ACRYLONITRILE
CAS No. 107-13-1
First Listed in the *Second Annual Report on Carcinogens*

$H_2C{=}CH{-}C{\equiv}N$

CARCINOGENICITY

Acrylonitrile is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity in experimental animals (IARC 1979, 1982, 1987, 1999, ATSDR 1990). When administered orally (by gavage or in drinking water), acrylonitrile induced increased incidences of forestomach squamous cell papillomas, central nervous system microgliomas, mammary gland carcinomas, and Zymbal gland carcinomas in rats of both sexes. Inhalation studies demonstrated that acrylonitrile induced Zymbal gland carcinomas, glial cell tumors, forestomach papillomas and acanthomas, and central nervous system neoplasms in rats of both sexes, mammary tumors and extrahepatic angiosarcomas in female rats, and hepatocellular tumors in male rats (IARC 1999).

There is limited evidence for the carcinogenicity of acrylonitrile in humans (IARC 1979, 1982, 1987, 1999). An epidemiological study of textile-plant workers potentially exposed to acrylonitrile and observed for at least 20 years showed an increased incidence of cancers of the lung; further follow-up of this cohort revealed a continued excess of lung cancer, although during the actual 5-year follow-up period there was no excess. The follow-up also showed a significant excess of cancer of the prostate. In a similar study at another textile-fiber plant, an excess of prostatic cancer was observed, but there was no excess of lung cancer. Another occupational study of persons potentially exposed to acrylonitrile and followed for at least 10 years indicated an increased incidence of cancers of the stomach, colon, brain, and respiratory tract (IARC 1979). Among rubber workers exposed to acrylonitrile, excesses were noted for cancers of the lung and of the lymphatic and hematopoietic systems. Another study of rubber workers, however, showed no association between exposure to acrylonitrile and lung cancer. One study of workers exposed to acrylonitrile in 12 different plants showed excesses of bronchial cancer and of tumors of the lymphatic system. Four cohort studies conducted in the U.S. (2), the U.K. (1), and the Netherlands (1) attempted to establish acrylonitrile exposure levels in workers exposed during manufacturing processes that produce or use acrylonitrile (IARC 1999). Findings from these studies indicated that no significant risk for any type of cancer existed when all exposed workers were compared with unexposed workers or with an external comparison population. Further, earlier indications of an increased risk of lung cancer among workers exposed to acrylonitrile (IARC 1979, 1982, 1987) were not confirmed by these larger, more recent studies (IARC 1999).

PROPERTIES

Acrylonitrile is a colorless, volatile liquid that is soluble in water and most common organic solvents such as acetone, benzene, carbon tetrachloride, ethyl acetate, and toluene. It melts at -84°C and boils at 77°C. Technical-grade acrylonitrile is more than 99% pure (IARC 1999). The technical-grade product always contains a polymerization inhibitor. Acrylonitrile is a reactive chemical that polymerizes spontaneously and can explode when exposed to flame (HSDB 2002).

USE

Acrylonitrile is an important industrial chemical. It is used extensively in the manufacture of synthetic fibers, resins, plastics, elastomers, and rubber for a variety of consumer goods such as textiles, dinnerware, food containers, toys, luggage, automotive parts, small appliances, and telephones (SRI 1984). In 1986, about 40% of the acrylonitrile produced was used to produce acrylic and modacrylic fibers, 28% to produce acrylonitrile-butadiene-styrene (ABS) and styrene-acrylonitrile (SAN) resins, and 15% to produce adiponitrile, an intermediate used in nylon production. The remainder was used in the production of acrylamide (10%), nitrile elastomers, barrier resins, and miscellaneous specialty chemicals (4%) (Chem. Profile 1986). The manufacture of carbon fibers used for high-performance applications in the aircraft, defense, and aerospace industries is a growing specialty application of acrylonitrile. Other specialty applications include the production of fatty amines, ion exchange resins, and fatty amine amides used in cosmetics, adhesives, corrosion inhibitors, and water-treatment resins (IARC 1999). Acrylonitrile has also been used as a fumigant; however, most pesticide registrations of the chemical were canceled in 1978, and its use as a fumigant has been abandoned (ATSDR 1990).

PRODUCTION

Acrylonitrile has been produced in the United States since 1940 (IARC 1979). It has been ranked in the top 50 highest-volume chemicals by Chemical and Engineering News for the past several years (Chem. Eng. News 1998). U.S. production of acrylonitrile averaged 2.7 billion lb for the time period 1985 to 1987. In 1990 and 1993, 2.7 billion lb and 2.5 billion lb were produced, respectively. U.S. production of acrylonitrile increased to 3.4 billion lb in 1996 (IARC 1999). Chem Sources (2001) identified 21 suppliers of acrylonitrile in the United States in 2001.

