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Flowsheeting Project

Pressure Swing Distillation Of WATER-CYCLOHEXANE Mixture

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Introduction:

It is been observed that the separation of components forming an azeotrope is quite a challenging task because due to the formation of azeotrope it is not possible to the separation through a simple distillation process because their relative volatility becomes equal to unity. However, separation of such non-ideal mixtures is a very common process in chemical industries. There are three methods to separate such mixtures. (i) azeotropic distillation (ii) extractive distillation and (iii)pressure swing distillation column. Here I am using Pressure Swing Distillation for separation of Water-Cyclohexane mixture.

Methodology:

Here, In this simulation I have used two components water and Cyclohexane. The thermodynamic package used in this simulation is "Raoult's Law". Here, I have used two columns which are operating at different pressure as name suggest one with Low Pressure Column (LPC) and another one is High Pressure Column (HPC). The LPC is operating at 1 atm pressure with number of theoretical stages are 18. The main feed is introduced at stage number 7 and Recycle feed is at stage number 3 in LPC. The reflux ratio in LPC is = 2. In LPC, bottom product contains pure water and top product is mixture of water-cyclohexane. Top product is passed through the heater and than it is introduced in HPC as feed.

The HPC is operating at pressure of 3 atm with number of theoretical stages are 40. The feed is introduced in HPC at a feed stage number 21 with reflux ratio of 10. In HPC, The top product contains pure cyclohexane in liquid form and bottom product contains mixture of Water-Cyclohexane mixture. The bottom product from HPC is recycled and again introduced in LPC. The results and other necessary parameters are as shown below.

- The azeotropic data for Water-Cyclohexane at different pressure are as given below.
  - Azeotropic Data at Pressure = 1 atm

Components	Pure compound boiling point (˚C)	Azeotropic temperature (˚C)	Azeotropic composition (mole fraction)	Type of azeotropic point
Water	100	69.2765	0.297415	Minimum Boiling Point
Cyclohexane	80.7846		0.702585	

- Azeotropic Data at Pressure = 3 atm

Components	**Pure compound boiling point (˚C)**	**Azeotropic temperature (˚C)**	**Azeotropic composition (mole fraction)**	**Type of azeotropic point**
Water	135.765	103.377	0.351057	Minimum Boiling Point
Cyclohexane	122.441		0.648943	

Results:

Object	Feed (LPC)	Pure Water	Feed (HPC)	Pure Cyclohexane	Recycle Feed	Units
Temperature	342.424	372.931	450	395.762	342.075	K
Pressure	101325	101325	101325	303975	101325	Pa
Mass Flow	10.5163	3.65295	11.0271	6.86256	4.1645	kg/s
Molar Flow	277.778	195.588	202.698	82.1676	120.531	mol/s
Molar Fraction (Mixture) / Water	0.7	0.99	0.449899	0.00968305	0.75	
Molar Fraction (Mixture) / Cyclohexane	0.3	0.01	0.550101	0.990317	0.25	

References:

Azeotropic Data: https://en.wikipedia.org/wiki/Azeotrope_tables

VLE Data : http://vle-calc.com/