Mono Ethylene Glycol from Hydration of Ethylene Oxide

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Background & Description:
Monoethylene glycol (MEG) is an important raw material for industrial applications. MEG is used in the manufacture of polyester resins, antifreezes, and solvents, etc. MEG is commonly produced by the hydration of ethylene oxide (EtO). During the reaction, diethylene glycol (DEG) and triethylene glycol (TEG) are also produced as byproduct. Both DEG and TEG are also used for the manufacture of many chemicals, especially in the production of various of polymers.
EtO can be hydrolyzed either non-catalytically or catalytically. Noncatalytic hydration of EtO for the production of MEG is a well-known process in which a large amount of water is required. This increases the purification cost of products. Furthermore, the reaction has to be carried out at high temperature to increase the reaction rate appreciably, which causes high energy consumption.

In this flowsheet, water and ethylene oxide are given as a feed at 170 C and 35 bar pressure to the plug flow reactor. After reaction in PFR, monoethylene glycol, diethylene glycol, triethylene glycol and tetraethylene glycol are formed as product. They are separated by simple distillation process using 8 distillation columns. The water separated is used as recycle.

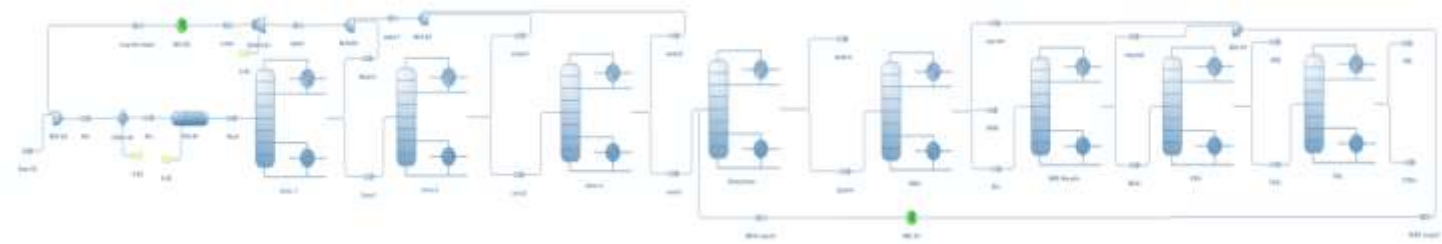
System of Units:
Temperature : °C,
Pressure : bar,
Molar flow : Kmol/h,
Mass flow : kg/h

Property Package:
Soave-Redlich-Kwong (SRK)

Reactions:
Water + Ethylene Oxide $\xrightarrow{k1}$ Monoethylene Glycol (k1/[L/(mol.min)] = exp(13.62-8220/T))
Ethylene Glycol + Ethylene Oxide $\xrightarrow{k2}$ Diethylene Glycol (k2/[L/(mol.min)] = exp(15.57-8700/T))
Diethylene Glycol + Ethylene Oxide $\xrightarrow{k3}$ Triethylene Glycol (k3/[L/(mol.min)] = exp(16.06-8900/T))
Triethylene Glycol + Ethylene Oxide $\xrightarrow{k4}$ Tetraethylene Glycol (k4/[L/(mol.min)] = exp(16.30-9000/T))

Dimension of Plug Flow Reactor:
Length: 10 m
Diameter: 4.999 m

Flowsheet:



Results:

Object	Rin	Rout	Conc1	Conc2	Conc3	glycols	EG+	DEG+	TEG+	TTEG+
Temperature(C)	170	211.83	196.65	178.22	152.0	135.21	152.21	220.45	174.88	173.61
Pressure(bar)	35	33.96	14	9	4	0.17	0.22	0.12	0.025	0.015
Mass flow(kg/h)	550624	551093	385745	251464	110469	90904.6	21274.4	5474.9	245.06	13.82
Mass fraction (water)	0.91	0.87	0.82	0.72	0.37	0.003	1.1E-9	6.4E-23	0	0
Mass fraction (Ethylene Oxide)	0.09	1.3E-8	1E-10	3.1E-13	9.3E-17	0	0	0	0	0
Mass fraction (Ethylene glycol)	6.9E-6	0.12	0.17	0.25	0.58	0.93	0.74	2.8E-5	4.8E-12	6E-22
Mass fraction (Diethylene glycol)	6.2E-13	0.009	0.01	0.02	0.04	0.06	0.24	0.95	0.001	2.3E-9
Mass fraction (Triethylene glycol)	1.8E-13	0.0004	0.0006	0.0009	0.0022	0.003	0.011	0.045	0.965	0.473
Mass fraction (Tetraethylene glycol)	6.7E-15	1.5E-5	2.15E-5	3.3E-5	7.5E-5	9.1E-05	0.0004	0.0015	0.034	0.527