Pressure Swing Distillation for Separation of Water and Cyclohexane

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Background & Description:

Cyclohexane, commonly used as an intermediate chemical, is used majorly for production of adipic acid and caprolactum, which are vital for nylon production. In other cases, it also finds use in production of solvents, plasticizers and insecticides. Therefore, it is of paramount interest to recover cyclohexane from waste water not only for reuse but also for environmental safety as it usually vaporizes from surface waters. However, cyclohexane forms a binary azeotrope mixture with water rendering conventional distillation ineffective.

In the following flowsheet, a double column pressure swing distillation process has been employed, where change in column pressure is used to shift azeotropic compositions. The feed (S-01), with 70% water and 30% pyridine, and recycle enter the first column (DC-01), operating at 1.01325 bar, at stages 3 and 7, respectively. The first bottom product (S-04) obtained is 99% water while the distillate enters the second column (DC-02), operating at 3.03975 bar, as feed at stage 21. The second distillate (S-06) obtained is 99.39% cyclohexane while the bottoms is recycled back to the first column (DC-01).

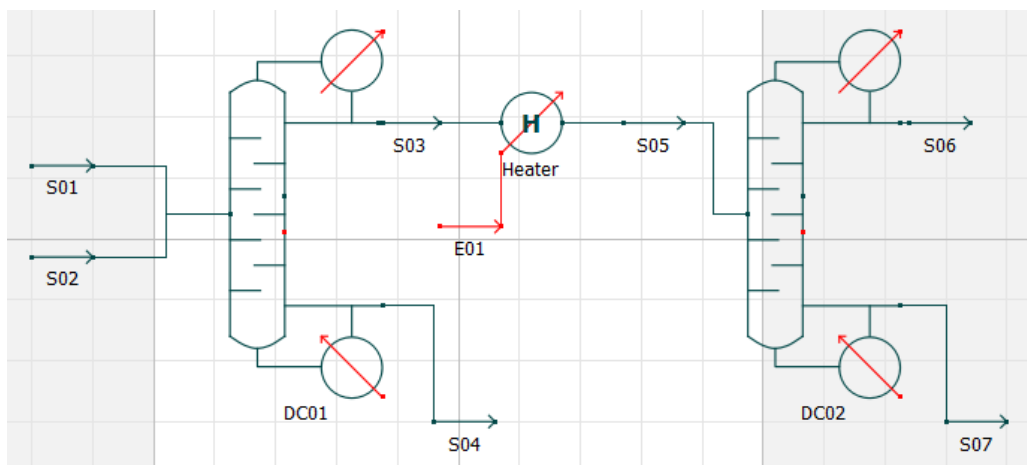*Note: All percentage compositions mentioned above are on mole basis.*

Figure 1: Water and Cyclohexane DCPSD Separation Flowsheet

Results:

Object	Feed (S-01)	Bottom 1 (S-04)	Distillate 2 (S-06)	
Temperature	69.274	99.781	122.566	**C**
Pressure	1.01325	1.01325	3.03975	**bar**
Mass Flow	37858.824	13170.1536	24714.756	**kg/h**
Molar Flow	1000	705.17455	295.07100	**kmol/h**
Molar Fraction (Mixture) / Water	0.7	0.99	0.0061	
Molar Fraction (Mixture) / Cyclohexane	0.3	0.01	0.9939	

Table 1: Streamwise Results for Water and Cyclohexane DCPSD Separation Flowsheet

Reference:
1. Completed DWSIM Flowsheet: Pressure Swing Distillation for Separation of Water and Cyclohexane
2. Azeotropic Data
3. VLE Data