Nitromethane

CAS No. 75-52-5

Reasonably anticipated to be a human carcinogen

First listed in the *Eleventh Report on Carcinogens* (2004)

$O_2N—CH_3$

Carcinogenicity

Nitromethane is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals

Exposure to nitromethane by inhalation caused tumors in two rodent species and at several different tissue sites. Nitromethane caused benign and malignant mammary-gland tumors (fibroadenoma and carcinoma) in female rats. In mice, it increased the combined incidences of benign and malignant tumors of the Harderian gland (adenoma and carcinoma) and lung (alveolar/bronchiolar adenoma and carcinoma) in both sexes and liver tumors (hepatocellular adenoma and carcinoma) in females (NTP 1997).

Cancer Studies in Humans

No epidemiological studies were identified that evaluated the relationship between human cancer and exposure specifically to nitromethane.

Studies on Mechanisms of Carcinogenesis

The mechanism by which nitromethane causes cancer is not known. Nitromethane did not cause mutations in bacteria and does not appear to cause genetic damage in mammalian test systems. In cultured mammalian cells, nitromethane did not cause chromosomal aberrations, sister chromatid exchange, or micronucleus formation. Inhalation exposure of mice to nitromethane did not cause micronucleus formation in the erythrocytes, in either bone marrow or peripheral blood (IARC 2000). In cultured Syrian hamster embryo cells, nitromethane induced cell transformation (a step in tumor formation) (Kerckaert *et al.* 1996, NTP 2002). Nitromethane appears to be absorbed by inhalation; the available data suggest that dermal absorption is negligible. Metabolism of nitromethane by experimental animals *in vivo* has not been characterized. Metabolism of nitromethane by rat liver microsomes resulted in formation of only trace amounts of formaldehyde (IARC 2000).

Properties

Nitromethane is a nitroalkane compound that is a colorless oily liquid with a fruity odor at room temperature. It is soluble in water, alcohol, ether, acetone, and dimethylformamide. Nitromethane is sensitive to shock and is unstable when heated. It also forms an explosive sodium salt that bursts into flame on contact with water (Akron, 2009). Physical and chemical properties of nitromethane are listed in the table in the next column (HSDB 2009).

Property	Information
Molecular weight	61.0
Specific gravity	1.1322 at 25°C/4°C
Melting point	–29°C
Boiling point	101.2°C
Log K_{ow}	0.17
Water solubility	111 g/L
Vapor pressure	27.8 mm Hg at 20°C
Vapor density relative to air	2.11
Dissociation constant (pK_a)	10.2 at 25°C

Source: HSDB 2009.

Use

Most of the nitromethane produced in the United States (85% to 90%) is used in the synthesis of nitromethane derivatives used as pharmaceuticals, agricultural soil fumigants, and industrial antimicrobials (Markofsky 1991, Angus 2001). Nitromethane also is used as a fuel or fuel additive with methanol in racing cars, boats, and model engines. It formerly was used in the explosives industry as a component in a binary explosive formulation with ammonium nitrate and in shaped charges, and it was used as a chemical stabilizer to prevent decomposition of various halogenated hydrocarbons (NTP 1997, IARC 2000, Angus 2001).

Production

Nitromethane is produced commercially by high-temperature vapor-phase nitration of propane, a reaction that also yields nitroethane, 1-nitropropane, and 2-nitropropane. In 2001, annual U.S. production was reported to be about 16 million pounds from one producer (Angus 2001). In 2009, nitromethane was available from 16 U.S. suppliers (ChemSources 2009).

Exposure

Nitromethane has been detected in air, surface water, and drinking water (NTP 1997, IARC 2000). The general population may be exposed by inhalation of nitromethane in motor vehicle exhaust and cigarette smoke. In a simulated city driving study, estimated concentrations of nitromethane in motor vehicle exhaust ranged from less than 0.8 to 5.0 ppm, depending on the conditions (Angus 2001). Nitromethane may also be released into air and wastewater during manufacture of royal demolition explosive (RDX) and high melting explosive (HMX), which are widely used in the military. Maximum ground-level concentrations of nitromethane in air at three locations on the boundary of an ammunition plant were 0.21, 2.0, and 2.0 μg/m^3 (HSDB 2009, IARC 2000). Nitromethane was identified, but not quantified, as a pollutant in drinking water in two of five cities (Philadelphia, Pennsylvania, and Cincinnati, Ohio) tested in a 1975 U.S. Environmental Protection Agency survey (HSDB 2009). People may also be exposed to nitromethane through skin contact with or accidental ingestion of methanol-nitromethane fuel mixtures. However, products containing nitromethane are not widely used by consumers (IARC 2000).

Occupational exposure to nitromethane may occur through inhalation of vapors or skin contact during its production, use, or disposal. The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 134,803 workers, including 46,338 women, potentially were exposed to nitromethane (NIOSH 1990). In addition, workers may have been exposed to nitromethane in the past through exposure to other chemicals (such as 1,1,1-trichloroethane) containing nitromethane as an additive or contaminant (Henschler *et al.* 1980).

Regulations

Department of Transportation (DOT)

Nitromethane is considered a hazardous material, and special requirements have been set for marking, labeling, and transporting this material.

Environmental Protection Agency (EPA)

Clean Air Act

New Source Performance Standards: Manufacture of nitromethane is subject to certain provisions for the control of volatile organic compound emissions.

Emergency Planning and Community Right-To-Know Act

Toxics Release Inventory: Listed substance subject to reporting requirements.

Occupational Safety and Health Administration (OSHA, Dept. of Labor)

While this section accurately identifies OSHA's legally enforceable PELs for this substance in 2018, specific PELs may not reflect the more current studies and may not adequately protect workers.
Permissible exposure limit (PEL) = 100 ppm (250 mg/m^3).
Considered a highly hazardous chemical: Threshold quantity (TQ) = 2,500 lb.

Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 20 ppm.

National Institute for Occupational Safety and Health (NIOSH, CDC, HHS)

Immediately dangerous to life and health (IDLH) limit = 750 ppm.

References

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