Production of Ethylene Oxide by Air (Oxygen) oxidation process

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A. Background

Ethylene Oxide production plant is downstream plant of Gas Cracker. Ethylene Oxide is widely used in production of Ethylene Glycol. In US and also in India, Ethylene Oxide has principle outlet in production of Ethylene Glycol. It also used as other derivatives like glycol polyesters, non-ionic detergents and ethanol-amines. This project relates actual plant production of ethylene oxide using ethylene and oxygen.

B. Description of Flowsheet

Ethylene from Gas Cracker plant and Oxygen from Air Separation plant are come to Ethylene Oxide (EO) plant. Then it compressed to 21.7 bar (2170 kPa) in compressor for achieving reaction pressure. Then oxygen goes to oxygen mixing station, where oxygen is carefully supplied. After that, mixture goes to Shell and Tube Reactor, where partial oxidation of Ethylene takes place in presence of silver (Alumina based) catalyst. Only 12 % of Ethylene converted to EO. Some CO_2 also produced during reaction. After reaction, EO, CO_2 and unreacted feed are going to absorption column. In absorption column, most of the EO is absorbed in water and lean EO stream goes to heat-exchanger. Lean EO stream consist mainly Ethylene, Oxygen and CO_2. It will exchange heat with reactor outlet stream. After exchanging heat, this stream will go to reactor feed stream via recycle. Absorption column bottom goes to disorber, where some amount of water removed. The top of column will go to further purification in stripper and distillation column. After purification, pure Ethylene Oxide get it from top and it send to EO storage tank.

C. Result

The capacity of production of Ethylene Oxide is 79.95 ton/day. The reaction temperature is around 250-300 ^{0}C and pressure is 21.7 bar. 12 % conversion of Ethylene was taken as a real plant information. Side reaction as formation of CO_2 also produced in very small amount was taken. Reactor outlet was sent to heat exchanger and then to absorption column. Lean gases are found at the top. They are recycled back to main feed stream. Rich water + gases are sent to distillation column. Rigorous column was taken for distillation using shortcut distillation column data. In both column, Ethylene Oxide taken as light key and water taken as heavy key. Two distillation columns required to remove almost all water. As per data of shortcut column, reflux ratio of 1st column taken 16 (above minimum), 35 stages (as suggested) and for 2nd column reflux ratio taken 2.5 (above minimum), 5 stages (as suggested). It was then simulated and 79.95 ton/day (0.9254 kg/s) obtained.

D. Conclusion and Recommendation

DWSIM provides good platform for simulation. With the knowledge of DWSIM, one can simulate plant. That data can further be use to design equipment as in chemical engineering, process equipment design. The stripper column not work good in DWSIM. Using script, future work can be done. Purging is also not available. Stream splitter is also not very much effective. If in future, purging is available, then flowsheet will be more effective. Also, in rigorous column, FUG, Mac-Cab-Thiele, etc popular methods not available. It might be available in future. Using that, one can understand better.

E. Why oxygen not air???

Low cost oxygen is available.

Space time Yield is increased.

Absorber required smaller volume.

F. Unit system and version

All units taken in SI system.

Molar flowrate: mol/s

Mass flowrate: kg/s

Volumetric flowrate: m^3/s

Temperature: K

Pressure: Pa