Propylene oxide

75-56-9

Hazard Summary

Propylene oxide is used in the production of polyethers (the primary component of polyurethane foams) and propylene glycol. Acute (short-term) exposure of humans and animals to propylene oxide has caused eye and respiratory tract irritation. Dermal contact, even with dilute solutions, has caused skin irritation and necrosis in humans. Propylene oxide is also a mild central nervous system (CNS) depressant in humans. Inflammatory lesions of the nasal cavity, trachea, and lungs and neurological effects have been observed in animals chronically (long-term) exposed to propylene oxide by inhalation. Propylene oxide has been observed to cause tumors at or near the site of administration in rodents, causing forestomach tumors following ingestion via gavage (experimentally placing the chemical in the stomach) and nasal tumors after inhalation exposure. EPA has classified propylene oxide as a Group B2, probable human carcinogen.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) (5), which contains information on inhalation chronic toxicity of propylene oxide and the RfC and the carcinogenic effects of propylene oxide including the unit cancer risk for inhalation exposure, and EPA's Summary Review of the Health Effects Associated with Propylene Oxide. (2)

Uses

- The major use of propylene oxide is in the production of polyethers (the primary component of polyurethane foams) and propylene glycol. (2)
- Propylene oxide is also used in the fumigation of foodstuffs and plastic medical instruments and in the manufacture of dipropylene glycol and glycol ethers, as herbicides, as solvents, and in the preparation of lubricants, surfactants, and oil demulsifiers. (2,8)

Sources and Potential Exposure

- Occupational exposure by the inhalation and dermal routes related to the production, storage, transport, and use of propylene oxide may be significant. However, occupational exposures are generally believed to be less than 1 part per million (ppm). (1,2)
- Release of propylene oxide into the atmosphere is expected to primarily occur during its production or use as an intermediate or as a fumigant and a soil sterilant. Inhalation of contaminated air in these areas may provide a significant route of exposure. However, average atmospheric concentrations at a distance of more than 20 km from production facilities are estimated to be less than 10^{-10} ppm. (1,2)
- Propylene oxide has been detected in fumigated food products; consumption of contaminated food is another possible route of exposure. (1,2)

Assessing Personal Exposure

- No information was located regarding the measurement of personal exposure to propylene oxide.

Health Hazard Information

Acute Effects:

- Acute exposure of humans and animals to propylene oxide has caused eye and respiratory tract irritation. As a respiratory irritant, coughing, dyspnea (difficulty in breathing), and pulmonary edema may result from inhalation exposure and possibly lead to pneumonia. Dermal contact, even with dilute solutions, has caused skin irritation and necrosis. (1-3)
- Propylene oxide is a mild CNS depressant. Acute exposure to high concentrations may cause headache, motor weakness, incoordination, ataxia, and coma in humans. (1,3)
- Tests involving acute exposure of rats, mice, guinea pigs, and rabbits have demonstrated propylene oxide to have moderate acute toxicity from inhalation, high acute toxicity from dermal exposure, and moderate to high acute toxicity from ingestion. (4)

Chronic Effects (Noncancer):

- Health effects from chronic exposure to propylene oxide in humans have not been reported in the literature.
- A significant decrease in body weight gain, increased mortality, and an increased incidence of inflammatory lesions of the nasal cavity, trachea, and lungs have been observed in rodents chronically exposed to propylene oxide by inhalation. (5)
- Chronic inhalation exposure to propylene oxide may cause some neuropathological changes in rats and monkeys. (2,5)
- The Reference Concentration (RfC) for propylene oxide is 0.03 milligrams per cubic meter (mg/m^3) based on respiratory effects in rats. The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfC, the potential for adverse health effects increases. Lifetime exposure above the RfC does not imply that an adverse health effect would necessarily occur. (5)
- EPA has medium confidence in the study on which the RfC was based because the study used a large number of animals, examined the critical effect with sensitive techniques and at multiple durations and exposure levels, and was of chronic duration, but did not identify a no-observed-adverse-effect level (NOAEL); medium confidence in the database because there were several corroborative chronic inhalation studies and inhalation developmental studies, although the inhalation two-generation reproductive study was inadequate; and, consequently, medium confidence in the RfC.
- EPA has not established a Reference Dose (RfD) for propylene oxide. (5)

