Acrylamide

79-06-1

Hazard Summary

The largest use for acrylamide is as an intermediate in the production of organic chemicals and in the synthesis of polyacrylamides. Acute (short-term) and chronic (long-term) oral exposures to acrylamide have resulted in damage to the nervous system in humans and animals. Human data are inadequate on acrylamide and cancer risk. In rats orally exposed to acrylamide, significantly increased incidences of tumors at multiple sites have been observed. EPA has classified acrylamide as a Group B2, probable human carcinogen.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) (7), which contains information on oral chronic toxicity and the RfD, and the carcinogenic effects of acrylamide including the unit cancer risk for inhalation exposure, and EPA's Health and Environmental Effects Profile for Acrylamide. (2) Other secondary sources include the Hazardous Substances Data Bank (HSDB) (1), a database of summaries of peer-reviewed literature, and the Registry of Toxic Effects of Chemical Substances (RTECS), a database of toxic effects that are not peer reviewed. (5)

Uses

- Acrylamide is used as a reactive monomer and intermediate in the production of organic chemicals and in the synthesis of polyacrylamides. Acrylamide is also used as a flocculent for sewage and waste treatment, soil conditioning agents, ore processing, paper and textile industries, and in the manufacture of dyes, adhesives, and permanent press fabrics. (1,2,7,9)

Sources and Potential Exposure

- Human exposure to acrylamide occurs primarily in the workplace from dermal contact and inhalation of dust and vapor. (1)
- In one study, no acrylamide was detected in the ambient air of areas surrounding five U.S. producer and user sites of acrylamide. (2)
- The general public may be exposed to low levels of acrylamide through contaminated drinking water. (1,2)

Personal Exposure

- No information was located regarding the measurement of personal exposure to acrylamide.

Health Hazard Information

Acute Effects:

- Central and peripheral nervous system damage, with effects such as drowsiness and hallucinations, has been observed in humans acutely exposed to acrylamide through inhalation exposure. Acrylamide (when occurring as a monomer) is a potent neurotoxicant at low levels. (1,3,4)
- Acute oral exposure to acrylamide has resulted in neurotoxic effects in rats and effects on the kidney in monkeys exposed by injection. (1)
- Tests involving acute exposure of rats, mice, rabbits, and guinea pigs have demonstrated acrylamide to

have high acute toxicity from oral or dermal exposure. (5)

Chronic Effects (Noncancer):

- Chronic oral exposure to acrylamide has been observed to produce nerve damage, with effects such as numbness and weakness in the hands and legs, in humans and animals. (1,2,6,7)
- Chronic dermal exposure may result in an exfoliative, reddish rash in humans. (1)
- EPA has not established a Reference Concentration (RfC) for acrylamide. (7)
- The California Environmental Protection Agency (CalEPA) has calculated a chronic inhalation reference exposure level of 0.0007 milligrams per cubic meter (mg/m^3) for acrylamide based on degeneration of the peripheral nervous system 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. (8)
- The Reference Dose (RfD) for acrylamide is 0.0002 milligrams per kilogram body weight per day (mg/kg/d) based on nerve damage 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. (7)
- EPA has high confidence in the study on which the RfD was based because the study was very well designed for the evaluation of a large number of endpoints, employed a sensitive measure of the most appropriate endpoint, used more than the minimum number of treatment groups, and included a long post-treatment recovery period; medium confidence in the database because there are no accepted chronic studies; and consequently medium confidence in the RfD. (7)

Reproductive/Developmental Effects:

- No information is available on the reproductive or developmental effects of acrylamide in humans.
- In one animal study, decreases in body weight and body weight gain and an increase in preimplantation loss were observed in rats orally exposed to acrylamide. (7)
- In mice orally exposed to acrylamide, decreased sperm counts were reported. (2,6)

Cancer Risk:

- Two studies have been carried out examining worker exposure to acrylamide and cancer mortality. EPA considers both of these studies to be inadequate to determine cancer risk due to the small populations studied and incomplete exposure data. (7)
- In rats orally exposed to acrylamide, significantly increased incidences of tumors at multiple sites have been observed. These include mammary tumors, central nervous system tumors, thyroid follicular tumors, and uterine adenocarcinoma in female rats and thyroid follicular tumors and scrotal mesothelioma in males. (2,7,9)
- EPA has classified acrylamide as a Group B2, probable human carcinogen. (7)
- 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 has calculated an inhalation unit risk estimate of $1.3 \times 10^{-3}\ (\mu g/m^3)^{-1}$. EPA estimates that, if an individual were to continuously breathe air containing acrylamide at an average of 0.0008 $\mu g/m^3$ (8×10^{-7} mg/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 0.008 $\mu g/m^3$ (8×10^{-6} mg/m^3) would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing 0.08 $\mu g/m^3$ (8×10^{-5} mg/m^3) would result in not greater than a one-in-ten thousand increased chance of developing cancer. (7)
  EPA has calculated an oral cancer slope factor of 4.5 $(mg/kg/d)^{-1}$. (7)

