243c Process Chemistry and Design Alternatives for Recovery of Dilute Acetic Acid through Esterification in Reactive Distillation

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This work explores the recovery of acetic acid aqueous solution with different acid concentrations. Instead of separating acid from water using azeotropic distillation, acetic acid is converted to acetate via esterification. Two questions then arise. First, what is a better choice of alcohol (e.g., ranging from methanol to pentanol, C1- C5) for the esterification: a solvent selection problem. Second, what is the more economical process flowsheet (e.g., a standalone reactive distillation versus a pre-treatment unit followed by a reactive distillation)? For the solvent selection problem, the study of Tang et al. (2005) indicates that the esterifications using methanol or pentanol is much more economical as compared to other choices, e.g., ethanol, isopropanol, or butanol. Quantitative analysis reveals that the production of methyl acetate (from methanol and acetic acid) is not tolerable to acid concentration variation and a very high purity acid feed is need to achieve product specification. Thus, methanol is ruled out for esterification and pentanol is selected to convert acid into the ester. Next, a systematic design procedure is taken to design the process flowsheets and the total annual cost (TAC) is used to discriminate between different flowsheets, with and without pre-treatment unit. A range of acetic acid concentration is explored, varying from 100 wt%, to 75 wt%, to 50 wt%, and then to 30 wt%. The TAC analysis shows that a standalone reactive distillation is more economical than the flowsheet with a pretreatment unit.