

# Ethylene Oxide

75-21-8

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## Hazard Summary

The major use for ethylene oxide is as a chemical intermediate in industry. The acute (short-term) effects of ethylene oxide in humans consist mainly of central nervous system (CNS) depression and irritation of the eyes and mucous membranes. Chronic (long-term) exposure to ethylene oxide in humans can cause irritation of the eyes, skin, and mucous membranes, and problems in the functioning of the brain and nerves. Some human cancer data show an increase in the incidence of leukemia, stomach cancer, cancer of the pancreas, and Hodgkin's disease in workers exposed to ethylene oxide. However these data are considered to be limited and inconclusive due to uncertainties in the studies. EPA has classified ethylene oxide as a Group B1, probable human carcinogen.

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Please Note: The main source of information for this fact sheet is the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for Ethylene Oxide. (1) Other secondary sources include the Hazardous Substances Data Bank (HSDB), a database of summaries of peer-reviewed literature (2), and the Registry of Toxic Effects of Chemical Substances (RTECS), a database of toxic effects that are not peer reviewed. (3)

## Uses

- Ethylene oxide is used mainly as a chemical intermediate in the manufacture of textiles, detergents, polyurethane foam, antifreeze, solvents, medicinals, adhesives, and other products. (1)
- Relatively small amounts of ethylene oxide are used as a fumigant, a sterilant for food (spices) and cosmetics, and in hospital sterilization of surgical equipment and plastic devices that cannot be sterilized by steam. (1)

## Sources and Potential Exposure

- Sources of ethylene oxide emissions into the air include uncontrolled emissions or venting with other gases in industrial settings. (1)
- Other sources of ethylene oxide air emissions include automobile exhaust and its release from commodity-fumigated materials, as well as its use as a sterilizer of medical equipment. (1)
- The general population may be exposed to ethylene oxide through breathing contaminated air or from smoking tobacco or being in the proximity to someone who is smoking. Certain occupational groups (e.g., workers in ethylene oxide manufacture or processing plants, sterilization technicians, and workers involved in fumigation) may be exposed in the workplace. (1)

## Assessing Personal Exposure

- There are tests currently available to determine personal exposure to ethylene oxide, such as the determination of ethylene oxide in the blood or the amount breathed out of the lungs. (1)

## Health Hazard Information

Acute Effects:

- Acute inhalation exposure of workers to high levels of ethylene oxide has resulted in nausea, vomiting, neurological disorders, bronchitis, pulmonary edema, and emphysema at high concentrations. (1,2)
- Dermal or ocular contact with solutions of ethylene oxide has caused irritation of the eyes and skin in humans. (1,2)
- Tests involving acute exposure of animals has shown ethylene oxide to have high acute toxicity from oral and inhalation exposures. (3)

#### Chronic Effects (Noncancer):

- Major effects observed in workers exposed to ethylene oxide at low levels for several years are irritation of the eyes, skin, and mucous membranes and problems in the functioning of the brain and nerves. (1,2)
- There is evidence suggesting that long-term exposure to high levels of ethylene oxide, at a level of 700 parts per million (ppm), can result in cataracts in humans. (2)
- EPA has not established a Reference Dose (RfD) or a Reference Concentration (RfC) for ethylene oxide.
- The California Environmental Protection Agency (CalEPA) has established a chronic reference exposure level of 0.005 milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) for ethylene oxide based on hematological effects in humans. The CalEPA reference exposure level is a concentration at or below which adverse health effects are not likely to occur. It is not a direct estimator of risk, but rather a reference point to gauge the potential effects. At lifetime exposures increasingly greater than the reference exposure level, the potential for adverse health effects increases. (4)
- ATSDR has established an intermediate inhalation minimal risk level (MRL) of  $0.2 \text{ mg}/\text{m}^3$  (0.09 ppm) based on respiratory effects in humans. The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. (1)

#### Reproductive/Developmental Effects:

- Some evidence exists indicating that inhalation exposure to ethylene oxide can cause an increased rate of miscarriages in female workers. These effects could be seen from acute, as well as chronic, exposure. (1,2)
- Various adverse reproductive effects have been noted in inhalation exposure studies of animals including decreased number of implantation sites, decreased testicular weights and sperm concentration, and testicular degeneration. (1,2)

#### Cancer Risk:

- Human occupational studies have shown elevated cases of leukemia, stomach and pancreatic cancer, and Hodgkin's disease in workers exposed to ethylene oxide by inhalation. However, the data are considered to be limited and inconclusive due to the small number of individuals studied and uncertainties about the exposure levels. (1,2)
- Animal studies have shown lung, gland, and uterine tumors caused by inhalation exposure to ethylene oxide. (1,2)
- EPA considers ethylene oxide to be a probable human carcinogen and has ranked it in EPA's Group B1. This classification has had some form of Agency review, but does not appear on IRIS. (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 has calculated a provisional inhalation unit cancer risk estimate of  $1.0 \times 10^{-4} (\mu\text{g}/\text{m}^3)^{-1}$ . A provisional value is one that has not received Agency-wide review. (5)
- EPA has calculated a provisional oral cancer slope factor of  $1.0 (\text{mg}/\text{kg}/\text{d})^{-1}$ . (5)

