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Project Summary

Health Assessment Document for Acrylonitrile: Final Report

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The Office of Health and Environmental Assessment of the USEPA's Office of Research and Development has prepared this health assessment document to serve as a source document for Agency-wide use. The document was originally developed at the request of the Office of Air Quality Planning and Standards; however, the scope of the assessment has since been expanded to address multimedia aspects. This assessment will help ensure consistency in the Agency's consideration of the relevant scientific health data associated with acrylonitrile.

In the development of the assessment document, the scientific literature was inventoried, key studies evaluated and conclusions presented to qualitatively identify the chemical's toxicity and related characteristics. Observed effect levels and other measures of dose-response relationships are discussed, where appropriate, so that the nature of the adverse health responses are placed in perspective with observed environmental levels.

The full document represents an up-to-date data base and considers all sources of acrylonitrile in the environment, a characterization of ambient exposure to humans, and the possible effect on man and lower organisms resulting from exposure. The information in the document is integrated into a format which serves as a basis for performing risk assessments. When appropriate, the authors of the document have attempted to identify gaps in current knowledge that limit risk evaluation capabilities.

This Project Summary was developed by EPA's Office of Health and Environmental Assessment, Washington, DC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

EPA's Office of Research and Development has prepared this health assessment to serve as a "source document" for Agency use. This health assessment was originally developed for use by the Office of Air Quality Planning and Standards to support decision-making regarding possible regulations of acrylonitrile under Section 112 of the Clean Air Act. However, based on the expressed interest of other agency offices, the scope of this document was expanded to address acrylonitrile in relation to sectors of the environment outside of air.

Acrylonitrile monomer production capacity in the United States is approximately 1,128,000 million grams. Of the 862,000 million grams of acrylonitrile produced in 1980, approximately 77% (664,000 Mg) will be used domestically; the remainder is exported. Acrylonitrile is used primarily as a raw material in the synthesis of acrylic and modacrylic fibers, acrylonitrile-butadiente-styrene (ABS) and styrene-acrylonitrile (SAN) resins, adiponitrile, acrylamide, and barrier resins. A small percentage of the acrylonitrile produced is used as a chemical intermediate.

The major sources of acrylonitrile emissions are monomer and polymer production facilities; other sources are transport and end-product usage. Of the estimated total of 3,856 Mg emission per year, monomer ABS-SAN resin and acrylic fiber production facilities emit 802 Mg, 1,424 Mg, and 1,276 Mg, respectively, of acrylonitrile in the atmosphere per year. The atmospheric half-life of acrylonitrile has been estimated to be between 9 and 10 hours, which is long enough to allow transport of acrylonitrile from emission sources to nearby populations.

In general, acrylonitrile levels around user plants may be greater than around producing plants. Acrylonitrile was detected in the air at distances up to 5 km from a user facility; however, the concentrations of acrylonitrile were dependent on meteorological conditions and the production stage within the plant at the time of sampling. No acrylonitrile was detected in the soil near these plants. Variable low levels of acrylonitrile were generally detected in the water downstream from the plants, except for high levels of 35 to 4,300 $\mu g/l$ detected in some samples near wastewater discharge points. Acrylonitrile has also been detected in drinking water, although the levels were not quantified.

Few studies are available that investigate the transport of acrylonitrile in water other than the river water. The partial vapor pressure of acrylonitrile in its water azeotrope is 80 mm Hg at 20°C, significant enough to cause evaporation of acrylonitrile from water.

There are insufficient data with which to determine the human intake of acrylonitrile through food and drinking water. The effects of acrylonitrile on wildlife, insects, and plants were also investigated, and are described fully in the final report.

Chemical and Physical Properties

Acrylonitrile is a clear, colorless, and highly flammable liquid that has an unpleasant and irritating odor. The boiling point of acrylonitrile is 77.3°C; the melting point is -83.55°C, and the density of the liquid at 20°C is 0.8060. Acrylonitrile is soluble in water between 7.2 and 9.1 weight % at temperatures of 0°C and 60°C, respectively. The open-cup flash point of acrylonitrile is 0°C, and the explosive limits are between 3.0 and 17% by volume in air at 25°C. Synonyms for acrylonitrile include 2-propenenitrile, cyanoethylene, and vinyl cyanide. Acrylonitrile has a molecular weight of 53.06 and a molecular formula of C_3H_3N.

Human and Animal Studies

Acrylonitrile intoxication in humans results in irritation of the eyes and nose, weakness, labored breathing, dizziness, impaired judgment, cyanosis, nausea, and convulsions. Acrylonitrile also causes severe burns to the skin. In animals, effects of intoxication include respiratory changes, cyanosis, convulsions, and death. There is some evidence that acrylonitrile produces abnormal function of both the peripheral and central nervous systems of rats and that acrylonitrile causes damage to the adrenals.

Carcinogenicity Studies

The carcinogenicity of acrylonitrile has been studied in seven cancer bioassays in rats: four in drinking water, one by gastric intubation, and two by inhalation. In addition, 10 epidemiologic studies of cancer incidence have been reported.

There is evidence that acrylonitrile is a human carcinogen. This conclusion is based on (1) findings of three positive drinking water rat bioassays and one positive rat gastric intubation study; (2) statistically significant positive findings of respiratory cancer in four epidemiologic studies; (3) the positive mutagenic evidence in bacteria and sister chromatid exchange tests; (4) *in vitro* evidence of interaction of acrylonitrile and/or its metabolites with DNA; and (5) acrylonitrile's structural similarity to vinyl chloride, a known animal and human carcinogen.

This level of animal evidence would be regarded as "sufficient" evidence of carcinogenicity according to the International Agency for Research on Cancer (IARC) classification scheme. The human evidence for the carcinogenicity of acrylonitrile would be regarded as somewhere between "sufficient" and "limited," using the IARC classification. Therefore, in combining the human and animal evidence, acrylonitrile would be placed in group 2A, which IARC characterizes as "probably carcinogenic in humans, where the evidence for human carcinogenicity is almost sufficient."

Unit Risk Estimates

To provide a rough estimate of the potency of acrylonitrile relative to other chemicals and a crude indication of population risks associated with known exposure in air, drinking water, unit risk estimates were calculated and are fully described in the final report.

Recommendations

The present data base from human and toxicologic studies provides enough evidence such that the IARC has characterized acrylonitrile as an animal carcinogen and a likely human carcinogen. Unlike the animal bioassay data, the human data base does not unequivocally demonstrate a causal association. In addition to the human data, there are also limitations in the available animal bioassay data within the areas of reproduction and genotoxicity, which have an important bearing on both the qualitative and quantitative aspects of carcinogenicity.

The highest priority with respect to future recommendations for research should be placed on well-designed epidemiology studies (i.e., case referent or more vigorously designed historic and prospective studies that will adequately sort out and control the effects of smoking). Careful workplace exposure monitoring should be routinely conducted on members of the study population in order to adequately determine acrylonitrile dosage. More detailed recommendations are presented in the final report.