Acrylonitrile

CAS No. 107-13-1

Reasonably anticipated to be a human carcinogen

\[ \ce{H2C == H -> C == N} \]

Carcinogenicity

Acrylonitrile is reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals

Acrylonitrile caused tumors at several different tissue sites in rats. Exposure to acrylonitrile in drinking water or by inhalation caused cancer of the central nervous system (microglioma or glioma) and Zymbal gland (carcinoma) and benign tumors of the forestomach (squamous-cell papilloma or acanthoma) in both sexes (IARC 1979).

Since acrylonitrile was listed in the Second Annual Report on Carcinogens, additional studies in rodents have been identified. Oral exposure to acrylonitrile caused cancer of the forestomach (squamous-cell carcinoma) and increased the combined incidence of benign and malignant Harderian-gland tumors (adenoma and carcinoma) in mice of both sexes. Benign and malignant tumors of the ovary (granulosa-cell tumors) and lung (alveolar/bronchiolar adenoma and carcinoma) in female mice also may have been related to acrylonitrile exposure (NTP 2001). In rats, prenatal exposure followed by postnatal inhalation exposure to acrylonitrile caused brain tumors (glial-cell tumors) in both sexes. In females, it also caused cancer of the mammary gland and the blood vessels (angiosarcoma); in males, it caused cancer of the Zymbal gland and increased the combined incidence of benign and malignant liver tumors (hepatocellular adenoma and carcinoma) (IARC 1999).

Cancer Studies in Humans

The data available from epidemiological studies are inadequate to evaluate the relationship between human cancer and exposure specifically to acrylonitrile. An increased risk of cancer of the lung and colon was reported in U.S. textile plant workers exposed to acrylonitrile and observed for 20 years or more (IARC 1979).

Since acrylonitrile was listed in the Second Annual Report on Carcinogens, additional epidemiological studies have been identified. In studies of workers exposed to acrylonitrile (including textile workers and rubber workers) published in the 1980s and 1990s, including several meta-analyses, the risk of cancer was increased only for lung cancer among workers with the highest cumulative exposure levels in a large National Cancer Institute cohort study (IARC 1999). An update of a U.S. textile-worker cohort followed for five decades found no association between acrylonitrile exposure and cancer at any tissue site (Symons et al. 2008). A large international case-control study of lung cancer found a significant smoking-adjusted risk of lung cancer with increasing acrylonitrile exposure (Scélo et al. 2004), and a meta-analysis of lung-cancer findings found increased risk with acrylonitrile exposure after adjusting for a healthy-worker effect (Sponsiello-Wang et al. 2006). A small cohort study (Czeizel et al. 2004) found no excesses of lung or other cancer among workers possibly exposed to acrylonitrile; however, the study’s statistical power to detect effects was limited. In an update of a cohort study in the Netherlands, excesses of brain cancer were found in some exposure categories (Swaen et al. 2004).
Exposure

The potential routes of human exposure to acrylonitrile are inhalation, ingestion, and dermal contact. Exposure is greater in occupational settings than in the general population. The general population may be exposed through the use of consumer products made with polymers of acrylonitrile, such as acrylic carpeting or polyacrylonitrile-resin-based food packaging. However, exposure from these sources is very low, because little of the monomer migrates from such products into air or food (ATSDR 1990). The U.S. Consumer Product Safety Commission in 1978 estimated concentrations of acrylonitrile as less than 1 ppm in acrylic and modacrylic fibers, 30 to 50 ppm in acetonitrile-butadiene-styrene copolymers, 15 ppm in styrene-acrylonitrile copolymers, and 0 to 750 ppm in nitrile rubber and latex goods (as cited in IPCS 1983). Foods most likely to contain measureable acrylonitrile are high-fat or highly acidic items, such as luncheon meat, peanut butter, margarine, vegetable oil, or fruit juice. In 1984, typical concentrations of acrylonitrile in margarine were reported to be 0.5 to 1.2 μg/m³ (Nazaroff and Singer 2004). Acrylonitrile-hemoglobin adducts are a reliable marker of smoking behavior and correlate with the number of cigarettes smoked per day (Bergmark 1997, Fennell et al. 2000). The adducts may also be present in infants born to mothers who smoke (Tavares et al. 1996, Schettgen et al. 2004).

According to the U.S. Environmental Protection Agency’s Toxics Release Inventory, the volume of environmental releases of acrylonitrile has remained high since 2001, when 11.5 million pounds was released, and most releases since 2000 have been to underground injection wells. In 2007, 94 facilities released a total of about 7 million pounds of acrylonitrile, most of which (6.6 million pounds) was released by two facilities to on-site hazardous waste underground injection wells (TRI 2009).

Occupational exposure to acrylonitrile may occur during its manufacture and production and in factories where it is used as a monomer; exposure levels are highest where acrylonitrile is manufactured. Typical workplace air concentrations were reported to range from 0.1 to 4 mg/m³ (ATSDR 1990). The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 51,153 workers, including 25,320 women, potentially were exposed to acrylonitrile. Occupations with potential for exposure included acrylic resin, rubber, synthetic fiber, and textile maker; synthetic organic chemist; and pesticide worker (NIOSH 1990).

Regulations

Coast Guard (Dept. of Homeland Security)

Minimum requirements have been established for safe transport of acrylonitrile on ships and barges.

Department of Transportation (DOT)

Acrylonitrile is considered a hazardous material, and special requirements have been set for marking, labeling, and transporting this material.

Environmental Protection Agency (EPA)

Clean Air Act

National Emission Standards for Hazardous Air Pollutants: Listed as a hazardous air pollutant.

New Source Performance Standards: Manufacture of acrylonitrile is subject to certain provisions for the control of volatile organic compound emissions.

Prevention of Accidental Release: Threshold quantity (TQ) = 20,000 lb.

For definitions of technical terms, see the Glossary.