## Physical Properties

- Ethylene oxide is a colorless gas with a sweet odor. (1,6)
- The chemical formula for ethylene oxide is  $\text{C}_2\text{H}_4\text{O}$  and the molecular weight is 44.1 g/mol. (6)

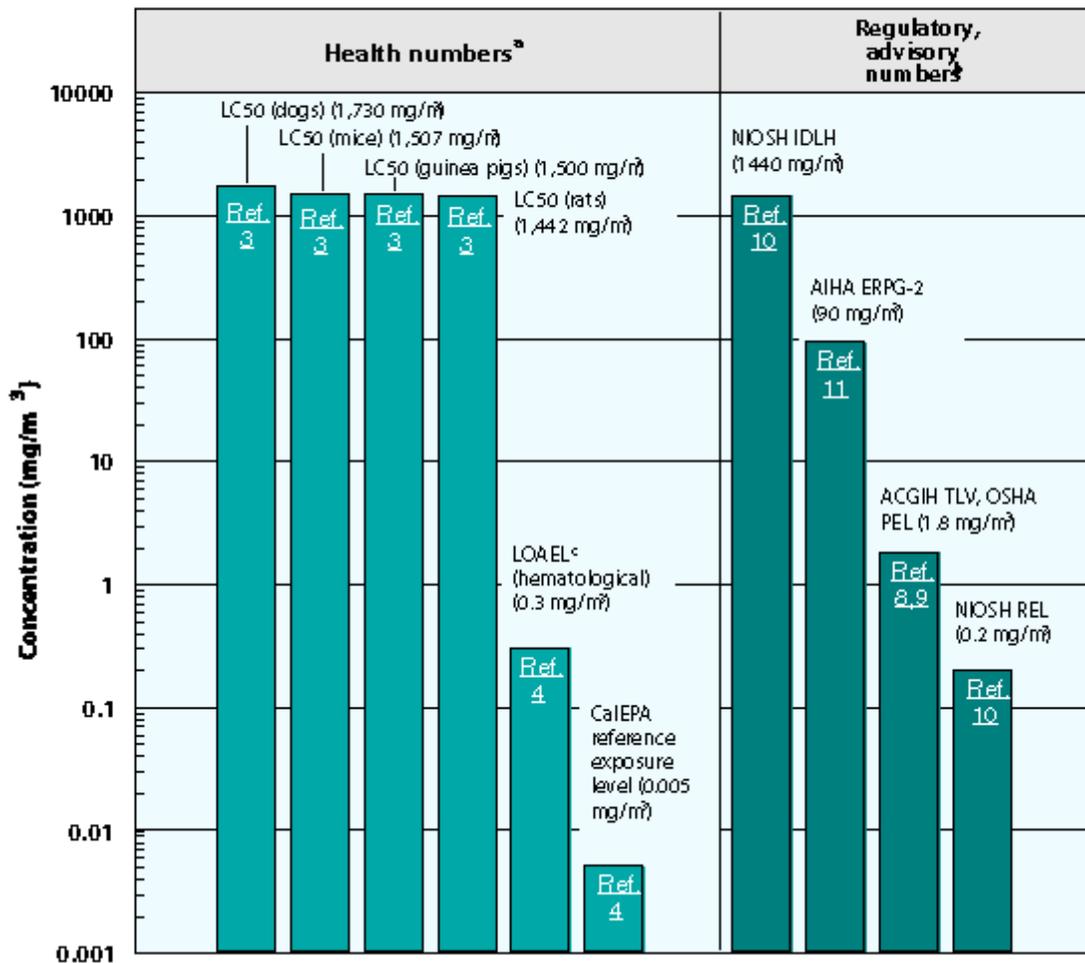
- The vapor pressure for ethylene oxide is 1,095 mm Hg at 20 °C, and it has an octanol/water partition coefficient ( $\log K_{ow}$ ) of -0.30. (6)
- Ethylene oxide is very soluble in water and is flammable. (1)
- Ethylene oxide has an odor threshold of 430 ppm. (7)
- Ethylene oxide has an estimated half-life in air ranging from 69 to 149 days, while its half-life in water is about 50 years. (1).

Conversion Factors:

To convert concentrations in air (at 25°C) from ppm to  $\text{mg}/\text{m}^3$ :  $\text{mg}/\text{m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$ . For ethylene oxide:  $1 \text{ ppm} = 1.8 \text{ mg}/\text{m}^3$ . To convert concentrations in air from  $\mu\text{g}/\text{m}^3$  to  $\text{mg}/\text{m}^3$ :  $\text{mg}/\text{m}^3 = (\mu\text{g}/\text{m}^3) \times (1 \text{ mg}/1,000 \mu\text{g})$ .

## Health Data from Inhalation Exposure

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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<sub>50</sub> (Lethal Concentration<sub>50</sub>)--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.

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.

NIOSH REL--NIOSH's recommended exposure limit; NIOSH-recommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.

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.

<sup>a</sup> Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

<sup>b</sup> 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.

<sup>c</sup> The LOAEL is from the critical study used as the basis for the CalEPA chronic reference exposure level.

Summary created in April 1992, updated January 2000

## References

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