Ethylene Oxide

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CAS number 75-21-8

Ethylene oxide is an organic compound with the formula C_2H_4O.
Ethylene oxide is a colorless gas at room temperature and a colorless liquid below 10.7°C. It is shipped as a liquefied, compressed gas. Both the gas and liquid are potential fire and explosion hazards.

Ethylene oxide is soluble in water and organic solvents.

Ethylene oxide has a sweet, ether-like odor at air concentrations above 500 ppm. Odor is not a reliable indicator of ethylene oxide's presence and does not provide adequate warning of hazardous concentrations.

The gas is heavier than air and can cause asphyxiation in enclosed, poorly ventilated, or low-lying areas (ATSDR).

Usage and exposure

Ethylene oxide is produced by catalytically reacting ethylene and oxygen. Ethylene oxide ranks 26th in volume among the major industrial chemicals produced in the United States.

About 65% of ethylene oxide is used for synthesis of ethylene glycol, an antifreeze product.

A mixture of 88% Freon and 12% ethylene oxide is used as a cold sterilizing agent for foods and medical equipment and supplies.

Ethylene oxide is also used as a fumigant and fungicide in the manufacture of medical products and spices, and as a chemical intermediate (ATSDR).

A very small proportion of (0.05%) of the annual production of ethylene oxide is used directly in the gaseous form as a sterilizing agent, fumigant and insecticide. It is used to sterilize drugs, hospital equipment, disposable and reusable medical items, packaging materials, foods, books, museum artefacts, scientific equipment, clothing, furs, railcars, aircraft, beehives and other items (IARC).

Most of the data on occupational exposure are related to the production of ethylene oxide and its use in industrial and hospital sterilization. Exposures vary with job category: workers

involved in loading and distribution of ethylene oxide have the highest exposure .Ethylene oxide is widely used in hospitals as a gaseous sterilant for heat-sensitive medical items. Exposure to ethylene oxide appears to result mainly from peak emissions during operations such as opening the door of the sterilizer and unloading and transferring sterilized material (IARC).

Routs of exposure

Respiratory tract, skin, eyes.

Most ethylene oxide exposures occur by inhalation or skin contact.

Ethylene oxide is rapidly absorbed after inhalation, and solutions of ethylene oxide can penetrate human skin.

Target organs

Eyes, skin, respiratory system, liver, central nervous system, blood, kidneys, reproductive system [CDC]

Metabolism

Ethylene oxide is readily taken up by the lungs and is absorbed relatively efficiently into the blood. 20–25% of inhaled ethylene oxide that reached the alveolar space was exhaled as the unchanged compound and 75–80% was taken up by the body and metabolized. Ethylene oxide is converted (a) by enzymatic and non-enzymatic hydrolysis to ethylene glycol, which is partly excreted as such and partly metabolized further via glycolaldehyde, glycolic acid and glyoxalic acid to oxalic acid, formic acid and carbon dioxide; and (b) by conjugation with glutathione (GSH) followed by further metabolism and which are partly conversion to thio-diacetic acid (IARC).

Health hazards

Acute effects

Ethylene oxide gas may produce immediate local irritation of the skin, eyes, and upper respiratory tract. At high concentrations, it may cause an immediate or delayed accumulation of fluid in the lungs. Inhalation of ethylene oxide can produce CNS depression, and in extreme cases, respiratory distress and coma. Exposure to high levels of the gas may cause corneal burns and cataracts (ATSDR).

Chronic effects

Prolonged skin contact with dilute solutions of ethylene oxide (e.g., from contaminated clothing) can cause irritation and dermatitis (ATSDR).

Cancerogenicity

The Working Group of IARC noted that evaluation of the possible risks for lymphatic and haematopoietic cancer was hampered by inconsistencies in the histopathological classification of diagnoses over time. The interpretation of results for these malignancies was constrained by the diagnostic groupings that had been used by researchers when the studies were conducted (IARC).

There was no consistent evidence of an association of other cancers ((stomach, brain, pancreas) with exposure to ethylene oxide (IARC).

The Working Group found some epidemiological evidence for associations between exposure to ethylene oxide and lymphatic and haematopoietic cancers, and specifically lymphoid tumors (i.e. non-Hodgkin lymphoma, multiple myeloma and chronic lymphocytic leukaemia) (IARC).

There is limited evidence in humans for a causal association of ethylene oxide with lymphatic and haematopoietic cancers (specifically lymphoid tumors, i.e. non-Hodgkin lymphoma, multiple myeloma and chronic lymphocytic leukaemia), and breast cancer. There is sufficient evidence in experimental animals for the carcinogenicity of ethylene oxide.

There is strong evidence that the carcinogenicity of ethylene oxide, a direct-acting alkylating agent, operates by a genotoxic mechanism.

There is strong evidence that the carcinogenicity of ethylene oxide, a direct-acting alkylating agent, operates by a genotoxic mechanism. Ethylene oxide consistently acts as a mutagen and clastogen at all phylogenetic levels, it induces heritable translocations in the germ cells of exposed rodents, and a dose-related increase in the frequency of sister chromatid exchange, chromosomal aberrations and micronucleus formation in the lymphocytes of exposed workers.

In making the overall evaluation, the Working Group considered that ethylene oxide is carcinogenic to humans (Group 1) (IARC).

References

1. ATSDR . Toxicological Profile for Ethylene Oxide. <https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=734&tid=133>. Accessed 08/12/2018.
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3. IARC Monographs. Vol. 100F. Chemical Agents and Related Occupations. 2012 pp:379-400