Extractive Distillation Process for Separation of Ethyl Formate-Ethanol -Water Mixture

Abstract:

Extractive distillation process for separation of Ethyl formate (ETFO)-Ethanol-Water mixture with Ethylene glycol (EG) as the extractive solvent was investigated. Two columns are used, at the top of the first column high purity products i.e., Ethyl formate and ethanol could be obtained, and at the bottom of the recovery column ethylene glycol could be completely recycled back to the feed.

Introduction:

A certain pharmaceutical industry leads to an intermediate ETFO-ethanol-water mixture. Both ETFO-water and ethanol-water form minimum boiling point azeotropes. Therefore simple distillation cannot be used to separate them out. There are no studies available for the separation of this mixture hence, extractive distillation is chosen and steady state simulations carried out. Extractive distillation is used for the separation of this mixture to yield high purity ETFO, ethanol and for total recovery of EG (extractive solvent). The requirement of the process is that the content of water should not be more than 1 wt % in distillate of Column-I giving high purity ETFO-ethanol mixture and pure EG is obtained at the bottom of Column-II. Later, ETFO-ethanol mixture can be separated by simple distillation.

The solvent alters the relative volatility of the azeotropic mixture, thus ethanol and ethyl formate can be gathered in the top and the mixture of solvent and water in the base which is then fed to the recovery column in order to recycle the solvent.

Flowsheet Description:

In Figure-I column-I is extractive column and column-II is recovery column for the solvent. The azeotropic mixture of ethyl formate-ethanol-water is fed into column-I, the top product of column-I are ethyl formate and ethanol. The bottom product of column-I is the recovery stream which is fed to column-II where top product is 99 wt % water and 99 wt % ethylene glycol. Ethylene glycol is then recycled back to the feed stream after cooling and adding make-up of solvent. Make-up accounts for loss of solvent in distillates of column-I and column-II.

Fresh feed flow rate is kept at 1000kg/hr containing 0.53, 0.37 and 0.1 of ethyl formate, ethanol and water by mass fraction respectively at 30^{o}C. The pressure of both columns is maintained at 1.01325×10^{5} Pa.

Results:

Master Property Table										
Object	99 wt % EG	99 wt % water	Cooled Recycle	EG In	EG Make up	ETFO,Ethanol	Feed	Recovery stream	Recycle stream	
Temperature	196.273	99.398	78	78	30	69.9183	25	162.896	196.273	C
Pressure	1.01325	1.01325	1.01325	1.01325	1.01325	1.01325	1.01325	1.01325	1.01325	bar
Mass Flow	1116.26	24.7451	1116.26	1116.26	0.00018	975.255	1000	1141	1116.26	kg/h
Mass Fraction (Mixture) / Ethyl formate	2.10221E-17	4.47666E-06	1.66156E-19	1.66156E-19	0	0.543448	0.53	9.70859E-08	2.10221E-17	
Mass Fraction (Mixture) / Ethanol	7.60962E-09	0.00449872	1.39845E-10	1.39845E-10	0	0.379274	0.37	9.75717E-05	7.60962E-09	
Mass Fraction (Mixture) / Water	0.00029045	0.995497	0.000290453	0.000290453	0	0.0772786	0.1	0.0218736	0.00029045	
Mass Fraction (Mixture) / Ethylene glycol	0.99971	2.47921E-10	0.99971	0.99971	1	9.09298E-09	0	0.978029	0.99971	

Flowsheet:

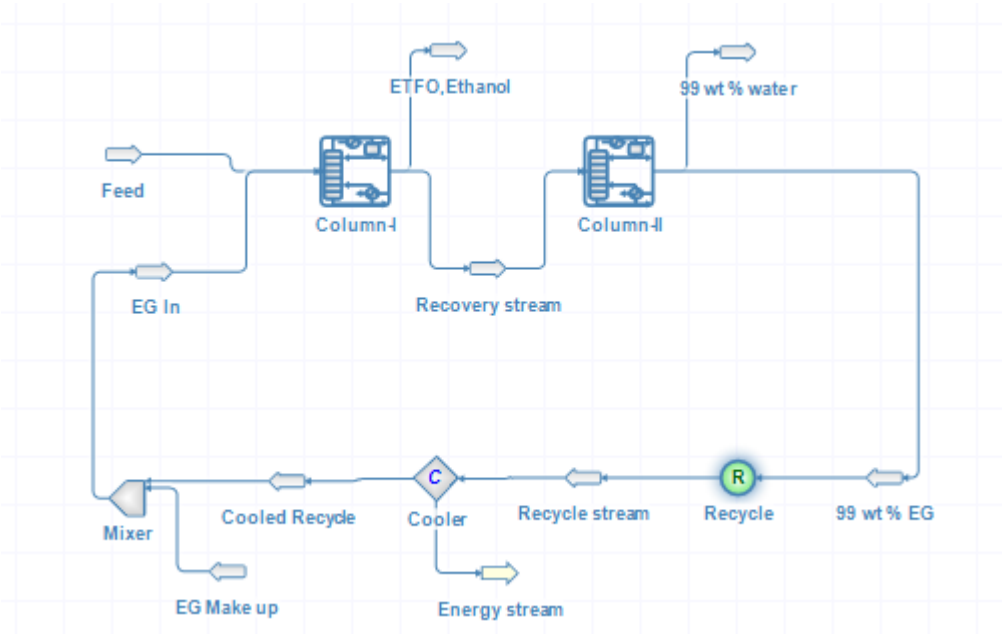

Figure-I

Reference:

Design and Control of Extractive Distillation Based on Effective Relative Gain Array

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