Separating Water/ Acetonitrile/ Isopropanol mixture via triple-column pressure-swing distillation

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Background & Description:
Acetonitrile (ACN) and isopropanol (IPA) are vital raw chemicals/organic solvents in the industry owing to excellent solubility. Therefore, it is of paramount interest to recover these products from wastewater for reuse as well as to protect the environment. However, their mixture in water forms binary and ternary azeotropes which makes conventional distillation ineffective for separation.

In the following flowsheet, a triple column pressure swing distillation process has been employed, where change in column pressure is used to shift azeotropic compositions. The feed (S-03) with 40% water, 30% ACN and 30% IPA and recycle enter the first column (DC-01), operating at 0.32 bar, at stages 41 and 34, respectively. The first bottom product (S-05) obtained is 99.90% water while the distillate enters the second column (DC-02), operating at 6.5 bar, as feed at stage 13. The second bottom product (S-09) obtained is 98.91% ACN while the distillate, in similar fashion as previous column, enters the third column (DC-03), operating at 4.5 bar, as feed at stage 26. The third bottom product (S-13) obtained is 99.17% IPA while the distillate is recycled back to the first column (DC-01) at stage 34.

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

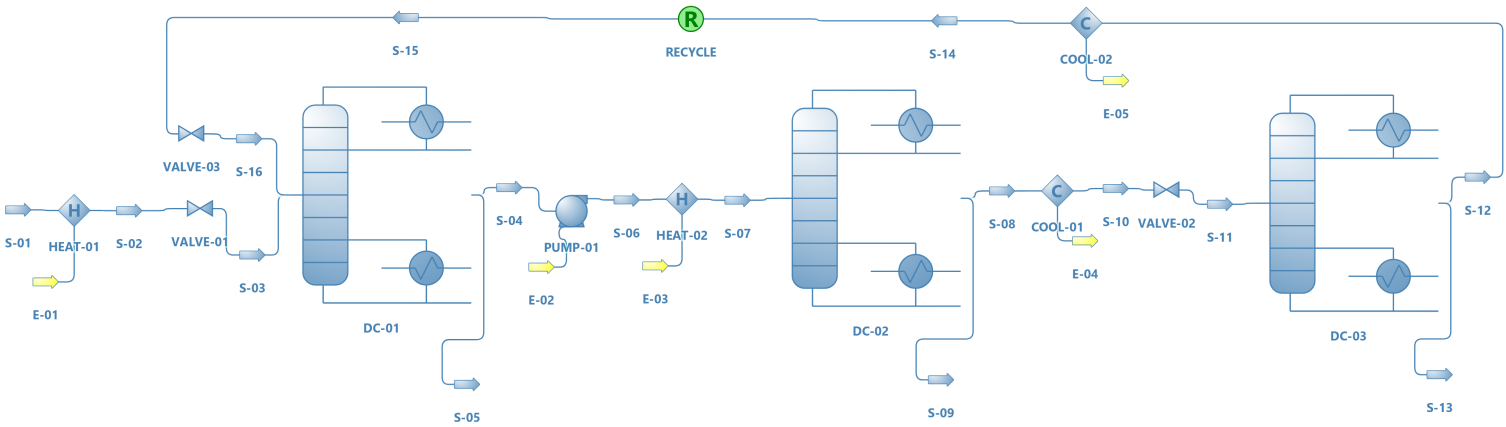

Figure 1: Water/ACN/IPA TCPSD Separation Flowsheet

Results:

Object	Feed (S-03)	Bottom 1 (S-05)	Bottom 2 (S-09)	Bottom 3 (S-13)	
Temperature	48.5147	70.5442	154.064	125.926	**C**
Pressure	0.36	0.32	6.5	4.5	**bar**
Mass Flow	3755.02	722.022	1237.78	1796.66	**kg/h**
Molar Flow	100	40	30	30	**kmol/h**
Molar Fraction (Mixture) / Water	0.4	0.999000	~ 0	~ 0	
Molar Fraction (Mixture) / Acetonitrile	0.3	0.000358	0.989099	0.010827	
Molar Fraction (Mixture) / Isopropanol	0.3	0.001248	0.016355	0.991727	

Table 1: Streamwise Results for Water/ACN/IPA TCPSD Separation Flowsheet

Reference:

Naigen Wang, Qing Ye, Lijuan Chen, Haoxiang Zhang, Jing Zhong, Improving the economy and energy efficiency of separating water/acetonitrile/isopropanol mixture via triple-column pressure-swing distillation with heat-pump technology, Energy, Volume 215, Part A, 2021, 119126, ISSN 0360-5442