The Separation Process of a Maximum Boiling Azeotropic System of Water and EDA using PSD

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BACKGROUND:

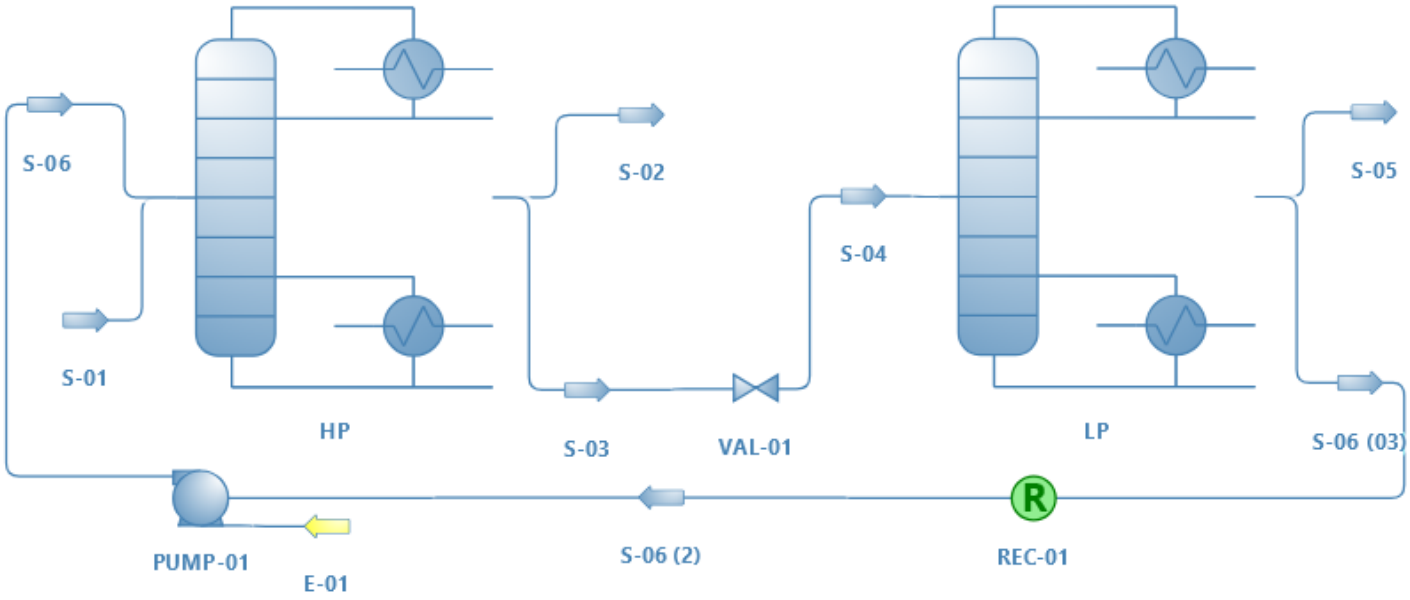
PSD method is only applicable for azeotropes whose composition can be shifted substantially by changing the system pressure which is found to be better conventional methods like Extractive Distillation method because no extra solvent is required to achieve the separation.
The principle of pressure swing distillation (PSD), changes in pressure can alter the relative volatility of a liquid mixture, even for liquid mixtures with a close boiling point or those that form an azeotrope. If the operating pressure increases, the azeotropic point shifts to lower composition values of the light component. The significant positive change in the azeotrope point and enlargement of the relative volatility of azeotropic mixtures allow the separation to take place without any need for a separating agent.
Pressure-swing azeotropic distillation uses two columns operating at two different pressures to separate azeotropic mixtures by taking high-purity product streams from one end of the columns and recycling the streams from the other end with compositions near the two azeotropes. It can be applied to both minimum-boiling and maximum-boiling azeotropic mixtures. With Minimum-boiling systems, the distillate streams are recycled. With Maximum boiling systems, the bottoms streams are recycled.

The separation of ethylenediamine (EDA) from aqueous solution is a challenging problem because its mixture forms a maximum boiling azeotropic mixture at about 118.5°C, moreover the boiling point of EDA is 117°C close to that of water (100), therefore we use PSD instead of convectional distillation as the mixture shows high deviation from Raoult's law and if it has close boiling point compounds then the system exhibits relative volatility close to one. For a maximum-boiling azeotropic system, pressure change does not greatly affect the azeotropic composition of the system.

DESCRIPTION OF THE FLOWSHEET:

Two Distillation columns operating at two different pressures are arranged in such a manner that the High-pressure column (operating at 2 atm) uses the recycle stream of Bottom product of Low-pressure column (operating at 0.1 atm) to help achieve maximum separation.
Pure feed of Aqueous EDA mixture (**S-01**, 0.4 EDA and 0.6 H_2O) is fed to the 6th tray of High-Pressure column (Total Theoretical stages= 90, including the reboiler) which has the Top product (**S-02**- Distillate, 0.015 EDA and 0.984 H_2O) rich in the more volatile component i.e. Water and the Bottom product (**S-03**-Residue, 0.7231 EDA and 0.2769 H_2O) in less volatile component i.e. EDA.
The EDA rich bottom stream is then fed to the 11th stage (**S-04**) of the Low-Pressure column (Total Theoretical stages = 22, including the reboiler) and the bottom product of this stream (**S-06 (03**), 0.5955 EDA and 0.4045 H_2O) has the composition near to the azeotropic composition (i.e. 0.45 H_2O and 0.55 EDA at 0.1 atm) and is thus recycled back via pump to 2Oth stage of the High-Pressure column (**S-06**), and the distillate of the low pressure column gives us high purity EDA solution (S-05, 0.996 EDA and 0.003 H_2O)

FLOWSHEET:



RESULT:

MASTER PROPERTY TABLE							
Object	S-02	S-03	S-01	S-05	S-04	S-06 (03)	
Temperature	120.654	136.411	25	58.3105	55.7352	54.8888	C
Pressure	2	2	1	0.1	0.1	0.1	atm
Molar Flow	60.849	123.479	100	39.2864	123.479	84.1928	kmol/h
Molar Fraction (Mixture) / Water	0.984722	0.2769	0.6	0.00344635	0.2769	0.4045	
Molar Fraction (Mixture) / Ethylenediamine	0.015278	0.7231	0.4	0.996554	0.7231	0.5955	
Phases	Liquid Only	Liquid Only	Liquid Only	Liquid Only	Mixed	Liquid Only	
Energy Flow	-4672.32	-3758.8	-5527.83	-658.411	-3758.8	-3533.83	kW

REFERENCES:

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