

# Acrylonitrile

107-13-1

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## Hazard Summary

Exposure to acrylonitrile is primarily occupational: it is used in the manufacture of acrylic acid and modacrylic fibers. Acute (short-term) exposure of workers to acrylonitrile has been observed to cause mucous membrane irritation, headaches, dizziness, and nausea. No information is available on the reproductive or developmental effects of acrylonitrile in humans. Based on limited evidence in humans and evidence in rats, EPA has classified acrylonitrile as a probable human carcinogen (Group B1).

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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 acrylonitrile and the RfC and the carcinogenic effects of acrylonitrile including the unit cancer risk for inhalation exposure, EPA's [Health Effects Assessment for Acrylonitrile](#) (6), and the Agency for Toxic Substances and Disease Registry's (ATSDR's) [Toxicological Profile for Acrylonitrile](#) (1).

## Uses

- Acrylonitrile is primarily used in the manufacture of acrylic and modacrylic fibers. It is also used as a raw material in the manufacture of plastics (acrylonitrile-butadiene-styrene and styrene-acrylonitrile resins), adiponitrile, acrylamide, and nitrile rubbers and barrier resins. (1,6)

## Sources and Potential Exposure

- Human exposure to acrylonitrile appears to be primarily occupational, via inhalation. (1)
- Acrylonitrile may be released to the ambient air during its manufacture and use. (1)

## Assessing Personal Exposure

- Acrylonitrile can be detected in the blood to determine whether or not exposure has occurred. Metabolites may be detected in the urine, but some breakdown products are not specific to acrylonitrile. (1)

## Health Hazard Information

### Acute Effects:

- Workers exposed via inhalation to high levels of acrylonitrile for less than an hour experienced mucous membrane irritation, headaches, nausea, feelings of apprehension and nervous irritability; low grade anemia, leukocytosis, kidney irritation, and mild jaundice were also observed in the workers, with these effects subsiding with the ending of exposure. Symptoms associated with acrylonitrile poisoning include limb weakness, labored and irregular breathing, dizziness and impaired judgment, cyanosis, nausea, collapse, and convulsions. (1-4)
- A child died after being exposed to acrylonitrile by inhalation, suffering from respiratory malfunction, lip cyanosis, and tachycardia before death. Several adults exposed to the same concentration of acrylonitrile exhibited eye irritation, but no toxic effects. (1,4)
- Acute dermal exposure may cause severe burns to the skin in humans. (3)
- Acute animal tests in rats, mice, rabbits, and guinea pigs have demonstrated acrylonitrile to have high acute toxicity from inhalation and high to extreme acute toxicity from oral or dermal exposure.

(5)

#### Chronic Effects (Noncancer):

- In one study, headaches, fatigue, nausea, and weakness were frequently reported in chronically (long-term) exposed workers. (6)
- In rats chronically exposed by inhalation, degenerative and inflammatory changes in the respiratory epithelium of the nasal turbinates and effects on brain cells have been observed. (1,4,6)
- The Reference Concentration (RfC) for acrylonitrile is 0.002 milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) based on degeneration and inflammation of nasal respiratory epithelium in rats. 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 was a well-conducted chronic study in an appropriate number of animals, it was performed on only one species, did not identify a no-observed-adverse-effect level (NOAEL), was confounded by the early sacrifice of rats with large mammary gland tumors and the target organ (nasal turbinates) was examined only at the end of the study in relatively few animals; medium to low confidence in the database because of the lack of chronic or subchronic inhalation data in a second species, the lack of reproductive data by the inhalation route and the existence of an oral study showing reproductive effects; and, consequently, medium to low confidence in the RfC. (4)
- EPA has calculated a provisional Reference Dose (RfD) of 0.001 milligrams per kilogram body weight per day ( $\text{mg}/\text{kg}/\text{d}$ ) for acrylonitrile based on decreased sperm counts in mice. The provisional RfD is a value that has had some form of Agency review, but it does not appear on IRIS. (7)

#### Reproductive/Developmental Effects:

- No information is available on the reproductive or developmental effects of acrylonitrile in humans.
- Fetal malformations (including short tail, missing vertebrae, short trunk, omphalocele, and hemivertebra) have been reported in rats exposed to acrylonitrile by inhalation. (1,4)
- In mice orally exposed to acrylonitrile, degenerative changes in testicular tubules and decreased sperm count were observed. (1)

#### Cancer Risk:

- A statistically significant increase in the incidence of lung cancer has been reported in several studies of chronically exposed workers. However, some of these studies contain deficiencies such as lack of exposure information, short followup, and confounding factors. (1,4,6,8)
- In several studies, an increased incidence of tumors has been observed in rats exposed by inhalation, drinking water, and gavage. Astrocytomas in the brain and spinal cord and tumors of the Zymbal gland (in the ear canal) have been most frequently reported, as well as tumors of the stomach, tongue, small intestine in males and females, and mammary gland in females. (1-4,6,8)
- EPA has classified acrylonitrile as a Group B1, probable human carcinogen (cancer-causing agent). (4)
- EPA uses mathematical models, based on human and animal studies, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of a chemical. EPA calculated an inhalation unit risk estimate of  $6.8 \times 10^{-5}$  ( $\mu\text{g}/\text{m}^3$ )<sup>-1</sup>. EPA estimates that, if an individual were to continuously breathe air containing acrylonitrile at an average of  $0.01 \mu\text{g}/\text{m}^3$  ( $1 \times 10^{-5} \text{mg}/\text{m}^3$ ), over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing air containing this chemical. Similarly, EPA estimates that breathing air containing  $0.1 \mu\text{g}/\text{m}^3$  ( $1 \times 10^{-4} \text{mg}/\text{m}^3$ ) would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing  $1.0 \mu\text{g}/\text{m}^3$  ( $1 \times 10^{-3}$

