

# 4,4'-Methylenedianiline (MDA)

101-77-9

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## Hazard Summary

4,4'-Methylenedianiline (MDA) is primarily used to produce 4,4'-methylenedianiline diisocyanate and other polymeric isocyanates. Acute (short-term) oral and dermal exposure to MDA causes liver damage in humans and animals. MDA can irritate the skin and eyes in humans. No information is available on the chronic (long-term), reproductive, developmental, or carcinogenic effects of MDA in humans. In rats and mice exposed to the dihydrochloride salt of MDA in their drinking water, statistically significant increases in the incidence of several types of tumors, including liver and thyroid tumors, were reported. EPA has not classified MDA for carcinogenicity. The International Agency for Research on Cancer (IARC) has classified MDA as a Group 2B, possible human carcinogen.

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Please Note: The main sources of information for this fact sheet are the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for Methylenedianiline (5) and EPA's Health and Environmental Effects Profile for Benzenamine, 4,4'-Methylenebis. (2)

## Uses

- MDA is primarily used to produce 4,4'-methylenedianiline diisocyanate and other polymeric isocyanates which are used to manufacture polyurethane foams. (2,3,5)
- MDA is also used as a curing agent for epoxy resins and urethane elastomers, as a corrosion preventative for iron, as an antioxidant for lubricating oils, as a rubber processing chemical, as an intermediate in the manufacture of elastomeric fibers (e.g., Spandex), and in the preparation of azo dyes. (2,3)

## Sources and Potential Exposure

- Occupational exposure to MDA is possible through inhalation and dermal contact during its commercial manufacture and use as an intermediate. (1)
- In the late 1960s, some people were accidentally exposed by eating MDA-contaminated bread. (2)

## Assessing Personal Exposure

- Samples of urine can be tested to determine if exposure to MDA has occurred. (5)

## Health Hazard Information

### Acute Effects:

- Acute oral and dermal exposure to MDA causes liver damage in humans and animals. MDA is a causative agent in "Epping Jaundice," which has symptoms including jaundice, tender liver, weakness, abdominal pain, nausea, vomiting, headache, fever, chills, and muscle pain in humans. (2,3,5,6)
- MDA can irritate the skin and eyes in humans. (1)
- A single oral exposure to MDA caused liver damage in rats. (5)
- Tests involving acute exposure of rats, mice, and rabbits have demonstrated MDA to have moderate acute toxicity from oral exposure. (4)

### Chronic Effects (Noncancer):

- No information is available on the chronic effects of MDA in humans.
- Damage to the liver and thyroid, mineralization in the kidneys, and reduced body weight gain have been observed in rats and mice chronically exposed to MDA in their diet. (2,5,6)
- EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for MDA.
- The California Environmental Protection Agency (CalEPA) has calculated a chronic inhalation reference exposure level of 0.02 milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) based on ocular effects in guinea pigs. 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. (6)
- ATSDR has calculated an intermediate oral minimal risk level (MRL) of 0.08 milligrams per kilogram body weight per day ( $\text{mg}/\text{kg}/\text{d}$ ) based on liver effects in rats. The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. (5)

#### Reproductive/Developmental Effects:

- No adequate information is available on the reproductive or developmental effects of MDA in humans or animals.

#### Cancer Risk:

- No information is available on the carcinogenic effects of MDA in humans.
- In rats and mice exposed to MDA (as a dihydrochloride salt) in their drinking water, statistically significant increases in the incidence of several types of tumors, including liver and thyroid tumors, were reported. (2,5)
- EPA has not classified MDA for carcinogenicity.
- IARC has classified MDA as a Group 2B, possible human carcinogen. (1)
- CalEPA has calculated an oral cancer slope factor of  $1.6 \text{ (mg}/\text{kg}/\text{d})^{-1}$ . (7)

