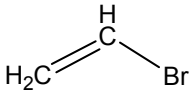
VINYL BROMIDE
CAS No. 593-60-2
First Listed in the *Tenth Report on Carcinogens*



CARCINOGENICITY

Vinyl bromide (VB) is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in experimental animals, which indicates there is an increased incidence of malignant and/or a combination of malignant and benign tumors at multiple tissue sites in experimental animals. Both male and female rats exposed to VB by inhalation showed increased incidences of hepatic hemangiosarcoma, Zymbal gland carcinoma, liver neoplastic nodules, and hepatocellular carcinoma (Benya *et al*. 1982, IARC 1986).

The tumor responses of laboratory animals to VB are similar to their responses to vinyl chloride, a known human carcinogen (IARC 1987), and to vinyl fluoride, a probable human carcinogen (IARC 1995). A unique feature of vinyl chloride carcinogenicity is that vinyl chloride induces rare hepatic hemangiosarcomas in experimental animals and is causally associated with excess risk of liver hemangiosarcoma in epidemiological studies of exposed workers. VB appears to be a more potent inducer of liver hemangiosarcoma in rats than is vinyl chloride. The fact that VB, vinyl chloride, and vinyl fluoride all induce rare hemangiosarcomas of the liver in experimental animals and induce the formation of similar DNA adducts suggests a possible common mechanism of carcinogenicity for all three of these chemicals.

No adequate human studies of the relationship between exposure to VB and human cancer were found.

OTHER INFORMATION RELATING TO CARCINOGENESIS OR POSSIBLE MECHANISMS OF CARCINOGENESIS

VB is genotoxic in *Salmonella typhimurium* (IARC 1986) and *Drosophila melanogaster* (Ballering *et al*. 1996) and induces DNA damage in several organs of mice (Sasaki *et al*. 1998). VB is metabolized in a manner similar to vinyl fluoride and vinyl chloride: oxidation via cytochrome P450 to bromoethylene oxide, followed by rearrangement to 2-bromoacetaldehyde, which is oxidized to bromoacetic acid. VB metabolizes more slowly than does vinyl chloride (K_m for VB metabolism is approximately an order of magnitude lower) (Bolt *et al*. 1978). The greater potential of VB to induce liver hemangiosarcomas in rats.

VB metabolites bind covalently to DNA and to protein; 2-bromoethylene oxide is the major DNA binding agent, and 2-bromoacetaldehyde is the major protein alkylating agent (Guengerich *et al*. 1981). After exposure to vinyl chloride, the major DNA adduct

formed is 7-(2-oxoethyl)guanine (constituting approximately 98% of all adducts) (Bolt 1988). By analogy, the 7-position of guanine is considered to be the preferred site of DNA alkylation by bromoethylene oxide, the primary metabolite of VB (Bolt 1988). Chloroacetaldehyde and bromoacetaldehyde can react with adenine or cytosine bases in DNA or RNA to produce cyclic etheno-DNA/RNA adducts (1,N^6-ethenoadenosine and 3,N^4-ethenocytosine). Etheno-DNA adducts can cause DNA miscoding by modifying base-pairing sites. Because the cyclic etheno adducts have a longer half-life than does 7-(2-oxoethyl)guanine, they have a greater potential to accumulate with long-term exposure (Swenberg *et al*. 1992).

No available data suggest that mechanisms by which VB induces tumors in experimental animals would not also operate in humans.

PROPERTIES

VB is a colorless, highly flammable gas with a characteristic pungent odor. It is insoluble in water and soluble in chloroform, 10% ethanol, 10% ethyl ether, 10% acetone, and 10% benzene. It reacts with strong oxidizing agents, copper, copper alloys, and plastics (IARC 1986).

USE

VB is used primarily in the production of polymers and copolymers. It is used in polymers as a flame retardant and in the production of monoacrylic fibers for carpet-backing material. Combined with acrylonitrile as a co-monomer, it is used to produce fabrics and fabric blends used in sleepwear (mostly children's) and home furnishings. When copolymerized with vinyl acetate and maleic anhydride, VB is used to produce granular products. Copolymers of vinyl chloride and VB are used to prepare films, for impregnating or laminating fibers, and as rubber substitutes. VB also is used in leather and fabricated metal products. Polyvinyl bromide, made from VB, is a polymer of little commercial value because it is unstable at room temperature. VB also is used in the production of pharmaceuticals and fumigants (IARC 1986).

PRODUCTION

VB was first produced in the United States in 1968. In 1982, U.S. production was estimated to be approximately 51 million lbs. VB was not listed as a high production volume chemical in 1994, indicating that annual production was less than 1 million lb (EPA 1994). The Hazardous Substances Data Bank identified one U.S. manufacturer (HSDB 2001).

EXPOSURE

Exposure to VB in the environment will occur primarily by inhalation and dermal contact. VB is not known to occur naturally in the environment. It is assumed that most, if not all, VB environmental exposure occurs as a result of industrial contamination (IARC 1986).

In 1999, only one facility reported environmental releases of VB, consisting of 500 lb released into the air. No environmental releases were reported to the EPA's Toxic Release Inventory in 1998; however, environmental releases ranged from approximately 1,600 to almost 55,000 lb between 1988 and 1997 (TRI99 2001).

The National Institute for Occupational Safety and Health (NIOSH) has identified the following industries in which VB exposure occurs: chemicals and allied production, rubber and plastic production, leather and leather product production, and fabricated metal production for wholesale trade (NIOSH 1978). The NIOSH National Occupational Exposure Survey estimated that 1,821 workers potentially were exposed to VB between 1981 and 1983 (NIOSH 1990).

VB occupational exposures (median 8-hour time-weighted average) calculated for a VB manufacturing plant ranged from 0.4 to 27.5 mg/m^3 (0.1 to 6.3 ppm), depending on the job and the area surveyed. Personal air samples (one hour) showed that a plant operator was exposed to 0.4 to 1.7 mg/m^3 (0.09 to 0.4 ppm), a laboratory technician to 1.3 to 2.2 mg/m^3 (0.3 to 0.5 ppm), and two loading crewmen to 5.2 to 27.5 mg/m^3 (1.2 to 6.3 ppm) VB (IARC 1986).

REGULATIONS

EPA regulates VB under the Emergency Planning and Community Right-to-Know Act, with an effective date of January 1, 1987.

NIOSH recommends that vinyl bromide be considered a potential occupational carcinogen and that exposure be limited to the lowest feasible concentration.

OSHA regulates the vinyl bromide under the Hazard Communication Standard and as a chemical hazard in laboratories. Regulations are summarized in Volume II, Table 185.

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