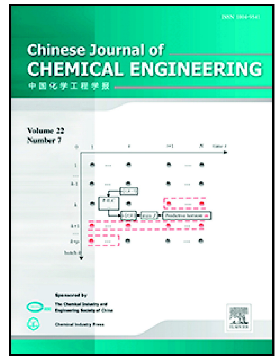

Process optimization of an industrial acetic acid dehydration progress via heterogeneous azeotropic distillation

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Process optimization of an industrial acetic acid dehydration progress via heterogeneous azeotropic distillation*

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Abstract:
The simulated process model of the HAc dehydration process under actual overloaded condition was conducted by amending the model of standard condition in our previous work[12] using the process data collected from actual production. Based on the actual process model, the operation optimization analysis of each plant (HAc dehydration column, decanter and NPA recycle column) was conducted using Residue Curve Maps (RCMs), sensitivity analysis and software optimization module. Based on the optimized parameters, the influence of feed impurity MA and the temperature of decanter on the separating effect and energy consumption of the whole process was analyzed. Then the whole process operation optimizing strategy were proposed with the objective that the total reboiler duty Q_{Total} of C-1 and C-3 reaches the minimum value, keeping C-1 and C-3 at their optimized separation parameters obtained above, connecting all the broken recycle and connection streams, and using the temperature of D-1 as operation variable. The optimization result shows that the total reboiler duty Q_{Total} of the whole process can reach the minimum value 128.2MkJ/hr when the temperature of decanter is 352.35K, and it can save 5.94 MkJ/hr, about 2.56t/hr low-pressure saturated vapor.

Key words: Acetic Acid Dehydration; Azeotropic Distillation; Process Simulation; Operation Optimization.

1 Introduction

In the production of pure terephthalic acid (PTA), acetic acid (HAc) dehydration system is one of the most important operation. When the p-xylene (PX) is oxidized to form PTA, HAc is used as the solvent, and Water is generated in the reaction process, meanwhile, there are unreacted reactant PX and by-product methyl acetate (MA) mixing in the HAc solvent besides Water. To save material consumptions, the solvent mixture should be separated and concentrated for recycle. The binary system of HAc-water has a tangent pinch on the pure-water end and its relative volatility is close to 1, so azeotropic distillation (AD) is commonly adopted to make the separation easier, and an entrainer is often introduced into the system. Previous research works in azeotropic distillation were comprehensively reviewed by Widagdo and Seider[1]. It showed that the most generally used entrainers are acetic esters, such as n-propyl acetate (NPA), n-butyl acetate (NBA), i-butyl acetate (IBA), and ethyl acetate (EA).

In recent years, most of the research about the HAc dehydration system was dedicated to the issues of process synthesis, design and control. Wasylkiewicz et al. [2] proposed using a geometric method for the optimum design of a HAc dehydrating column with NBA as the entrainer. Chien et al.[3-4] discussed the design and control of HAc dedydration system via heterogeneous AD using three candidate entrainers (EA, IBA, and NBA), and also investigated the influence of feed impurity on the dehydration column in which IBA was used as the entrainer. Huang et al.[5] and Lee et al.[6] also discussed the influence of feed