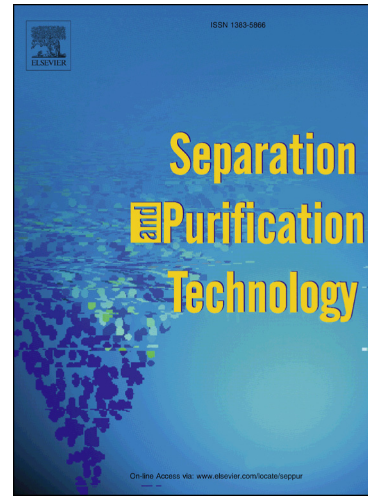
Accepted Manuscript

The production zone method: a non-ideal shortcut method for the design of distillation columns

Worms Guillaume, Meyer Michel, Rouzineau David, Brehelin Mathias



PII: S1383-5866(16)32742-3
DOI: http://dx.doi.org/10.1016/j.seppur.2017.04.019
Reference: SEPPUR 13681

To appear in: *Separation and Purification Technology*

Received Date: 16 December 2016
Revised Date: 6 April 2017
Accepted Date: 17 April 2017

Please cite this article as: W. Guillaume, M. Michel, R. David, B. Mathias, The production zone method: a non-ideal shortcut method for the design of distillation columns, *Separation and Purification Technology* (2017), doi: http://dx.doi.org/10.1016/j.seppur.2017.04.019

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

The production zone method: a non-ideal shortcut method for the design of distillation columns

WORMS Guillaume[a,b], MEYER Michel[a], ROUZINEAU David[a]*, BREHELIN Mathias[b]

a: UNIVERSITE DE TOULOUSE, ENSIACET—INP de Toulouse, Laboratoire de Génie Chimique, UMR CNRS 5503, 4 allée Emile Monso, BP 44362, 31432 Toulouse Cedex 4, France

b: SOLVAY — Research and Innovation Center of Lyon, 85 Avenue des Frères Perret, BP62, 69192 Saint-Fons Cedex, France

Abstract

Graphical shortcut methods are useful tools for the design of distillation columns. The proposed nonideal shortcut method includes a graphical representation and is based on the concept of operation leaves. This new method uses a production segment rather than a completely specified product, which eliminates any sensitivity to the composition of the minor product. Concerning phase equilibria, no restrictive assumptions are made. The study aimed 1) to determine whether a specified separation respects the mass balance and thermodynamic feasibility and 2) to find the minimum reflux ratio for a preliminary design of the column. Designs obtained with this new method for ideal, non-ideal, and azeotropic mixtures give purity and recovery rates close to the specifications, which might be impossible to obtain with a conventional ideal shortcut like the well-known Fenske–Underwood–Gilliland shortcut method. The distillation boundaries of azeotropic mixtures are taken into account thanks to a non-ideal thermodynamic model applied to the calculation, which is not the case with a conventional ideal shortcut. The paper examines the following mixtures: an ideal mixture of ethanol, n-propanol, and n-butanol; a non-ideal mixture of acetone, water, and acetic acid; and an azeotropic mixture of acetone, isopropanol, and water.

Keywords: Distillation, Shortcut method, Non-ideal mixture

1. Introduction

As one of the most important fields in process engineering, distillation column design has been researched extensively and is used in a wide range of industrial applications [3]. From a practical engineering standpoint, good distillation column design is the result of a complex process. First, certain operating and structural parameters such as the reflux ratio, feed position, and number of stages must be specified. Additionally, rigorous simulations and optimization are necessary. Finally, the column sizing must be established in accordance with the simulation.

In fact, distillation column design can be divided into three steps. The first step seeks to determine whether the desired separation is feasible from a mass balance and a thermodynamic point of view. Provided the separation is thermodynamically feasible, the aim of the second step is to obtain a preliminary design of the column and define certain key parameters such as the minimum reflux ratio (r_{min}), the total number of stages, and the feed location. Calculating the minimum energy demand of a separation is often a good way to identify the final column design with the lowest operating cost. The third and last step consists in running a rigorous simulation with a software process that uses the shortcut parameters for initialization. Optimizing this simulation provides a good compromise between capital cost and energy demand.

Download English Version:

https://daneshyari.com/en/article/4989771

Download Persian Version:

https://daneshyari.com/article/4989771

Daneshyari.com