Current Intelligence Bulletin 18

July 1, 1977

ACRYLONITRILE

CURRENT INTELLIGENCE BULLETIN:

ACRYLONITRILE

July 1, 1977

The National Institute for Occupational Safety and Health (NIOSH) has recently been informed that occupational exposure to acrylonitrile may be associated with an excess of lung and colon cancer.

In May 1977, E. I. du Pont de Nemours & Company, Inc., informed NIOSH of results of a preliminary epidemiologic study demonstrating an excess of cancer among workers exposed to acrylonitrile at a Du Pont textile fibers plant in Camden, South Carolina. Additionally, in April, NIOSH received from the Manufacturing Chemists Association (MCA) a one-year interim report of on-going ingestion and inhalation studies of acrylonitrile in laboratory rats; the rats developed a variety of tumors, including carcinomas.

Background

Acrylonitrile is an explosive, flammable liquid having a normal boiling point of 77°C and a vapor pressure of 80 mm (20°C). The toxic effects of acrylonitrile are similar to cyanide poisoning. The chemical structure of acrylonitrile, CH_2=CHCN, resembles that of vinyl chloride, a material known to cause human cancer. Synonyms for acrylonitrile include acrylon, carbacryl, cyanoethylene, fumigrain, 2-propenenitrile, VCN, ventox and vinyl cyanide.

Approximately one and one-half billion pounds per year of acrylonitrile are manufactured in the United States by the reaction of propylene with ammonia and oxygen in the presence of a catalyst. A number of other processes have been used in the past. Current domestic producers of acrylonitrile are American Cyanamid Company (New Orleans, Louisiana), E. I. du Pont de Nemours & Company, Inc. (Beaumont, Texas and Memphis, Tennessee), Monsanto Company (Chocolate Bayou, Texas), and The Standard Oil Company (Ohio) (Lima, Ohio).

The major use of acrylonitrile is in the production of acrylic and modacrylic fibers by copolymerization with methyl acrylate, methyl methacrylate, vinyl acetate, vinyl chloride, or vinylidene chloride. Acrylic fibers, marketed under tradenames including Acrilan, Creslan, Orlon, and Zefran, are used in the manufacture of apparel, carpeting, blankets, draperies, and upholstery. Some applications of modacrylic fibers are synthetic furs and hair wigs; tradenames for modacrylic fibers include Acrylan, Elura, SEF, and Verel. Acrylic and/or modacrylic fibers are manufactured from acrylonitrile by American Cyanamid Company (Milton, Florida), Dow Badishe Company (Williamsburg, Virginia), E. I. du Pont de Nemours & Company, Inc. (Camden, South Carolina and Waynesboro, Virginia), Eastman Kodak Company (Kingsport, Tennessee), and Monsanto Company (Decatur, Alabama).

Other major uses of acrylonitrile include the manufacture of acrylonitrile-butadiene-styrene (ABS) and styrene-acrylonitrile (SAN) resins (used to produce a variety of plastic products), nitrile elastomers and latexes, and other chemicals (e.g., adiponitrile, acrylamide). Acrylonitrile is also used as a fumigant. The U.S. Food and Drug Administration has recently banned the use of an acrylonitrile resin for soft drink bottles.

NIOSH estimates that 125,000 persons are potentially exposed to acrylonitrile in the workplace.

Human Epidemiologic Studies

A preliminary epidemiologic study conducted by the E. I. du Pont de Nemours & Company, Inc., indicated an excess risk of lung and colon cancer among workers with potential acrylonitrile exposure. This study examined the cancer experience of a cohort of 470 male workers who began working in the polymerization operation at Du Pont's Camden, South Carolina textile fibers plant between 1950 and 1955; only persons who are actively employed or who have retired from Du Pont were included in the study. A more complete analysis will include an approximately 400 additional workers also employed during this time, but who quit or were laid off.