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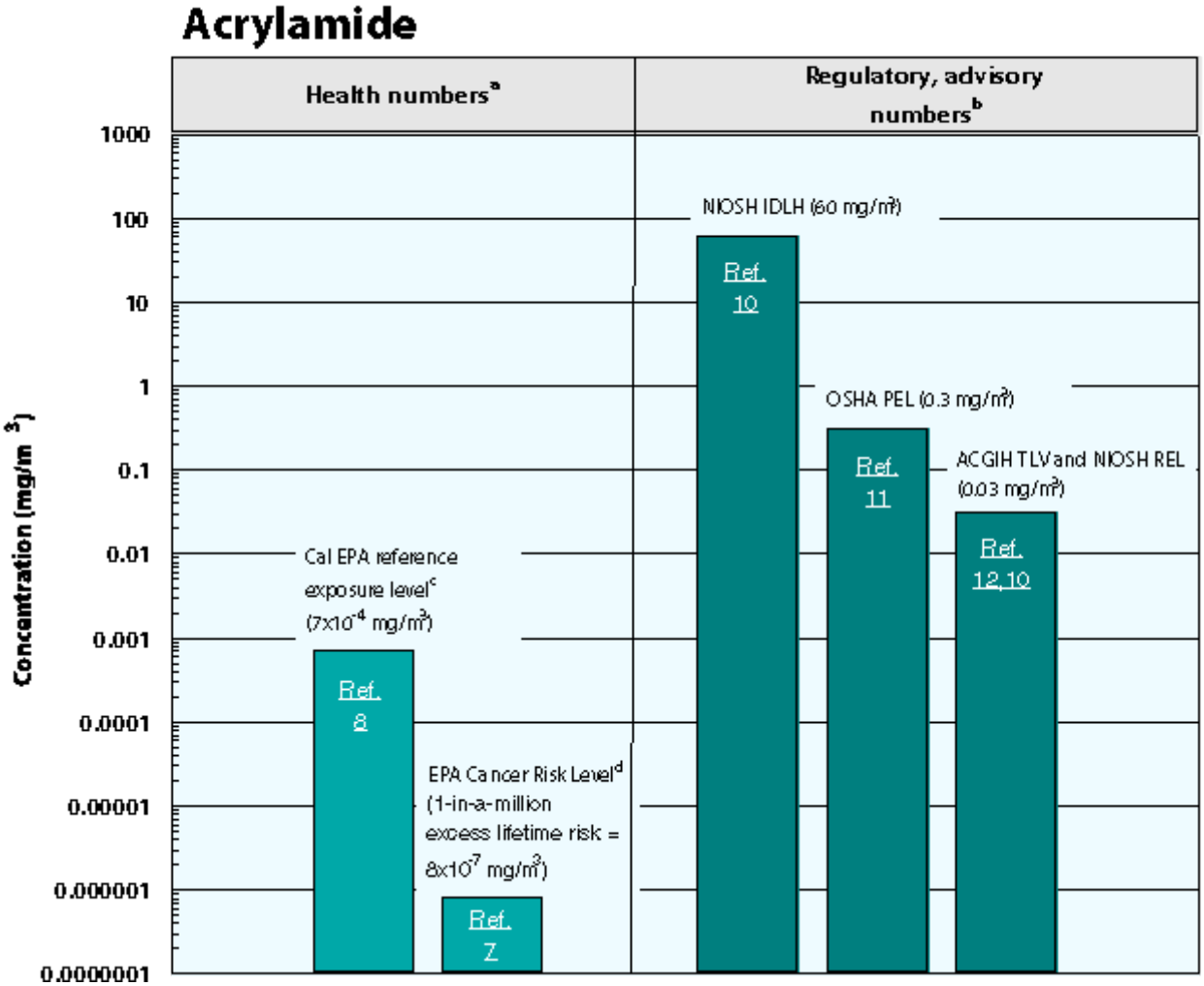
Physical Properties

- The chemical formula for acrylamide is C_3H_5NO, and the molecular weight is 71.08 g/mol. (2)
- Acrylamide occurs as a white, crystalline solid or flake-like crystals and is highly soluble in water. (2,3)
- Acrylamide is odorless. (2)
- The vapor pressure for acrylamide is 0.007 mm Hg at 25 °C, and its log octanol/water partition coefficient (log K_{ow}) is -0.67. (2)

Conversion Factors:
To convert concentrations in air (at 25°C) from ppm to mg/m^3: mg/m^3 = (ppm) × (molecular weight of the compound)/(24.45). For acrylamide: 1 ppm = 2.9 mg/m^3. To convert from $\mu g/m^3$ to mg/m^3: mg/m^3 = ($\mu g/m^3$) × (1 mg/1,000 µg).

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.
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--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.
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 and ACGIH numbers are advisory.
c The CalEPA REL was derived from an oral drinking water study.
d These cancer risk estimates were derived from oral data and converted to provide the estimated inhalation risk.

Summary created in April 1992, updated January 2000

References

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