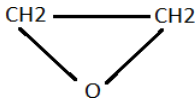


Sterilization by ethylene oxide

- **characteristic:**

ETO organic gas having the chemical formula C_2H_4O and extended formula



colorless with a boiling point of 10.8 °C at atmospheric pressure dissolve at alcohol and ether explosive in pure form and flammable when is content with outer air so it's using as mixture of ETO and carbon dioxide or with Fluoro-carbon compound (Barwell and Freeman ,1959) , ETO Available as gaseous form or liquid form under mild pressure and it has a strong activity as highly sterilant which has been confirmed after publication achieved by (Phillips and Kaye ,1949).

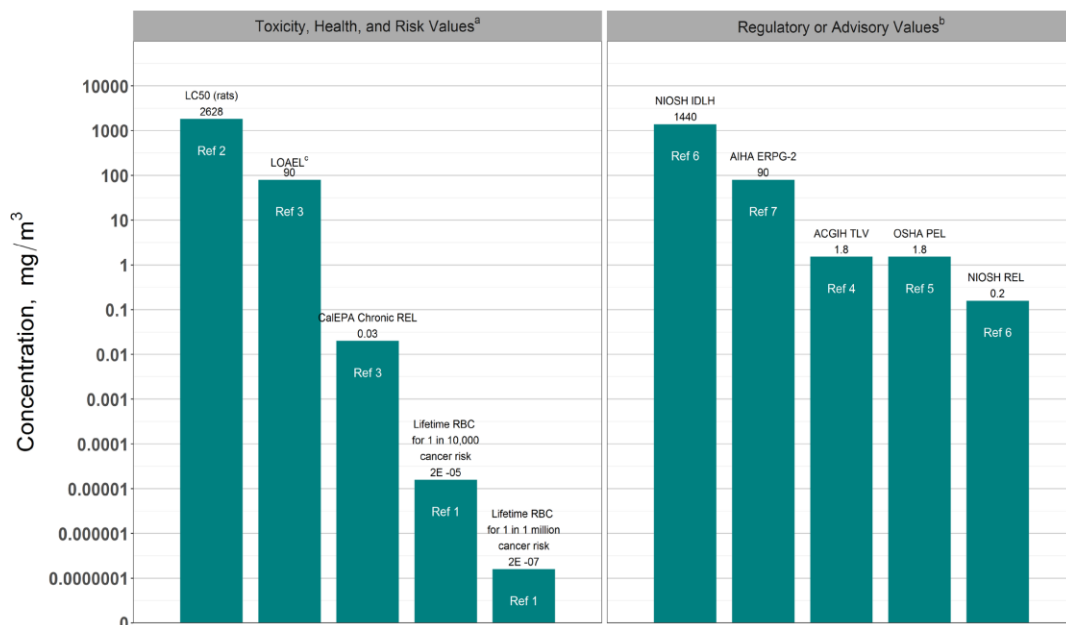
- **ETO Uses:**

Utilizes at manufacture of ethylene glycol (anti freezing) and manufacture of adhesives, solvent, polyurethane foam, detergents and another product. ETO use widely in hospital to sterilization of surgical equipment and sterilization process industry for the sterile-disposable (single-use) medical devices industry that are high heat or moisture sensitive like (plastic disposable syringe-medical suture-prostheses).

- **Hazard of ETO:**

Ethylene oxide is dangerous chemical material because of it's a flammable, explosive and toxic to avoid the explosion must maintain lower EO concentrations at sterilization chamber and the perfect concentrations are generally between 220,000 and 440,000ppm (400-800 mg/L). and the we have two point about the risk on human, the short-term exposure of ETO causes nervous system depression

and irritation of the eyes and mucous membranes and the long-term exposure of ETO causes irritation on eyes, skin and nose and damage at brain a study from (NIOSH) institute showed that long-term may increase possibility of bone cancer in men and breast cancer in women, Because of that the all sterilization machine make vacuum process at the end of sterilization cycle.