In a study based on Du Pont's Mortality File, the cohort experienced a total of 8 deaths due to cancer between 1969 and 1975 (allowing for a 20-year latency period). Only 4 deaths would have been expected among this cohort based on Du Pont company mortality rates, 1969-75 (excluding the mortality experience of the cohort), and about 5 deaths would have been expected based on rates for U.S. white males, 1970. Of the eight cancer deaths, four were due to cancer of the lung while the expected number of lung cancer deaths was 1.5.

In another analysis, data from the Du Pont Cancer Registry (including only cancer diagnoses for active employees enrolled in Du Pont's insurance program) revealed 16 cancer cases occurring between 1969 and 1975 among

the cohort of workers (again allowing for a 20-year latency period). Only 5.8 cases would have been expected based on Du Pont company rates (excluding the cohort). Six of these cases were lung cancers (1.5 expected), three were cancers of the large intestine (0.5 expected), and the remaining seven cancers were from seven other primary sites. Because of incomplete reporting, skin cancer cases were excluded from this analysis.

A total of 18 cancers (appearing on Du Pont's Mortality File and/or Cancer Registry) occurred between 1969 and 1975 among the cohort of 470 workers first exposed between 1950 and 1955. All cancer cases occurred among the approximately 350 workers who were first exposed to acrylonitrile during the start-up of the plant between 1950 and 1952. Du Pont stresses the preliminary nature of these findings and does "not consider this study to provide definitive evidence of the carcinogenicity of acrylonitrile in man;" however, Du Pont did state that these findings, when considered in light of the recent animal tests, "raise a serious suspicion that it [acrylonitrile] may be a human carcinogen."

Laboratory Animal Studies

In April 1977, the Manufacturing Chemists Association reported interim results of two-year feeding and inhalation studies of acrylonitrile in laboratory rats. The following results were reported at the end of the first year of investigation by The Dow Chemical Company.

In the ingestion study, acrylonitrile is being incorporated into the drinking water of laboratory rats at concentrations of 0, 35, 100, or 300 ppm (corresponding to doses of approximately 0, 4, 10, or 30 mg/kg body weight/day). Rats ingesting 35 ppm acrylonitrile exhibited mild signs of toxicity (decreased water and food consumption, and decreased body weight gain), while those ingesting 100 or 300 ppm showed marked signs of toxicity. Male and female rats that ingested 100 or 300 ppm acrylonitrile for 12 months were reported to have developed stomach papillomas (1 of 20 rats at 100 ppm, and 12 of 20 at 300 ppm), central nervous system tumors (2 of 20 at 35 ppm, 6 of 20 at 100 ppm, and 3 of 20 at 300 ppm), and Zymbal gland carcinoma (2 of 20 at 100 ppm, and 2 of 20 at 300 ppm); no such tumors were seen in control animals.

In the inhalation study, male and female rats are being exposed to 0, 20, or 80 ppm acrylonitrile for six hours per day, five days per week. Following one year of exposure to 80 ppm acrylonitrile, 26 rats were killed; three of these were found to have developed central nervous system tumors comparable to those reported in the ingestion study. The investigators also reported that gross examination of other rats in this study exposed to 80 ppm acrylonitrile has revealed an increased incidence of ear canal tumors and mammary region masses. In animals exposed to 20 ppm, there was an apparent increase in subcutaneous masses of the mammary region although

no ear canal or central nervous system tumors were observed at this dose level.

Acute toxic effects of acrylonitrile have been extensively studied in a wide variety of laboratory animals. There is considerable variation in resistance to acrylonitrile exposure in different species. Guinea pigs seem to be the most resistant to the toxic effects of acrylonitrile inhalation while dogs are least resistant. Toxic effects of acrylonitrile inhalation which have been noted in animals include damage to the central nervous system, lung, liver, and kidneys (Krysiak, Medycyna Pracy, 22:601-10, 1971; Knobloch, Medycyna Pracy, 22:257-69, 1971). When administered to pregnant mice, acrylonitrile has also been found to be embryotoxic (Scheufler, Biol. Rundsch., 14:227-9, 1976).

