Feasibility study of pressure-swing distillation process for separation of formic acid – water - acetic acid

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Abstract. The separation of the ternary mixture formic acid - acetic acid - water into three high-purity products is difficult due to the presence of binary and ternary azeotropes that divide the ternary diagram into four distinct distillation regions. Fortunately, the compositions of these azeotropes change significantly with pressure. The pressure-swing distillation process was proposed for the separation of this ternary system. The process simulations were carried out using Prosim Plus 3 software. The effects of the number of theoretical stages, feed stage and reflux ratio were investigated to optimize the operating parameters of the pressure-swing distillation. The best operating process parameters were defined for systems containing 30% mol. in formic acid, 60% mol. in water and 10% mol. in acetic acid. It has been found that, the water can be distillated in the first column operating at the pressure of 1.961 bar, then the formic acid can be separated at pressure 0.067 bar in the second one and acetic acid can be obtained in the bottom product of the third column operating at 1.013 bar. The three obtained products in the three distillation columns have a high purity of more than 99.9% in mole fraction. The distillate of the third column was recycled back to the first column.

Keywords: Vapor - liquid equilibrium, Binary Azeotrope, Pressure swing distillation.