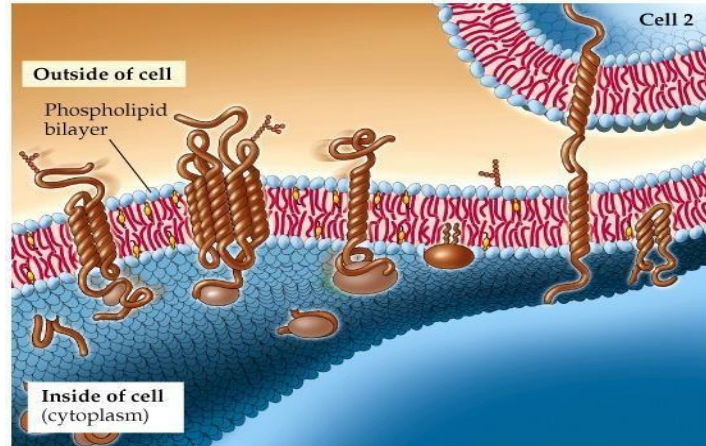
The chart showed Health information about gas inhalation

- **Sterile activity for ETO:**

ETO consider effective lethal for bacteria and their spores and fungus and viruses (Griffith and Hall, 1938) even the most resistant (*Bacillus atrophaeus*) which from it make biological indicators to ensure the success of the sterilization process, simply because it Has high permeability enable it to penetrate the sealed plastic wrap film and penetrate the cell membrane.

How does ethylene oxide sterilize?

ETO sterilized by alkylation process that damage the DNA of microorganism by alkylation of proteins molecules which consider alkylation agent ETO react with organic and inorganic acids like amino acid which make DNA, phenol, alcohol this chemical reaction called Alkylation. in Alkylation process the hydrogen replaced with the hydroxyethyl radical causes change the shape of amino acid which are found in cells proteins which Connects inside and outside the cell through the cell membrane this changing causes penetrate cell membranes and kill microorganism.



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This photo shows the cell membranes and the protein on the cell surface and the interact with other protein and make channel between the outside and inside of cell

- **Influence of humidity and temperature:**

1-Temperature:

The activity of ETO sterile effect increase with a rise in temperature (temperature coefficient= 2,4 for each 10-c degree).

2-Relative humidity:

Several researches have showed the desiccated cell is resist the sterilization influence by ETO and to overcome this resistance with ETO by dehydration the cell must to be an optimal humidity at sterilization chamber to make microorganism cells wetted and the optimum relative humidity is between 23-33% (Schley et al, 1960) whereas Insufficient humidity prevent the alkylation process and the high humidity (excess water) causes hydrolysis of ETO and convert it ethylene glycol ,the humidity content directly with microorganism themselves and some hypothesizing have showed the spores on cell surface will swell up in size by moisture making ETO sterile action easier.

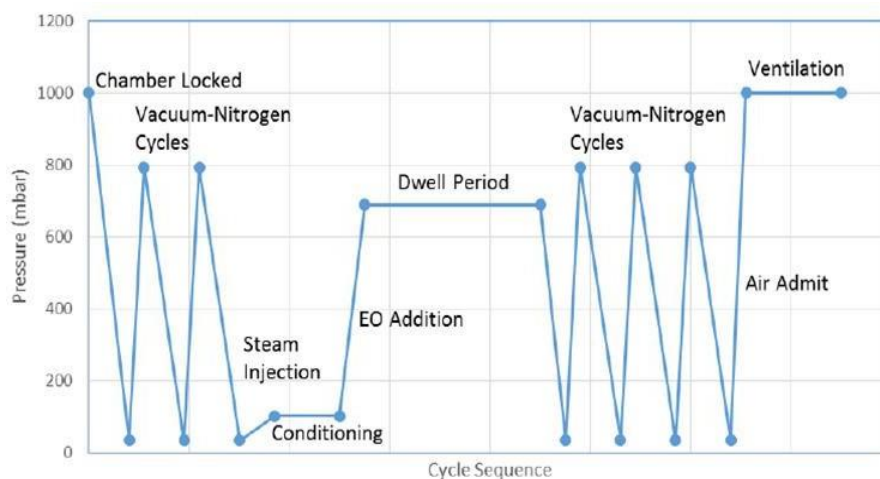


Chart of sterilization process by ETO sterilization machine and the level of it



- References:

- 1- Layer of Protection Analysis on Sterilization Process Using Ethylene Oxide- Gurkan Karakas, Woo Jong Shin and Kyoshik Park-BIOMEDICAL JORNALIST of scientific and technical research
- 2- United States Environmental Protection Agency
<https://www.epa.gov/sites/production/files/2016-09/documents/ethylene-oxide.pdf>
- 3- Encyclopedia of Environmental Science and Engineering-fifth edition-JAMAES R. PFAFFLIN AND EDWARD N. ZTEGLERN
- 4- Westphal et al. *Kinetics of size changes of individual Bacilius thuringiesnsis spores in response to changes in relative humidity*. PNAS March 18, 2003 (100)6: 3461-3466
- 5- Sintaur Inc., Cell Membrane Picture