NIOSH Action

In light of the Du Pont data, the National Institute for Occupational Safety and Health (NIOSH) has apprised major manufacturers and users of the possible health effects associated with acrylonitrile exposure. NIOSH has also suggested that these firms examine medical records of their employees in order to determine the existence of any such health effects. In addition, NIOSH is taking action to identify a suitable worker population for possible epidemiologic studies.

NIOSH is conducting an assessment of control technology in the plastics and resins industry (including acrylonitrile processes), which will identify and define technology for reducing occupational exposures. NIOSH is also developing a criteria document containing a recommended standard for occupational exposure to nitriles, including acrylonitrile.

Recommendation

The current Occupational Safety and Health Administration (OSHA) standard for occupational exposure to acrylonitrile is an 8-hour Time Weighted Average of 20 ppm. However, in light of the new human information generated by Du Pont, as well as the animal data provided by MCA, NIOSH believes it would be prudent to handle acrylonitrile in the workplace as if it were a human carcinogen. The attached interim recommended industrial hygiene practices were developed by NIOSH to help reduce occupational exposure to acrylonitrile.

John F. Finklea, M.D.
Director

Attachment

INDUSTRIAL HYGIENE PRACTICES TO REDUCE EXPOSURE TO ACRYLONITRILE

The recent finding of cancer associated with workers occupationally exposed to acrylonitrile has indicated a need to reduce worker exposure. The following are suggested good industrial hygiene practices that can help to reduce exposure to acrylonitrile.

A. Regulated Area. Regulated areas should be established during manufacture, polymerization, use, handling or storage.

1. Access. Access should be restricted to employees who have been properly informed of the potential hazard of acrylonitrile and proper control measures.

2. Engineering Controls. The most effective control of any contaminant is control at the source of generation wherever possible. Effective engineering measures may include enclosure and/or specific local exhaust ventilation with suitable collectors to prevent community air pollution.

   a. Wherever possible the operations utilizing acrylonitrile should be enclosed (with appropriate ventilation) to reduce exposures to the operators and others in the area.

   b. Due to the explosive potential of acrylonitrile, spark proof ventilation systems should be selected.

   c. Regularly scheduled examinations for leakage of acrylonitrile from the system should be performed using appropriate instrumentation, or sampling and analytical techniques.

   d. With specific respect to the polymerization operation, double mechanical pump seals have reduced leakage. Effective stripping of the acrylonitrile monomer before the polymer is dried and blended has decreased occupational exposure to the monomer.

3. Respirators. Personal respiratory protective devices should only be used as an interim measure while engineering controls are being installed, for non-routine use and during emergencies. Considering the carcinogenic potential of acrylonitrile, the appropriate personal respiratory protective measure is the use of a positive pressure supplied air respirator, or a positive pressure self-contained breathing apparatus.

4. Protective Clothing. Protective full body clothing should be provided and its use required for employees entering the regulated area. Upon exiting from the regulated area, the protective clothing should be left at the point of exit. With the last exit of the day, the protective clothing should be placed in a suitably marked and closed container for disposal or laundering. (Laundry personnel should be made aware of the potential hazard from handling contaminated clothing.)

5. Cleanliness. Employees should be required to wash all exposed areas of the body upon exiting from the regulated areas.

6. Isolation. Any operations involving acrylonitrile should be placed in an isolated area, in combination with other engineering controls, to reduce exposure to employees not directly concerned with the operations.

B. Medical Monitoring. All employees with a potential exposure to acrylonitrile should be placed under a medical monitoring program including history and periodic medical examinations.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1987 – 748-122/60513

NIOSH

Current Intelligence Bulletin

Reprints-Bulletins 1thru18 (1975-1977)

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health