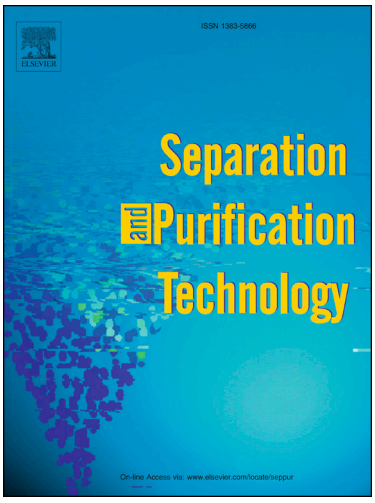

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Shoutao Ma, Xianyong Shang, Minyan Zhu, Jinfang Li, Lanyi Sun

PII: S1383-5866(18)30950-X
DOI: https://doi.org/10.1016/j.seppur.2018.09.021
Reference: SEPPUR 14919

To appear in: *Separation and Purification Technology*

Received Date: 20 March 2018
Revised Date: 20 June 2018
Accepted Date: 9 September 2018

Please cite this article as: S. Ma, X. Shang, M. Zhu, J. Li, L. Sun, Design, optimization and control of extractive distillation for the separation of isopropanol-water using ionic liquids, *Separation and Purification Technology* (2018), doi: https://doi.org/10.1016/j.seppur.2018.09.021

Design, optimization and control of extractive distillation for the separation of isopropanol-water using ionic liquids

Shoutao Ma, Xianyong Shang, Minyan Zhu, Jinfang Li, Lanyi Sun*

(a State Key Laboratory of Heavy Oil Processing, College of Chemical Engineering, China University of Petroleum (East China), Qingdao Shandong 266580, China)

Abstract: As an excellent solvent, ionic liquids (ILs) have received much attention in the last two decades. One of the most important applications is to be used as an extractant for separation of azeotropic mixtures via extractive distillation (ED). In this work, 1-ethyl-3-methylimidazolium dicyanamide ([emim][N(CN)2]) is selected as the extractant to separate isopropanol (IPA)-water azeotrope based on two ED processes. Multi-objective genetic algorithm (MOGA) is used to determine the operating parameters for these ED processes. Total annual cost (*TAC*), efficiency indicator of extractive section (E_{ext}), efficiency indicator of per tray in extractive section (e_{ext}) and energy consumption per product flow rate (*GEC*) are selected as objective functions in the ED process optimization, and the Pareto front provides a series of solutions satisfying the constraints with different operating parameters. The results show that *TAC* of the process 2 with two evaporators used in the phase of solvent recovery is 4.26% lower than that of process 1 with one evaporator. In addition, the thermodynamic efficiency (η) and CO_2 emissions are calculated for different cases, and they provide the reference for the selection of operating parameters. On this basis, the control structures of ED processes are further studied, and the traditional two-point temperature control structure works pretty well for disturbances of both feed rate and feed composition.

Keywords: Ionic liquids (ILs); Extractive distillation; Multi-objective genetic algorithm; Process optimization; Dynamic Control

1. Introduction

Distillation is one of the most widely used techniques for the separation of liquid mixtures, but the common distillation cannot be used to separate azeotrope [1]. Therefore, special distillation methods, such as pressure-swing distillation (PSD),