

Process Simulation of Heterogeneous Azeotropic Distillation of ethanol and water using di-isopropyl ether

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

❖ **Background**

Heterogeneous azeotropic distillation is commonly used in industry to separate mixtures of close relative volatility and breaking azeotropes. The advantage of this separation is to utilize a natural liquid-liquid separation in a decanter.

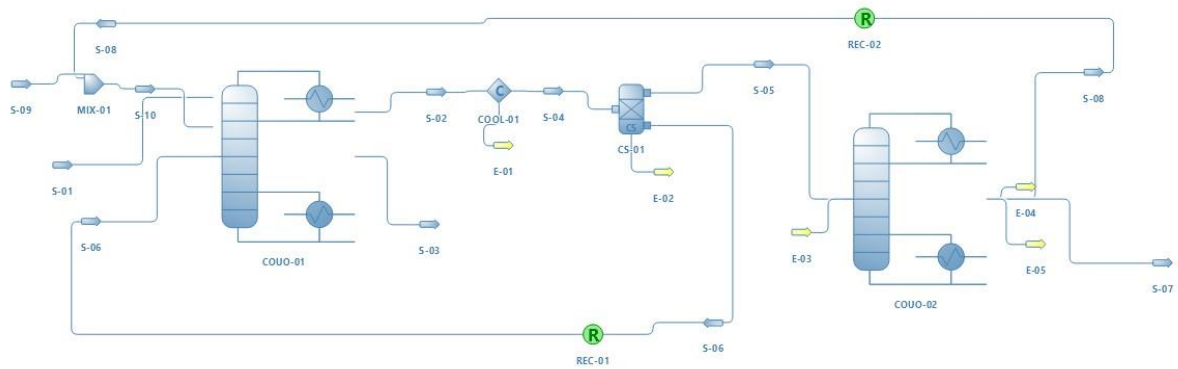
An ethanol-water mixture has an azeotrope with a composition of around 95.14 % (by mass) ethanol and azeotropic temperature of 78.4 °C. By adding di-isopropyl ether into the system, two additional binary azeotropes are formed. One desirable binary azeotrope (ethanol- di-isopropyl ether) is heterogeneous with an azeotropic temperature of 62.5 °C. Another binary azeotrope between water and di-isopropyl ether is also formed with a temperature of 64.15 °C.

❖ **Description of Flowsheet**

The flowsheet contains two distillation columns named “COUO-01” and “COUO-02”. COUO-01 has 15 trays and 1st stage is the feed location for feed S-01. COUO-02 has 10 trays and 6th tray is the feed location for the feed S-05. Di-isopropyl ether has been used as an entrainer. S-09 is Di-isopropyl ether feed which alters the relative volatility between ethanol and water. COOL-01 act as condenser for column COUO-01. Decanter is used in the reflux to separate the Entrainer-Rich Phase and Entrainer-Lean Phase layers. The Entrainer-Rich Phase is sent to COUO-01.

Pure ethanol of 98.2% purity is obtained as COUO-01 bottoms and water of 99.9 % purity is obtained as COUO-02 bottoms. The top product of COUO-02 is recycled and mixed with S-09 having di-isopropyl ether which act as feed for column COUO-01.

FLWSHEET



RESULT

Master Property Table					
Object	S-07	S-05	S-03	S-01	
Temperature	97.4861	73.8984	78.5198	78	C
Pressure	1.01325	1.01325	1.01325	1.01325	bar
Mass Flow	230.602	326.238	2832.01	3000.12	kg/h
Molar Flow	12.6041	14.8093	60.813	73.14	kmol/h
Volumetric Flow	0.241053	0.347273	3.85733	3.90364	m ³ /h
Molar Fraction (Mixture) / Ethanol	0.00999975	0.0965554	0.982685	0.82	
Molar Fraction (Mixture) / Water	0.99	0.887935	0.00559368	0.18	
Molar Fraction (Mixture) / Diisopropyl ether	2.50367E-07	0.0155092	0.0117211	0	

Master Property Table						
Object	E-05	E-04	E-03	E-02	E-01	
Energy Flow	-54.3462	47.522	0	-54.5054	13622.7	kW

❖ Reference

<https://pubs.acs.org/doi/abs/10.1021/ie403988c>