Comparison of Extractive Distillation and Pressure-Swing Distillation for Acetone and Chloroform separation

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A. Background

Separation of compounds is an integral part of almost every industrial process. A recurring problem in separation is the formation of azeotropes. These are constant boiling mixtures that have the same composition in liquid and vapour phase. These components cannot be separated by conventional distillation columns. Chloroform and Acetone at specific conditions forms an azeotrope. Two widely methods used to separate these types of mixtures are extractive distillation and pressure swing distillation. Extractive distillation uses the addition of a solvent to soak up one of the components and break the azeotrope. Pressure swing separates the components by using two columns of two different pressures. In this work, separation of chloroform and Acetone mixture is simulated using both the approaches and the results are compared.

B. Flowsheet description

Consider a separation process wherein azeotropic mixture of Chloroform and Acetone are to be separated. The boiling point of Acetone and chloroform are 329.4K and 334.3 K respectively. To compare the method of distillation, the separation process is simulated in using both the approaches i.e., Extractive distillation and Pressure swing distillation. This flowsheet is based on Luyben (2013)

In extractive distillation, the fresh feed of Acetone and Chloroform is mixed with the recycle feed, which is made up of the solvent (Dimethyl sulfoxide) with traceable quantities of Chloroform and Acetone. The mixed feed is then sent into the distillation column (DC-1) where acetone is obtained through the distillate. The residue which comprises mostly of the solvent and Chloroform is sent into the next distillation column (DC-2) where Chloroform is removed as the distillate. The solvent is recovered in the residue stream which is recycled and is sent to be mixed with the incoming fresh feed.

In pressure swing distillation, the fresh feed of Acetone and Chloroform is mixed with the recycle feed which is also made up of the same reactants. The mixed feed is then sent to a highpressure distillation column (DC-3) where Acetone is separated as the distillate. The residue is then sent to the low-pressure distillation column (DC-4) where Chloroform is obtained through the distillate. The residue stream is then recycled to be mixed with the fresh feed.

C. Results and Discussions

Energy required					
Object	E_Reboiler_DC-1	E_Reboiler_DC-2	E_Reboiler_DC-3	E_Reboiler_DC-4	
Energy Flow	-3.9905962	-1.0811942	-5.3980347	-4.7214342	MW

Chloroform Purity			
Object	Chloroform_2	Chloroform	
Molar Fraction (Mixture) / Chloroform	0.87813648	0.85930408	

Acetone Purity			
Object	Acetone_2	Acetone	
Molar Fraction (Mixture) / Acetone	0.88403042	0.82242656	

It is observed from the results that the extractive distillation method requires lesser amount of energy when compared with pressure swing distillation which requires greater amount of energy. Even though the extractive distillation consumes lower amount of energy, the pressure swing distillation is used in areas where the emphasis is more on the quality of the product rather than the energy to be used. This is because in pressure swing distillation, unlike extractive distillation, no other compounds or solvents are added. This enhances the purity of the product obtained. Therefore, the method of separation to be used depends upon the required quality of the product that is to be produced

D. References

Luyben W. L. (2013). Comparison of extractive distillation and pressure-swing distillation for acetone/chloroform separation, *Computers and Chemical Engineering*, 50, 1– 7