Reproductive/Developmental Effects:

- No information is available on the reproductive or developmental effects of propylene oxide in humans.
- A study with rats and rabbits exposed to propylene oxide by inhalation prior to and during gestation concluded that propylene oxide was harmful to the developing fetus but did not cause birth defects. In rats, some degree of fetotoxicity was observed in all exposed groups (including a significant reduction in the number of corpora lutea, implants, and live fetuses) and minor skeletal malformations in some; there was no maternal mortality. Increased resorptions per litter were observed in rabbits. (2,5)

Cancer Risk:

- Human carcinogenicity data for propylene oxide are inadequate. (5)
- Propylene oxide has been observed to cause tumors at or near the site of administration in rodents, causing forestomach tumors following exposure via gavage and nasal tumors after inhalation exposure. (2,5,6)
- EPA has classified propylene oxide as a Group B2, probable human carcinogen. (5)
- EPA uses mathematical models, based on human and animal studies, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of a chemical. EPA calculated an inhalation unit risk estimate of 3.7×10^{-6} $(\mu g/m^3)^{-1}$. EPA estimates that, if an individual were

to continuously breathe air containing propylene oxide at an average of 0.3 µg/m^3 (3 x 10^{-4} mg/m^3) over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing air containing this chemical. Similarly, EPA estimates that breathing air containing 3.0 µg/m^3 (0.003 mg/m^3) would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing 30.0 µg/m^3 (0.03 mg/m^3) would result in not greater than a one-in-ten thousand increased chance of developing cancer. For a detailed discussion of confidence in the potency estimates, please see IRIS. (5)

- EPA calculated an oral cancer slope factor of 0.24 $(mg/kg/d)^{-1}$. (5)

