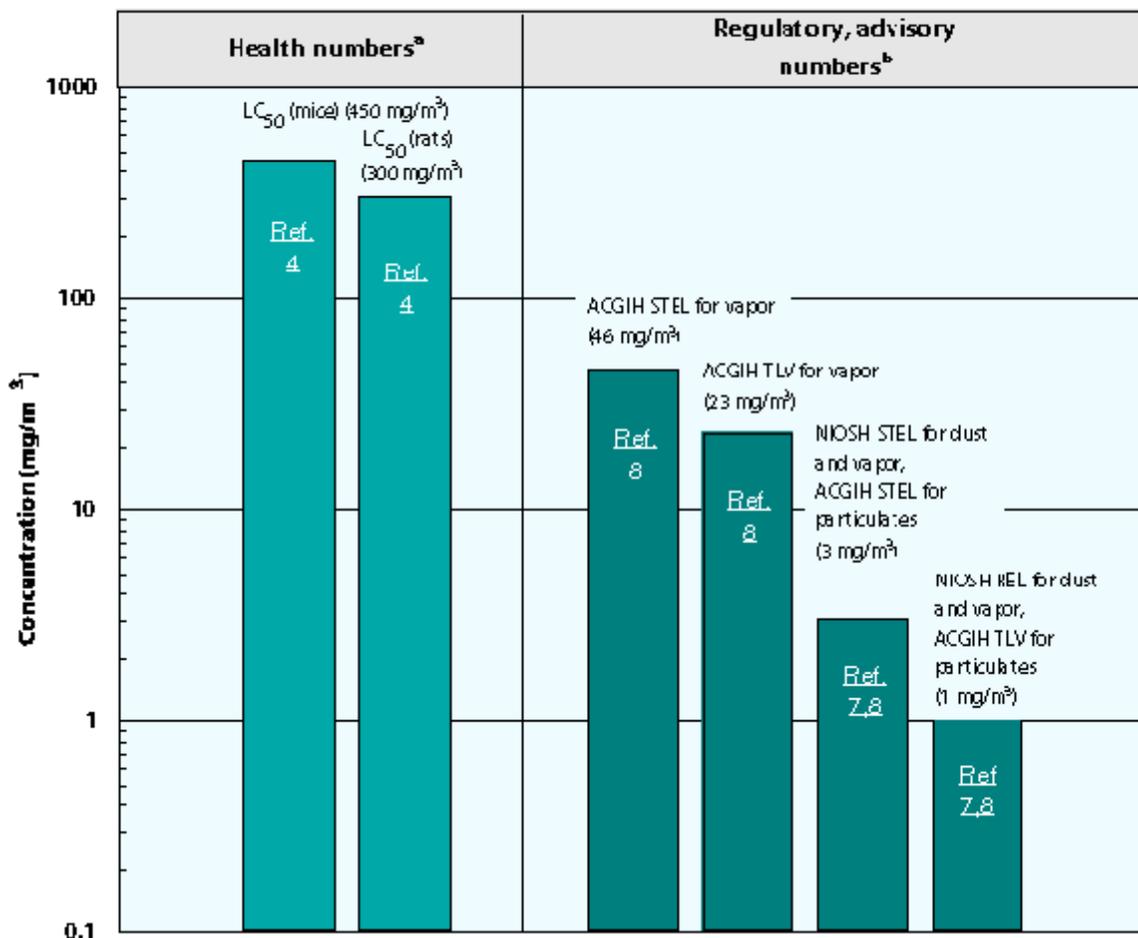
- The chemical formula for caprolactam is $C_6H_{11}ON$, and its molecular weight is 113.16 g/mol. (2)
- Caprolactam is a white, hygroscopic, crystalline solid or leaflets that are very soluble in water. (2,8)
- Caprolactam has a unique, unpleasant odor; the odor threshold has not been established. (2,7)
- The vapor pressure of caprolactam is 1.9×10^{-3} mm Hg at 25 °C, and its log octanol/water partition coefficient ($\log K_{ow}$) is -0.19. (2)

Conversion Factors:

To convert concentrations in air (at 25 °C) from ppm to mg/m^3 : $mg/m^3 = (ppm) \times (\text{molecular weight of the compound}) / (24.45)$. For caprolactam: $1 \text{ ppm} = 4.6 \text{ mg}/m^3$. To convert concentrations in air from $\mu g/m^3$ to mg/m^3 : $mg/m^3 = (\mu g/m^3) \times (1 \text{ mg}/1,000 \mu g)$.

Health Data from Inhalation Exposure

Caprolactam



ACGIH STEL-- American Conference of Governmental and Industrial Hygienists' short-term exposure limit; 15-minute TWA exposure which should not be exceeded at any time during a workday.

ACGIH TLV--ACGIH's threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

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 STEL-- NIOSH's short term exposure limit; NIOSH recommended exposure limit for a 15-minute period.

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. NIOSH and ACGIH numbers are advisory.

Summary created in April 1992, updated in January 2000.

References

1. 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.
2. U.S. Environmental Protection Agency. Health and Environmental Effects Profile for Caprolactam. ECAO-

- CIN-G018. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1988.
3. International Agency for Research on Cancer (IARC). IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: Some Monomers, Plastics and Synthetic Elastomers, and Acrolein. Volume 19. World Health Organization, Lyon. 1979.
 4. 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.
 5. U.S. Environmental Protection Agency. [Integrated Risk Information System \(IRIS\) on Caprolactam](#). National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999.
 6. The Merck Index. An Encyclopedia of Chemicals, Drugs, and Biologicals. 11th ed. Ed. S. Budavari. Merck and Co. Inc., Rahway, NJ. 1989.
 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. 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.
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