

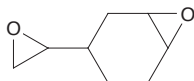
## 4-Vinyl-1-cyclohexene Diepoxide

### CAS No. 106-87-6

Reasonably anticipated to be a human carcinogen

First listed in the *Seventh Annual Report on Carcinogens* (1994)

Also known as 4-vinylcyclohexene diepoxide, 4-vinylcyclohexene dioxide, or 1-epoxyethyl-3,4-epoxycyclohexane



### Carcinogenicity

4-Vinyl-1-cyclohexene diepoxide is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in experimental animals.

#### Cancer Studies in Experimental Animals

Dermal exposure to 4-vinyl-1-cyclohexene diepoxide caused tumors in two rodent species and at two different tissue sites. It caused skin cancer (squamous-cell carcinoma) in rats and mice of both sexes and increased the combined incidence of benign and malignant basal-cell skin tumors (adenoma and carcinoma) in rats of both sexes; the predominant skin tumor observed in rats was squamous-cell carcinoma. In female mice, 4-vinyl-1-cyclohexene diepoxide also caused ovarian tumors, which are uncommon in rodents; it increased the combined incidence of benign and malignant granulosa-cell tumors, luteoma, and benign mixed ovarian tumors, and a few of the malignant tumors metastasized to the lung (IARC 1976, 1994, NTP 1989).

#### Cancer Studies in Humans

No epidemiological studies were identified that evaluated the relationship between human cancer and exposure specifically to 4-vinyl-1-cyclohexene diepoxide.

### Properties

4-Vinyl-1-cyclohexene diepoxide is a colorless liquid at room temperature (NTP 1989). It is soluble in water; however, it slowly hydrolyzes in aqueous solutions (Akron 2009). Physical and chemical properties of 4-vinyl-1-cyclohexene diepoxide are listed in the following table.

Property	Information
Molecular weight	140.2 <sup>a</sup>
Specific gravity	1.0986 at 20°C/20°C <sup>a</sup>
Melting point	< -55°C <sup>a</sup>
Boiling point	227°C at 760 mm Hg <sup>a</sup>
Log $K_{ow}$	0.44 <sup>b</sup>
Water solubility	35.2 g/L at 25°C <sup>b</sup>
Vapor pressure	1.17 mm Hg at 25°C <sup>b</sup>

Sources: <sup>a</sup>HSDB 2009, <sup>b</sup>ChemIDplus 2009.

### Use

4-Vinyl-1-cyclohexene diepoxide is used as a reactive diluent for other diepoxides and for certain epoxy resins derived from bisphenol A and epichlorohydrin (NTP 1989). The epoxy resins are used for embedding samples for electron microscopy (IARC 1994). 4-Vinyl-1-cyclohexene is also used as a chemical intermediate in condensation reactions with dicarboxylic acids, as a monomer for preparation of polyglycols containing epoxy groups, and for homopolymerization to a three-dimensional resin.

### Production

In 1989, one company was identified as the major U.S. manufacturer of 4-vinyl-1-cyclohexene diepoxide (NTP 1989). In 2009, no commercial producers of 4-vinyl-1-cyclohexene were identified worldwide, but it was available from twelve suppliers, including eight U.S. suppliers (ChemSources 2009). Reports filed under the U.S. Environmental Protection Agency's Toxic Substances Control Act Inventory Update Rule in 1986 and 1990 indicated that U.S. production plus imports of 4-vinyl-1-cyclohexene diepoxide totaled 10,000 to 500,000 lb (EPA 2004); no inventory update reports have been filed for 4-vinyl-1-cyclohexene diepoxide since 1990.

### Exposure

The primary route of potential human exposure to 4-vinyl-1-cyclohexene diepoxide is by inhalation or dermal contact. Workers may be exposed during the manufacture and use of 4-vinyl-1-cyclohexene diepoxide or epoxy-based polyglycols and resins prepared with this chemical (IARC 1994). Laboratory workers may be exposed during preparation of epoxy resin tissue-embedding agents for electron microscopy. The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 6,224 workers, including 1,718 women, potentially were exposed to 4-vinyl-1-cyclohexene diepoxide (NIOSH 1990).

### Regulations

No regulations specific to reduction of exposure to 4-vinyl-1-cyclohexene diepoxide were identified.

### Guidelines

#### American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 0.1 ppm.

#### National Institute for Occupational Safety and Health (NIOSH)

Recommended exposure limit (REL) = 10 ppm (60 mg/m<sup>3</sup>).

Potential for dermal absorption.

Listed as a potential occupational carcinogen.

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