Comparison of alternative distillation processes for the maximum-boiling ethylenediamine dehydration system

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Unit System: Pressure-atm; Molar Flow-kmol/hr; Other-SI

Background

Ethylenediamine (EDA) is extensively used in organic synthesis for preparation of pesticide, reactive dyes, epoxy resin, etc. EDA is used in large quantities for production of many industrial chemicals. It forms derivatives with carboxylic acids(including fatty acids), nitriles, alcohols (at elevated temperatures), alkylating agents, carbon disulfide, and aldehydes and ketones. Because of its bifunctional nature, having two amines, it readily forms heterocycles such as imidazolidines. **EDA** and **water** mixture forms a maximum-boiling homogeneous azeotrope at atmospheric pressure. Which must be separated out to obtain **EDA** as a pure component. This cannot be achieved by separating this maximum-boiling homogeneous azeotrope via the ordinary distillation processes.

Extractive Distillation of Close Boiling Compounds

Extractive distillation is the method of separating close boiling compounds from each other by carrying out the distillation in a multiplate rectification column in the presence of an added liquid or liquid mixture. This Liquid or Liquid mixture is known as extractive agent or **entrainer**. *This entrainer must have high boiling point than the compounds being separated.* The entrainer is introduced near the top of the column and flows downward until it reaches the stillpot or reboiler. ***Its presence on each plate of the rectification column alters the relative volatility of the close boiling compounds*** *in a direction to make the separation on each plate greater and thus require either fewer plates to effect the same separation or make possible a greater degree of separation with the same number of plates.*

Description of flowsheet

The flow sheet contains total two distillation columns named “**Extractive distillation column**" and “**Entrainer recovery column**". Here we use the *1,4-butanediol (BDO) as Entrainer and mixer of Ethylenediamine (EDA) and Water as feed.* The presence of 1,4-butanediol (BDO) alters the relative volatility between Ethylenediamine (EDA) and Water and to make Water move toward the top part and Ethylenediamine (EDA) move to the bottom part of the column. The “Extractive distillation" take Entrainer and feed and give the Water as top product and the bottom product which has the Ethylenediamine (EDA) and 1,4-butanediol (BDO) that enters to the “Entrainer recovery" column; which separate out pure Ethylenediamine (EDA) at top and the 1,4-butanediol (BDO) at the bottom, this recovered BDO is recycled to the “Extractive distillation". Feed rate with the composition of compounds and the other necessary data for the column are shown in the table in Results section with the Top and Bottom products.

Results

Parameters	Extractive Distillation	Entrainer recovery
Pressure(atm)	0.2	0.2
Total Stages	22	11
1st Feed	100(kmol/hr) Water 30 wt% EDA 70 wt%	336.084(kmol/hr) Water 0 mol% EDA 12.257 mol% BDO 87.743 mol%
1st Feed Stage	6	5
2nd Feed	0.005(kmol/hr) BDO 100 mol%	-
2nd Feed Stage	3	-
Top	58.8713(kmol/hr) Water 99.95209 mol% EDA 0.027606 mol% BDO 0.000203 mol%	41.147(kmol/hr) Water 0 mol% EDA 99.985 mol% BDO 0.015 mol%
Bottom	336.084(kmol/hr) Water 0 mol% EDA 12.257 mol% BDO 87.743 mol%	294.937(kmol/hr) Water 0 mol% EDA 0.018 mol% BDO 99.982 mol%

References

1. Hao Yu, Qing Ye*, Hong Xu, Xin Dai, Xiaomeng Suo, Rui Li “Comparison of alternative distillation processes for the maximum-boiling ethylenediamine dehydration system”; Chemical Engineering and Processing 97 (2015) 84–105 https://www.sciencedirect.com/science/article/pii/S0255270115301008