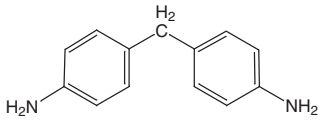
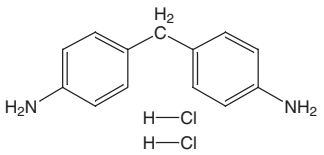
4,4´-Methylenedianiline and Its Dihydrochloride Salt CAS Nos. 101-77-9 and 13552-44-8

Reasonably anticipated to be a human carcinogen
First Listed in the *Fourth Annual Report on Carcinogens* (1985)



4,4'-Methylenedianiline



4,4'-Methylenedianiline dihydrochloride

Carcinogenicity

4,4′-Methylenedianiline and its dihydrochloride salt are *reasonably anticipated to be human carcinogens* based on sufficient evidence of carcinogenicity in experimental animals (NTP 1983, IARC 1986, 1987). When administered in the drinking water, 4,4′-methylenedianiline dihydrochloride increased the incidences of thyroid follicular cell carcinomas and neoplastic nodules of the liver in male rats; follicular cell and C-cell adenomas of the thyroid gland in female rats; thyroid follicular cell adenomas and hepatocellular carcinomas in mice of both sexes and adrenal pheochromocytomas in male mice; and hepatocellular adenomas and malignant lymphomas in female mice (NTP 1983). In a study in rats in which 4,4′-methylenedianiline was administered orally in conjunction with a known carcinogen, the incidence of thyroid tumors was greater than that produced by the carcinogen alone (IARC 1986).

No data were available to evaluate the carcinogenicity of 4,4′-methylenedianiline and its dihydrochloride in humans (IARC 1986, 1987).

Properties

4,4′-Methylenedianiline is a colorless to pale yellow or light brown crystalline solid with a faint amine-like odor. It is slightly soluble in water and very soluble in acetone, ethanol, benzene, and diethyl ether. It is stable for approximately six months when protected from heat, light, and oxygen. When exposed to oxygen and light, polymeric amines are formed (IARC 1986). When heated to decomposition, it emits toxic fumes of aniline and nitrogen oxides. The dihydrochloride is soluble in water (ATSDR 1998, HSDB 2001).

Use

More than 90% of the produced 4,4′-methylenedianiline in the United States is used as a chemical intermediate in the closed-system production of 4,4′-methylenedianiline diisocyanate and polyisocyanates. These are used to produce a variety of polymers and resins such as polyurethane foam, elastomers (e.g., Spandex fibers), and isocyanate resins. It is also used as a cross-linking agent for epoxy resins, in the determination of tungsten and sulfates, as an analytical reagent, as a corrosion inhibitor, as an antioxidant and curative agent in rubber and to prepare azo dyes (IARC 1986, ATSDR 1998). No data were available on the use of the dihydrochloride other than its use as a research chemical (IARC 1986, HSDB 2001).

Production

4,4′-Methylenedianiline has been produced commercially in the United States since the early 1920s (IARC 1986). It is available in bulk quantities containing approximately 96% 4,4′-methylenedianiline, 3% other isomeric amines, and traces of aniline. No recent data on production or production capacity were found; however, nine U.S. companies produced over 30 million lb of 4,4′-methylenedianiline in 1977, and two companies imported 110,000 lb of the chemical into the United States (TSCA 1979). Between 200 and 400 million lb/yr were produced in the early 1980s by six to seven manufacturers (ATSDR 1998). In 1987, approximately 600 million lb were produced and used captively as a chemical intermediate, 4.5 million lb were produced domestically for sale, and an additional 1 million lb were imported (OSHA 1987). Ten current U.S. suppliers were listed for 4,4′-methylenedianiline, but no suppliers were listed for the hydrochloride salt (Chem Sources 2001).

The available data indicate that both U.S. exports and imports declined in the early 1990s. U.S. exports were 28.9, 29.8, 12.8, 15.7, and 9.9 million lb in 1989, 1990, 1991, 1992, and 1993, respectively. During this same period, imports were 3.3, 2.9, 2.4, 2.0, and 1.1 million lb, respectively (ATSDR 1998).