$\text{mg/m}^3$ ) would result in not greater than a one-in-ten thousand increased chance of developing cancer. For a detailed discussion of confidence in the potency estimates, please see IRIS. (4)

- EPA has calculated an oral cancer slope factor of  $0.54 \text{ (mg/kg/d)}^{-1}$ . (4)

## Physical Properties

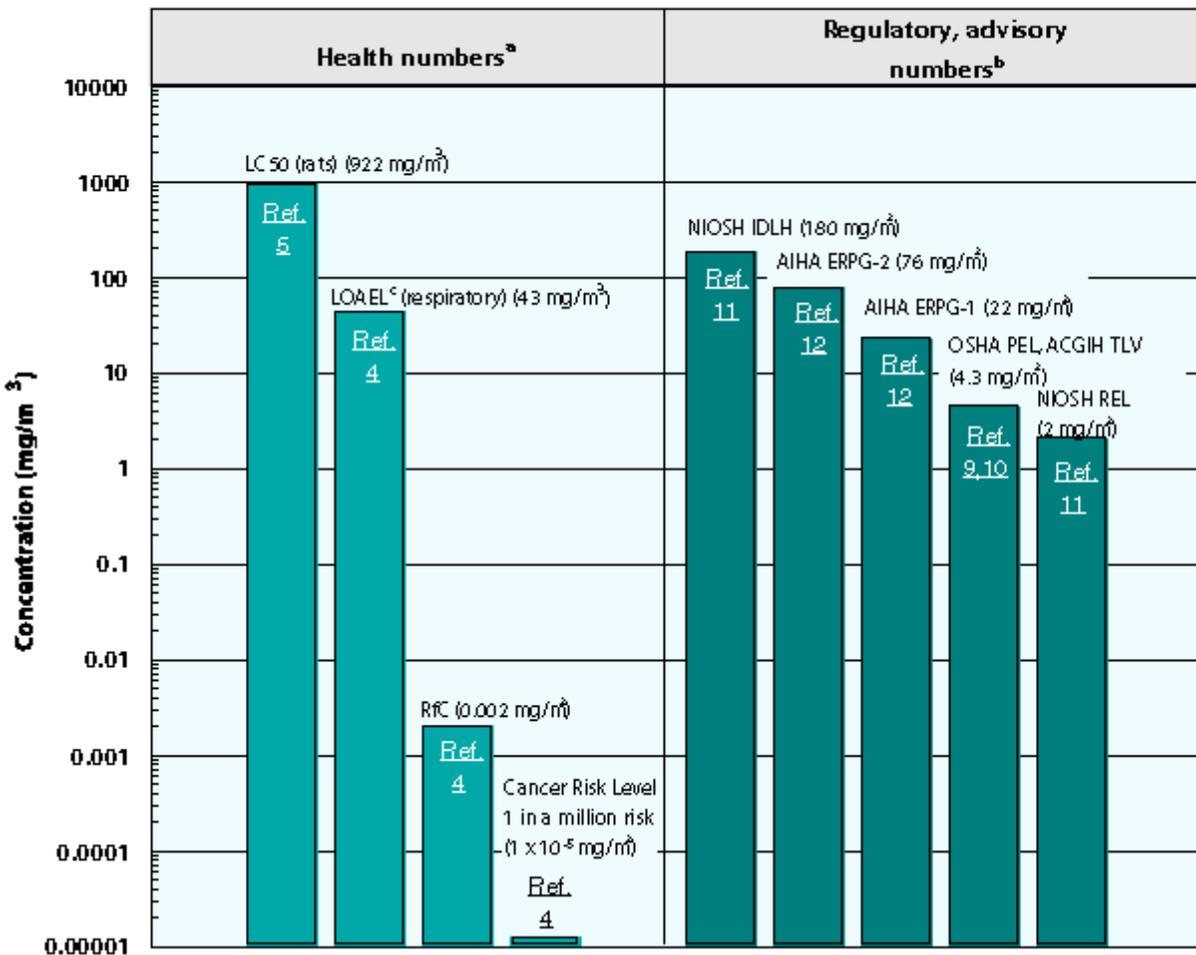
- The chemical formula for acrylonitrile is  $\text{C}_3\text{H}_3\text{N}$ , and its molecular weight is 53.06 g/mol. (1,8)
- Acrylonitrile occurs as a colorless liquid that is soluble in water. (1,8)
- Acrylonitrile has a pungent, onion- or garlic-like odor, with an odor threshold of  $47 \text{ mg/m}^3$ . (1)
- The vapor pressure for acrylonitrile is 100 mm Hg at 22.8 °C, and its log octanol/water partition coefficient ( $\log K_{ow}$ ) is -0.92. (1)

Conversion Factors (only for the gaseous form):

To convert concentrations in air (at 25°C) from ppm to  $\text{mg/m}^3$ :  $\text{mg/m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$ . For acrylonitrile: 1 ppm =  $2.17 \text{ mg/m}^3$ .

## Health Data from Inhalation Exposure

### Acrylonitrile



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 effect.

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.

LC<sub>50</sub> (Lethal Concentration<sub>50</sub>)--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.

<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 NIOSH, ACGIH, and AIHA numbers are advisory.

<sup>c</sup> The LOAEL is from the critical study used as the basis for the EPA RfC.

Summary created in April 1992, updated in January 2000.

## References

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