Process Simulation of Heterogeneous Extractive distillation methods for ternary azeotrope ethanol/toluene/water separation using glycerol

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Unit System: Temperature – C and Molar Flow- kmole/hr (other units- SI)

❖ **Background**

 A complex and common ternary mixture of ethanol-water-toluene mixture is encountered in Chemical industries. It is necessary to separate all these three components to increase the efficiency and purity of our product. It can be done by introducing glycerol solvent, which will alter the volatility of this ternary azeotrope. Glycerol will allow ethanol to separate in first column. And in the next column toluene, water and glycerol can be separated.

 An ethanol-water-toluene mixture has a ternary azeotrope with a composition of around 61.52 % (by mass) ethanol, 32.97% (by mass) toluene and 5.51% (by mass).

❖ **Description of Flowsheet**

The flowsheet contains two distillation columns named "COUO-01" and "COUO-02". COUO-01 has 40 trays and 25th stage is the feed location for feed S-01.and 3rd stage is the feed for solvent. COUO-02 has 2 trays and 2nd tray is the feed location for the feed S-04. Glycerol has been used as an entrainer. S-02 is a Glycerol feed which alters the relative volatility between ethanol, toluene and water. COOL-01 act as condenser for column COUO-02. Decanter is used in the reflux to separate the water Rich Phase and toluene-rich Phase layers. Then the solvent is sent to COUO-01 using recycle stream.

Pure ethanol of 99.89% purity is obtained in COUO-01 and water of 99.9 % purity and toluene of 95.99% are obtained in COUO-02. The bottom product of COUO-02 is recycled and mixed with S-02 having glycerol which act as solvent feed for column COUO-01.

FLOWSHEET
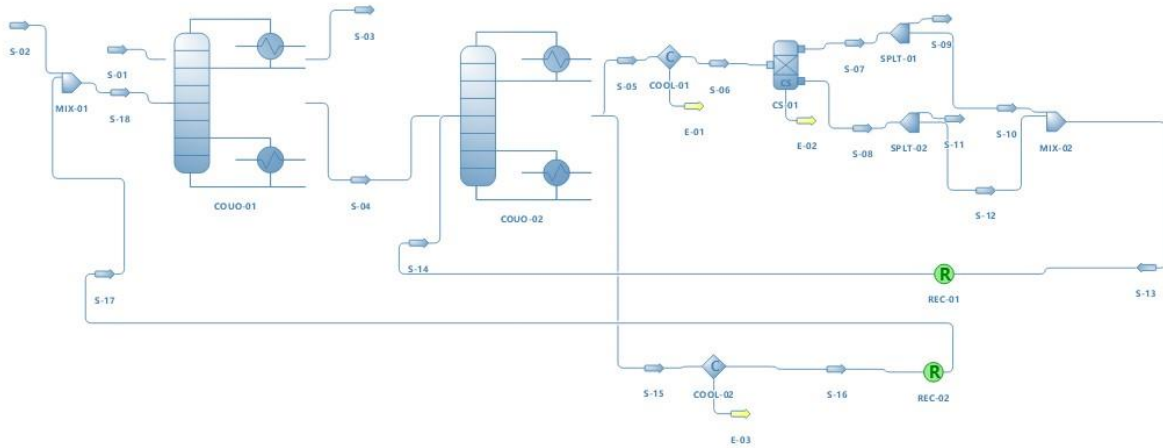
RESULT

Master Property Table							
Object	S-15	S-11	S-09	S-03	S-02	S-01	
Temperature	195.999	8.26	8.26	78.6447	63	63	C
Pressure	0.0506625	0.0506625	0.0506625	1.01325	1.11458	1.11458	bar
Mass Flow	1589.38	73.5013	314.861	615.434	0.04	1000	kg/h
Molar Flow	17.2607	3.25153	3.4211	13.3618	0.00043434	19.9909	kmol/h
Volumetric Flow	1.40767	0.0739868	0.357291	0.838274	3.26762E-05	1.26234	m3/h
Molar Fraction (Mixture) / Ethanol	4.42529E-08	0.00145791	0.000608092	0.998907	0	0.668007	
Molar Fraction (Mixture) / Toluene	0.000825042	0.0543116	0.993313	0.000287991	0	0.178997	
Molar Fraction (Mixture) / Water	0.000174913	0.937168	0.00101211	0.000805046	0	0.152996	
Molar Fraction (Mixture) / Glycerol	0.999	0.00706265	0.00506719	3.11605E-08	1	0	

Master Property Table				
Object	E-03	E-02	E-01	
Energy Flow	211.891	1.74588	98.1946	kW

❖ **Reference**

https://www.sciencedirect.com/science/article/abs/pii/S0098135417300637