As reported in 1990, imports of acrylonitrile had substantially decreased in the 1970s and had been considered negligible since 1984 (ATSDR 1990); for example, in 1985, only 441 lb were imported into the United States (USDOC Imports 1986). However, in 1989, the amount of acrylonitrile imported into the U.S. increased dramatically, with the reported import value greater than 400,000 lb (USDOC Imports 1990). In 2000, more than 17 million lb were imported (ITA 2001). In contrast, a sizable fraction of acrylonitrile is exported, with over 1.5 billion lb exported in 2000 (ATSDR 1990, ITA 2001). In 1989, over 942 million lb were exported (USDOC Exports 1990). This figure is similar to the 944 million lb reported for 1986 and the 943 million lb reported for 1985 (Chem. Week 1987, USDOC Exports 1986). In 1984, the value was 834 million lb (Chem. Prod. 1985).

EXPOSURE

The primary routes of potential human exposure to acrylonitrile are inhalation and dermal contact. Exposure to acrylonitrile may occur during its manufacture and production; greater potential for exposure exists for workers using acrylonitrile to make other products in factories where the compound is not easily contained (DPIM 1989). The National Occupational Exposure Survey (1981-1983) indicated that 51,153 total workers, including 25,320 women, were potentially exposed to acrylonitrile (NIOSH 1984). The National Occupational Hazard Survey, conducted by NIOSH from 1972 to 1974, estimated that 71,610 workers were potentially exposed to acrylonitrile in the workplace (NIOSH 1976). In a later report, NIOSH estimated that 125,000 persons have the potential for occupational exposure (NIOSH 1978). These may be overestimates because non-exposed workers within each Standard Industrial Classification may not have been excluded. Based on industrial sources, a more reasonable estimate of the number of workers exposed is 5,130 people (NCI 1985). These individuals include acrylic resin makers, synthetic organic chemists, pesticide workers, and rubber, synthetic fiber, and textile makers.

People living near chemical factories or waste sites are the likely candidates for exposure to measurable amounts of acrylonitrile in air and water. The remaining general population may be potentially exposed through consumer product usage such as acrylic carpeting or by ingestion of contaminated foods. Exposure in each case, however, is very low because of little migration of the monomer from such products (ATSDR 1990). The concentrations of acrylonitrile in consumer products are estimated to be less than 1 ppm in acrylic and modacrylic fibers, 30 to 50 ppm in ABS copolymers, 15 ppm in SAN copolymers, and 0 to 750 ppm in nitrile rubber and latex goods (Patrianakos and Hoffman 1979). In the 1960s and 1970s, acrylonitrile was also detected in cigarette smoke, usually at levels of 1 to 2 mg per cigarette, since the chemical was used as a fumigant for stored tobacco. It is unlikely that cigarette smoking is today a major source of exposure to acrylonitrile because its use as a fumigant has been discontinued (ATSDR 1990). The presence of acrylonitrile, even as a trace contaminant, may be cause for concern. The extent or risk of any potential exposure for the general population through air emissions from production, manufacture, bulk storage, and waste disposal has not been determined. A 1977 report stated that total acrylonitrile air emissions were 2.2% of total production. The Toxic Chemical Release Inventory (TRI) estimated that 4,891,577 lb of acrylonitrile were released to the environment from 97 facilities that produced, processed, or used the chemical in the United States in 1996. Of that total, 26.5% and 73.5% were released to the air and underground injection wells, respectively (TRI96 1998). In 1999, the amount of acrylonitrile released into the environment increased to 5,466,510 lb from 117 facilities that produced, processed, or used the chemical in the United States. Of that total, 17.9% was released to the air and 81.6% to underground injection wells. Air emissions from 17 facilities, each releasing >10,000 lb, represented 92.0% of the total atmospheric release. Four facilities, each releasing >100,000 lb, accounted for 98.4% of the total underground injection release. Releases to water and land were very low with 1,068 lb and 560 lb released, respectively (TRI99 2001).

REGULATIONS

EPA regulates acrylonitrile under the Clean Air Act (CAA), Clean Water Act (CWA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA), and Superfund Amendments and Reauthorization Act (SARA). A reportable quantity (RQ) of 100 lb has been established for acrylonitrile under the CWA and CERCLA. Acrylonitrile was classified for restricted use as a pesticide under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which led to voluntary cancellation of its product registration by the producer. Under RCRA, acrylonitrile has been designated a hazardous constituent of waste. Under SARA, EPA established reporting requirements and general threshold amounts for acrylonitrile; the threshold planning quantity (TPQ) for acrylonitrile is 10,000 lb.

FDA has set specific restrictions on use and migration of acrylonitrile for food containers and food contact surfaces.

ACGIH recommends a threshold limit value (TLV) at 2 ppm (4.5 mg/m^3). This standard requires personal protective equipment, training, medical surveillance, signs and labeling, and engineering controls. NIOSH has recommended TWA exposure limits for acrylonitrile be set at 1 ppm and a short-term ceiling value be set at 10 ppm. OSHA established a permissible exposure limit (PEL) of 2 ppm (4.5 mg/m^3) as an 8-hr TWA with no eye or skin contact. A short term ceiling (15 minutes) value was set at 10 ppm by OSHA. OSHA regulates acrylonitrile as a chemical hazard in laboratories under the Hazard Communication Standard. Regulations are summarized in Volume II, Table 4.

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