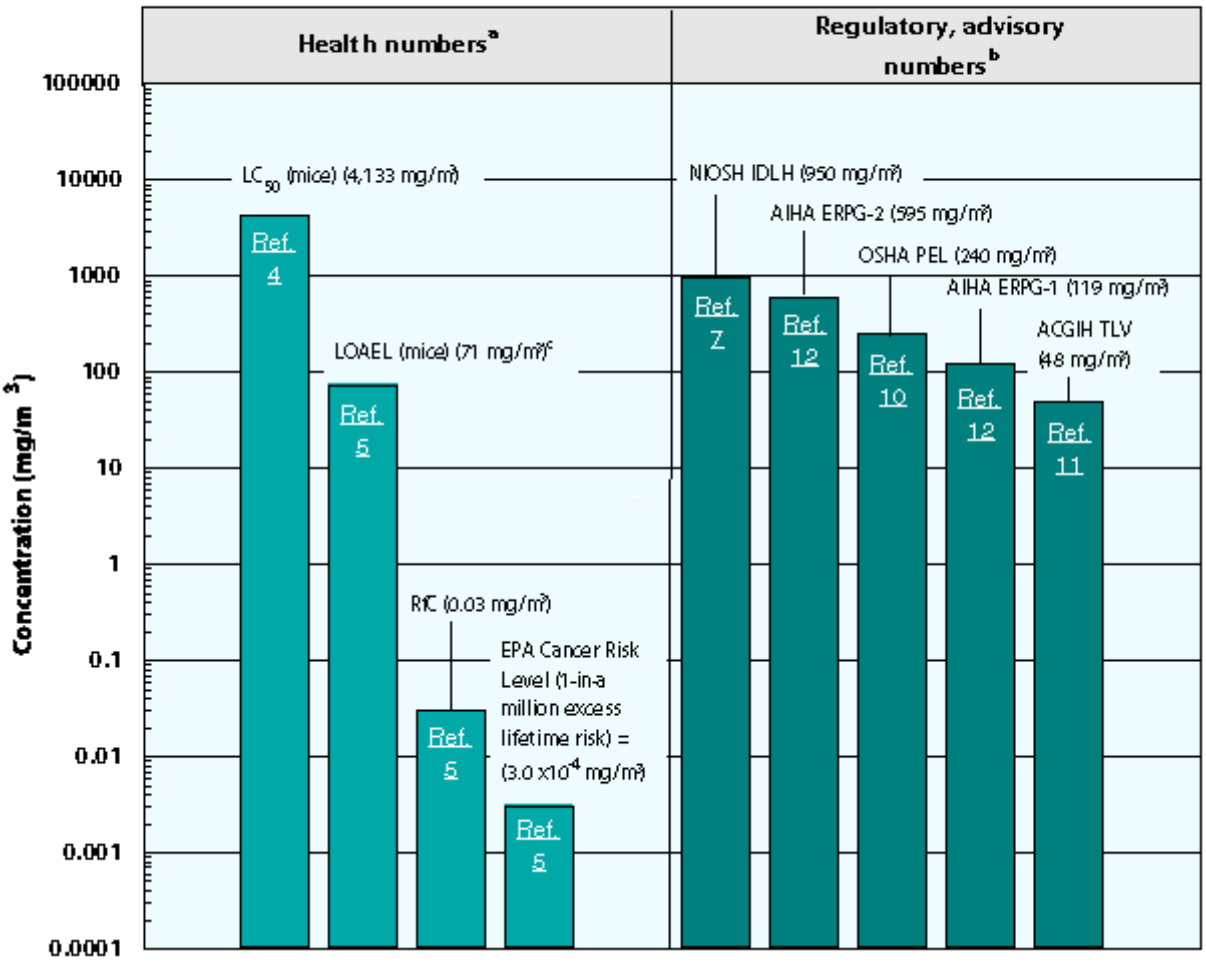
Physical Properties

- The chemical formula of propylene oxide is C_3H_6O, and it has a molecular weight of 58.08 g/mol. (8)
- Propylene oxide occurs as a colorless, ethereal liquid that is extremely flammable. It is very soluble in water. (2,8)
- The odor of propylene oxide is described as sweet, alcoholic, and ether-like with an odor threshold of 44 ppm. (3,9)
- Propylene oxide has a vapor pressure of 445 mm Hg at 20 °C and a log octanol/water partition coefficient (log K_{ow}) of -0.13. (2)

Conversion Factors:
To convert concentrations in air (at 25 °C) from ppm to mg/m^3: mg/m^3 = (ppm) × (molecular weight of the compound)/(24.45). For propylene oxide: 1 ppm = 2.4 mg/m^3. To convert concentrations in air from µg/m^3 to mg/m^3: mg/m^3 = µg/m^3 × (1 mg/1,000 µg).

Health Data from Inhalation Exposure

Propylene Oxide



ACGIH TLV --American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

AIHA ERPG --American Industrial Hygiene Association's emergency response planning guidelines. ERPG 1 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor; ERPG 2 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing or developing irreversible or other serious health effects that could impair their abilities to take protective action.

LC_{50} (Lethal Concentration $_{50}$)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

LOAEL--Lowest-observed-adverse-effect level.

NIOSH IDLH -- National Institute of Occupational Safety and Health's immediately dangerous to life or health concentration; NIOSH recommended exposure limit to ensure that a worker can escape from an exposure condition that is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from the environment.

OSHA PEL --Occupational Safety and Health Administration's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

The health and regulatory values cited in this factsheet were obtained in December 1999.

[a] Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

[b]

[b] Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH, ACGIH, and AIHA numbers are advisory.

[c] This LOAEL is from the critical study used as the basis for the EPA RfC.

References

Summary created in April 1992, updated in January 2000

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