Massachusetts Chemical Fact Sheet

Acrylonitrile

The primary uses of acrylonitrile in Massachusetts are the manufacture of styrene-acrylonitrile (SAN) resins and acrylamide-based coatings. A probable carcinogen and suspected reproductive toxin, exposure to acrylonitrile should be avoided. Because acrylonitrile is not persistent or bioaccumulative and is used as an intermediary chemical, the primary concerns have been with its exposure to workers.

FACTS

Common Name:	Acrylonitrile
CAS Number:	107-13-1
Chemical Formula:	C_2H_3CN
Vapor Pressure:	86 mm Hg at 20°C
Water Solubility:	Soluble
Odor:	pungent, onion- or garlic-like

Hazards

Acute (Short-Term) Health Effects

- Acrylonitrile is lethal at inhaled concentrations around 85 parts per million (ppm).
- Acrylonitrile may induce headaches, dizziness, nausea, vomiting, muscle weakness, convulsions, feelings of apprehension, or nervous irritability at less than lethal levels.
- Acrylonitrile inhalation can also irritate the lungs, causing coughing or shortness of breath, and airborne exposure can irritate the eyes and nose. These symptoms result from acrylonitrile's ability to inhibit the respiratory action of tissue cells and render them incapable of oxygen absorption.
- If acrylonitrile touches skin, it can cause severe burns, irritation, or blisters.

Chronic (Long-Term) Health Effects

Acrylonitrile is a probable carcinogen and a suspected reproductive toxicant. Since the purposeful testing of chemicals on humans is unethical, the lag time between exposure and effect is long, and the array of confounding factors is often great, solid epidemiological data confirming a chemical's carcinogenicity is rare. For this reason, government and research agencies identify different levels of carcinogenicity.

Acrylonitrile is a probable carcinogen according to the International Agency for Research on Cancer (a Group 2A carcinogen) and the U.S. Environmental Protection Agency (EPA) (a Group B1 carcinogen).

The U.S. Environmental Protection Agency (EPA) describes the current state of acrylonitrile's carcinogenicity as follows: "A statistically significant increase in the incidence of lung cancer has been reported in chronically exposed workers. However, many of these studies contain deficiencies such as lack of exposure information, short follow up, and confounding factors. In several studies, an increased incidence of tumors has been observed in rats exposed by inhalation, drinking water, and gavage."

While no data are available on the reproductive or developmental effects of acrylonitrile in humans, "Fetal malformations have been reported in rats exposed to acrylonitrile by inhalation. In mice orally exposed to acrylonitrile, degenerative changes in testicular tubules and decreased sperm count were observed."

Exposure

Worker Health

Facilities using acrylonitrile need to protect worker health by enclosing operations and/or using local exhaust ventilation. If these practices are not

implemented, workers need respirators to protect their health. Since acrylonitrile is a probable carcinogen, and there may be no safe level of exposure to a carcinogen, all contact should be reduced to the lowest possible level. Workers also need to wear protective gloves and clothing to avoid skin contact with acrylonitrile.

The legal airborne permissible exposure limit (PEL) for acrylonitrile, set by the Occupational Safety and Health Administration (OSHA), is 2 parts per million (ppm) — averaged over eight hours. The PEL for any 15-minute work period is 10 ppm or less.

Outside the daily routine, leaks, fires, and reactions pose the greatest threat to workers, as acrylonitrile is both a flammable and reactive liquid. During fires poisonous gases form, including hydrogen cyanide, and containers may explode.

Public Health

Data on the public and ecological exposure to acrylonitrile are scarce because it is an intermediary chemical, soluble in water, and is not persistent or bioaccumulative. As an intermediary chemical, acrylonitrile is typically used in enclosed applications and converted to other materials, resulting in low environmental releases. Soluble in water and absent persistent or bioaccumulative properties, acrylonitrile is seldom identified in drinking water, body fat, or the food chain.

An area of concern has been with the use of acrylonitrile-based polymers in food packaging. For example in 1977, the U.S. Food and Drug Administration (FDA) banned the use of acrylonitrile-based polymers in beverage containers. The FDA's concern was the leaching of unreacted acrylonitrile monomer into beverages, exposing the general public to small, but constant levels of acrylonitrile. In 1982, the FDA stepped back from the ban and now allows the use of acylonitrile in food packaging, including non-alcoholic carbonated beverages.

Use Nationally and in Massachusetts

Acrylonitrile is an intermediary chemical in manufacturing; it is used to produce other chemicals or materials. The dominant uses for acrylonitrile in the U.S. are in the manufacture of adiponitrile,[1] acrylonitrile-butadiene-styrene (ABS) and styrene-acrylonitrile (SAN) resins,[2] acrylic fibers,[3] acrylamide,[4] nitrile elastomers,[5] and acrylonitrile based polymers for packaging products.[6]

Massachusetts, with its very small petrochemical manufacturing base, uses small amounts of acrylonitrile, only 222,000 pounds in 1996 (see Table 1).[7] Reflecting national use patterns, Massachusetts

Table 1. Acrylonitrile: Inputs and Outputs for Massachusetts, 1990 and 1996 (pounds)

Input Data -- MA TURA	1990	1996	Change	% Change
Manufactured or Processed	287,105	222,437	-64,668	-23%
Otherwise Used	200	0	-200	-100%
Total Inputs	287,305	222,437	-64,868	-23%
Output Data -- MA TURA	**1990**	**1996**	**Change**	**% Change**
Byproduct	22,161	2,324	-19,837	-90%
Shipped In/As Product	312	199	-113	-36%
Total TURA Outputs	22,473	2,523	-19,950	-89%
Releases & Transfers -- US EPA, TRI	**1990**	**1996**	**Change**	**% Change**
Environmental Releases	1,324	388	-936	-71%
Off-site Transfers	20,855	2,485	-18,370	-88%
Total TRI Outputs	22,179	2,873	-19,306	-87%

Sources: MA TURA -- Massachusetts Toxics Use Reduction Act data, 1998; and US EPA, TRI -- US Environmental Protection Agency, Toxics Release Inventory data, 1998.

companies "process" — intentionally incorporate the chemical into a product — acrylonitrile. Acrylonitrile is seldom "otherwise used" — not intentionally incorporated into a product. Because acrylonitrile is transformed in the manufacturing process, outputs in the form of byproduct, product, and environmental releases and transfers are quite low.

