Extractive Distillation for Dehydration of Tetrahydrofuran

Abstract:

Extractive distillation technique for the dehydration of Tetrahydrofuran is investigated with Ethylene glycol as an entrainer. Two columns are used, Top product from the first column is desired product that is Tetrahydrofuran and other column is for entrainer recovery. The entrainer from the bottom of second column is recycled back with the feed stream with makeup.

Introduction:

Tetrahydrofuran is an important organic raw material. The demand for high purity Tetrahydrofuran is continuously increasing as it can be used as reaction solvent, adhesives etc. but it is commercially beneficial only when available in high purity i.e. 99.9% wt. basis. At atmospheric pressure Tetrahydrofuran gets easily dissolved in water and forms a minimum-boiling homogeneous azeotrope. Therefore it is not possible to separate Tetrahydrofuran-Water solution completely by Simple Distillation.

There are various methods available for separating Tetrahydrofuran-Water Azeotropic mixture like pressure swing distillation, pervaporation, and extractive distillation. Among these techniques the most commonly used method for Tetrahydrofuran dehydration is Extractive Distillation in which the addition of a separating agent is applied to increase the relative volatility of light and heavy components.

Flowsheet Description:

Fan et al [1] devised a two-column design with an entrainer. The reproduced flowsheet is shown in Figure 1. Among the various entrainer available like DMSO, DMF here ethylene glycol is used as it is easily and cheaply available. In Figure-I column-I is extractive column and column-II is for recovery of entrainer ethylene glycol. The azeotropic mixture of Tetrahydrofuran-Water along with entrainer is fed to column-I the top product of column-I is our desired product i.e. 99.9 wt. % Tetrahydrofuran. The bottom product is fed to column-II for entrainer recovery where ethylene glycol is separated from water and separated ethylene glycol is then obtained from the bottom with 99.9 wt. % purity. This entrainer is again recycled to column-I after cooling and adding make-up stream of entrainer to account for the loss of entrainer in distillates of column-I and column-II

Fresh feed flow rate is kept at 3000 kg/hr containing 0.9 wt. % Tetrahydrofuran and rest water at a temperature of 320 K. The pressure of both the columns are maintained at 1.1 atm. Distillate from column-I is our desired product i.e. Tetrahydrofuran with 99.9 wt. % purity.

Results:

Stream Properties					
Object	Recycle Stream	Cold Recycle	99.9 wt % Ethlylene Glycol	88 wt % Water	
Temperature	472.842	320	472.842	349.296	K
Pressure	1.1	1.1	1.1	1.1	atm
Mass Flow	0.82624	0.825241	0.82624	0.0946421	kg/s
Mass Fraction (Mixture) / Tetrahydrofuran	7.64741E-12	7.52427E-12	7.64741E-12	0.123272	
Mass Flow (Mixture) / Water	0.000239984	0.000239694	0.000239984	0.0829754	kg/s
Mass Fraction (Mixture) / Ethylene glycol	0.99971	0.99971	0.99971	1.44516E-07	

Stream Properties					
Object	Make Up	Feed	Bottom-I	99.9 wt. % THF	
Temperature	320	320	412.729	342.038	K
Pressure	1.1	1.1	1.1	1.1	atm
Mass Flow	0.001	0.833333	0.920882	0.738692	kg/s
Mass Fraction (Mixture) / Tetrahydrofuran	0	0.9	0.0126691	0.999513	
Mass Fraction (Mixture) / Water	0	0.1	0.0903649	0.000484107	
Mass Fraction (Mixture) / Ethylene glycol	1	0	0.896966	2.8017E-06	

Flowsheet:

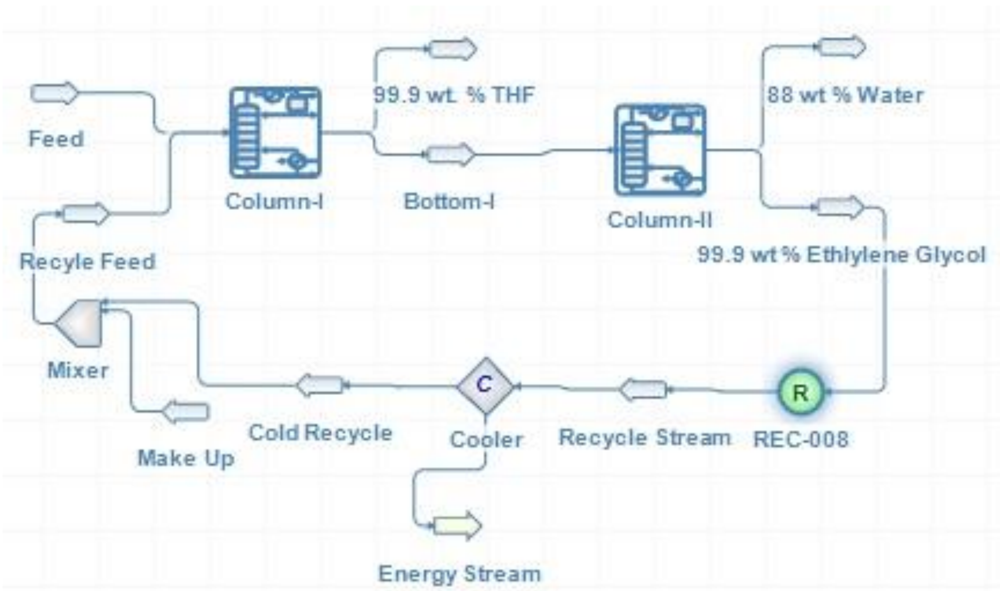

Figure-I

Reference:

[1] Design and Control of Extraction Distillation for Dehydration of Tetrahydrofuran
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DOI: 10.1002/ceat.201200611