## Physical Properties

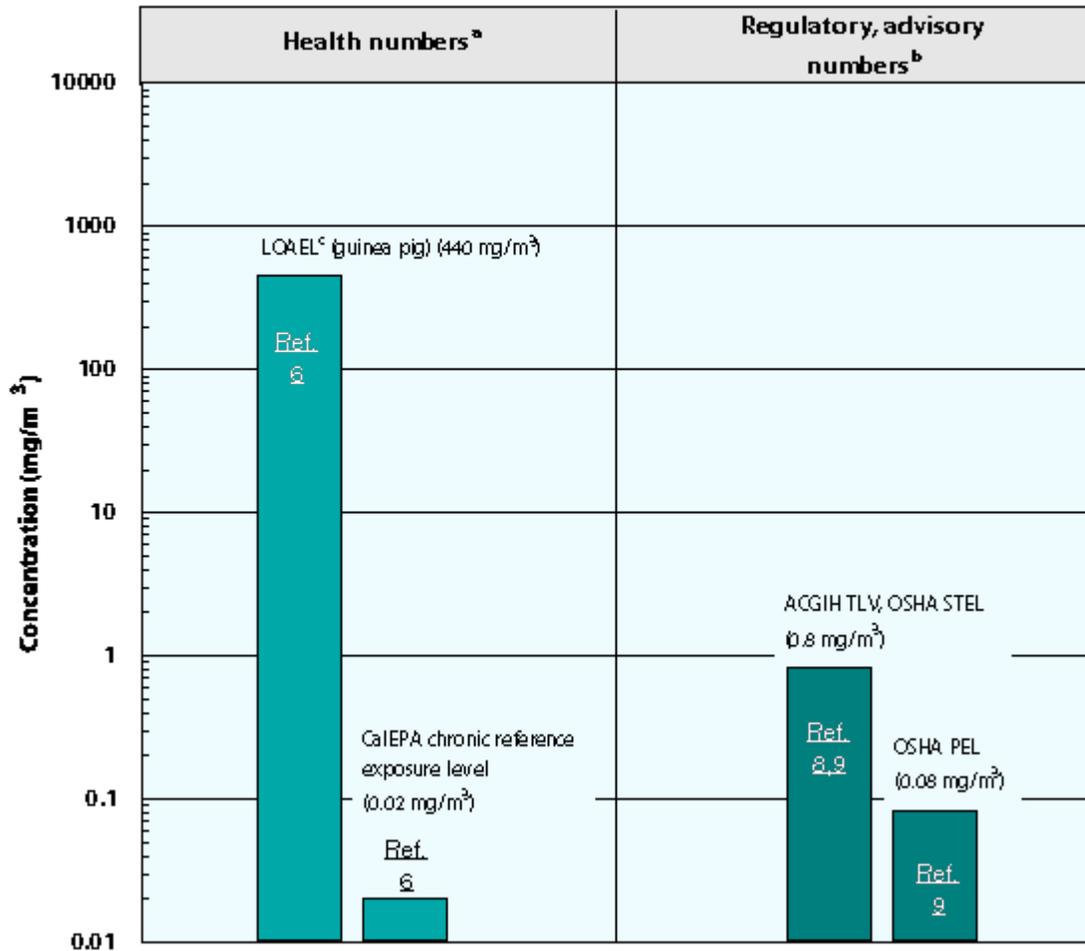
- MDA is also known as 4,4'-methylenebisbenzenamine.
- The chemical formula for MDA is  $\text{C}_{13}\text{H}_{14}\text{N}_2$ , and its molecular weight is 198.26 g/mol. (2,5)
- MDA occurs as pale yellow crystals that darken when exposed to air and are slightly soluble in cold water. (2,3)
- MDA has a faint amine-like odor; the odor threshold has not been established. (5)
- The vapor pressure for MDA is  $2.15 \times 10^{-7}$  mm Hg at 25 °C, and its log octanol/water partition coefficient ( $\log K_{ow}$ ) is about 1.59. (5)

#### Conversion Factors:

To convert concentrations in air (at 25 °C) from ppm to  $\text{mg}/\text{m}^3$ :  $\text{mg}/\text{m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$ . For 4,4'-methylenedianiline:  $1 \text{ ppm} = 8.1 \text{ mg}/\text{m}^3$ .

### Health Data from Inhalation Exposure

## 4,4-Methylenedianiline



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.

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 STEL--OSHA's short-term exposure limit; a 15-minute TWA exposure which should not be exceeded at any time during a workday.

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

<sup>a</sup> Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

<sup>b</sup> 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 ACGIH numbers are advisory.

<sup>c</sup> The LOAEL is from the critical study used as the basis for the CalEPA chronic inhalation reference exposure level.

Summary created in April 1992, updated January 2000

### References

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2. U.S. Environmental Protection Agency. Health and Environmental Effects Profile for Benzenamine, 4,4'-Methylenebis. EPA/600/x-84/231. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1984.
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5. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Methylenedianiline. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1998.
6. [CaliforniaEnvironmentalProtectionAgency\(CalEPA\)](#). 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.
7. California Environmental Protection Agency (CalEPA). Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II. Technical Support Document for Describing Available Cancer Potency Factors. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1999.
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.
9. Occupational Safety and Health Administration (OSHA). Occupational Safety and Health Standards, Toxic and Hazardous Substances. Code of Federal Regulations 29 CFR 1910.1050. 1998.