Exposure

The primary routes of potential occupational exposure to 4,4′-methylenedianiline are inhalation and dermal contact. Potential exposure occurs during production, packaging, and reprocessing of the chemical and during its use in epoxy resins. The National Occupational Hazard Survey, conducted by NIOSH from 1972 to 1974, estimated that 9,163 workers were potentially exposed to 4,4′-methylenedianiline in the workplace (NIOSH 1976). The National Occupational Exposure Survey (1981-1983) estimated that more than 15,000 workers in various industries were potentially exposed to the compound in the workplace (ATSDR 1998). The Methylenedianiline Mediated Rulemaking Advisory Committee convened by OSHA (1987) published an industry and exposure profile. The industry sectors were divided into three categories: production for 4,4′-methylenedianiline diisocyanate synthesis or sale, reprocessing, and use in epoxies. In the production sector, the committee estimated a reasonable worst-case scenario in which 525 workers were potentially exposed to 1 to 41 ppb of this chemical. In the reprocessing sector, the Committee estimated 756 workers were potentially exposed to 1 to 20 ppb with a maximum of 250 ppb. At least 3,500 workers were exposed in the epoxy use sector with average exposures varying from 0.1 to 20 ppb. In addition, an estimated 252 maintenance workers were exposed at levels up to 250 ppb.

The primary route of potential exposure to 4,4′-methylenedianiline dihydrochloride is dermal contact. This potential exposure could occur during its production or during the use of the chemical by laboratory personnel. Data on the number of people potentially exposed were not available.

Although some consumer products contain 4,4′-methylenedianiline (e.g., polyurethane foam, Spandex, and epoxy-containing products), very little of the chemical is present in its free state in these products. Consumer exposure may occur through dermal contact with trace amounts of the chemical present in these products. Levels in food and food packaging are so low that exposure is unlikely. Polyurethane is used in medical devices such as potting material for components of plasma separators and artificial dialyzers; exposure may occur from the release of 4,4′-methylenedianiline during sterilization, and therefore, patients receiving frequent blood transfusions or kidney dialysis may be exposed (ATSDR 1998).

4,4′-Methylenedianiline may be released to the environment during industrial production and use; however, very few data were available regarding concentrations in ambient air, surface water, industrial effluents, soil, or foods (IARC 1986, ATSDR 1998). According to EPA's Toxics Chemical Release Inventory (TRI), environmental releases from industry declined dramatically between 1988 (735,792 lb) and 1991 (53,632 lb). After 1991, environmental releases fluctuated between 29,436 lb (1992) and 78,223 (1999). Seventeen facilities reported releasing 4,4′-methylenedianiline in 1999; however, approximately 80% of the total releases were reported by two facilities (TRI99 2001).

Regulations

EPA

Clean Air Act

NESHAP: 4,4´-Methylenedianiline listed as a Hazardous Air Pollutant (HAP)

NSPS: Manufacture of 4,4´-Methylenedianiline is subject to certain provisions for the control of Volatile Organic Compound (VOC) emissions

Comprehensive Environmental Response, Compensation, and Liability Act

Reportable Quantity (RQ) = 10 lb (4,4´-Methylenedianiline only)

Emergency Planning and Community Right-To-Know Act

Toxics Release Inventory: Listed substance subject to reporting requirements (4,4´-Methylenedianiline)

OSHA

Permissible Exposure Limit (PEL) = 0.010 ppm

Short-Term Exposure Limit = 0.100 ppm

"Comprehensive Standards" for occupational exposure to 4,4´-Methylenedianiline and the salts of 4,4´-Methylenedianiline have been developed

Guidelines

ACGIH

Threshold Limit Value - Time-Weighted Average Limit (TLV-TWA) = 0.1 ppm (4,4´-Methylenedianiline)

NIOSH

Listed as a potential occupational carcinogen

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