Table 2. Massachusetts Acrylonitrile Consumption by Use Categories (1990 and 1996)

Use Categories[1]	Facility Name	Use (pounds) 1990	1996	Percent Change
Coatings Production				
	Polymer Latex Inc.	39,400	137,746	250%
	Surface Coatings Inc.	39,914	37,612	-6%
	Total	79,314	175,358	121%
Resin Production				
	Zeneca Resins	174,791	47,079	-73%
Unknown [2]				
	Monsanto	33,200		-100%
	Grand Total	287,305	222,437	-23%

[1] Use Categories were assigned based on the Institute's examination of TURA data and in some cases may not represent the actual use; [2] Production unit data was not available for Monsanto due to trade secret claims; Source: Massachusetts Toxics Use Reduction Act data, 1998.

Table 1 includes two sources of "output" data: Massachusetts Toxics Use Reduction Act (MA TURA) and U.S. EPA, Toxics Release Inventory (TRI) data. The MA TURA database includes all non-product material created by a process line prior to release, on-site treatment, or transfer ("byproduct") and the amount of toxic chemical incorporated into a product ("shipped in or as product"). The U.S. EPA, TRI database includes information on the waste materials generated by a facility after on-site treatment including: releases to air, land, and water ("environmental releases") and transfers off-site for treatment or disposal ("off-site transfers"). The use of acrylonitrile in Massachusetts declined by almost 25% between 1990 and 1996. This decline differs markedly from national consumption of acrylonitrile, which grew annually at a rate of 5 percent between 1990 and 1993 and is projected to grow at a rate between 2 and 2.5 percent between 1994-1999. As shown in Table 2, Monsanto[8] no longer reports use of acrylonitrile and Zeneca cut its acrylonitrile use in the manufacture of acrylic resin emulsions by almost 75% between 1990 and 1996. Conversely, the use of acrylonitrile in the manufacture of water-based coating compounds increased by over 100% between 1990 and 1996. Polymer Latex, for example, uses acrylonitrile to manufacture specialty coatings for use in the textile and paper industries.

Driving the decline in TURA byproducts was Monsanto's decision to cease using acrylonitrile. In 1990, Monsanto generated 21,000 pounds of MA TURA byproducts, nearly all of which was transferred off-site. By 1995, their last year of reporting, Monsanto had reduced use to 18,000 pounds and byproducts to 1,400 pounds.

Regulatory Context

Reflecting the potent hazards posed by acrylonitrile, it is part of six different lists of toxic chemicals that have been established under separate U.S. legislative authorities:

- Clean Air Act — Hazardous Air Pollutant and Regulated Toxic, Explosive, Or Flammable Substances List
- Clean Water Act — Priority Pollutants List
- Comprehensive Environmental Responsibility, Compensation and Liability Act (popularly known as "Superfund") — Extremely Hazardous Substances List
- Occupational and Safety Health Act — Air Contaminants List
- Resource Conservation and Recovery Act — Hazardous Constitutents List
- Superfund Amendments Reauthorization Act — Toxics Release Inventory

In addition, the U.S. FDA regulates acrylonitrile as a

food additive because acrylonitrile may leach from plastic packaging into food.

References

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This is one in a series of Massachusetts Chemical Fact Sheets prepared for each of the chemicals in significant use on the Toxics Use Reduction Science Advisory Board's 'more hazardous chemicals' list. For more information on the Chemical Categorization Project, consult the Institute's Technical Report #47.

Endnotes

1 Adiponitrile is also an intermediary. It is used to manufacture hexamethylenediamine (HMDA), which is used to manufacture nylon.

2 The major markets for ABS are automotive and appliance parts; pipes, conduit, and fittings; business machine housings; and telephones. The major markets for SAN — a clear polymer — are household goods (such as drinking cups), packaging products, appliance parts, and automobile instrument panels.

3 Acrylic fibers are used to manufacture textile products for the apparel, home furnishings, and industrial markets.

4 Acrylamide is also an intermediary, with its primary use as the monomer in polyacrylamide (PAM). The primary function of PAM is to facilitate the separation of solids from liquids. PAM markets include water treatment, minerals processing, and papermaking. The paper industry also uses PAM as a strengthener, retention aid, and drainage improver. Acrylamide is also an intermediary in the manufacture of N-methylolacrylamide (NMA), which is used in textile backcoatings, adhesives, non-wovens, and surface coatings.

5 Nitrile elastomers are used primarily in industrial applications where oil resistance and low temperature flexibility are valued: automotive uses are the dominant end use of nitrile elastomers.

6 In 1993, 30 million pounds of acrylonitrile were consumed in the U.S. for use as a packaging material, representing only 2 percent of consumption.

7 Massachusetts consumes less than one tenth of one percent of total U.S. consumption of acrylonitrile. For example in 1993, Massachusetts businesses consumed 542 thousand pounds of acrylonitrile, while total U.S. consumption was 1,584,000 thousand pounds.

8 The Massachusetts Monsanto facility, which is now called Solutia, stopped reporting acrylonitrile use in 1995.