Simulation and Optimization of Three-component Mixture for pressure-swing Distillation

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Abstract

The economical effect of different operational pressures in a pressure-swing distillation (PSD) process for the separation of a ternary homogeneous mixture is studied in present paper. The feasibility of the process is confirmed by residue curve maps (RCM), and rigorous steady-state simulations are implemented on Aspen Plus. By analyzing RCM of a ternary mixture of C₇H₈-C₂H₅OH-CCL₄, a two-column configuration with high- and low-pressure distillation columns is proposed to purify C₇H₈ from this ternary mixture by recovering C₂H₅OH at the bottom of low-pressure column. There are two low-boiling azeotropes C₇H₈-C₂H₅OH and CCl₄-C₂H₅OH forming in this ternary mixture which the composition of the later changes significantly with pressure. It is demonstrated that the operational pressure has great effect on this process. On basis of minimum total annual cost (TAC), several different operational pressures of the high- and low-pressure distillation columns are changed to investigate this separation process. As a result, the schemes with optimal pressure sequence of the high- and low-pressure distillation columns are obtained, in which several operating parameters are optimized by using optimization module of Aspen plus and heat integrations are applied to PSD system to reduce low and high temperature utility consumption.