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Review Paper

Distillation-Research, Studies and Reviews on Modeling, Simulation and Combined Mode Separations

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ABSTRACT

Distillation is one of the major separation operations used for separation of light compounds from the solution or mixtures. This operation is energy intensive and energy requirements are quite high. Efficient and effective use of the operation depends on efficiency and economy. Almost all the separation processes have some advantages and disadvantages. In many cases it is possible to combine more than one operation and minimize drawbacks and maximize the positive aspects. Distillation can be coupled with membrane operations, extraction, and solar energy in order to make it effective. Many investigators have carried out investigations on these aspects. Also modeling and simulation for distillation column is widely discussed topic. Current review summarizes research and studies on these aspects.

Key words: Energy, separation, azeotrope, binary distillation, parameters.

INTRODUCTION

Distillation is one of the major separation operations used for separation of light compounds from the solution or mixtures. This operation is energy intensive and energy requirements are quite high. Efficient and effective use of the operation depends on efficiency and economy. Almost all the separation processes have some advantages and disadvantages. In many cases it is possible to combine more than one operation and minimize drawbacks and maximize the positive aspects. Distillation can be coupled with membrane operations, extraction, and solar energy in order to make it effective. Many investigators have carried out investigations on these aspects. Also modeling and simulation for distillation column is widely discussed topic. Current review summarizes research and studies on these aspects.

REVIEW

Muyassaroh et.al. used distillation for Patchouli Alcohol of Patchouli Oil. [1] Their research was aimed at knowing how to treat the material and find out the appropriate distillation pressure to generate patchouli oil. They used leaves with three treatments: fresh leaves, aerated leaves and burned leaves in the oven. They suggested that microwave distillation can be used to increase the yield within a shorter time than conventional method. Kalla et.al. investigated separation of IPA-water mixture by extractive distillation. [2] They carried out simulation study for separation of isopropyl alcohol-water azeotrope mixture using ethylene glycol as entrainer. Their investigation indicated that top of the column contains IPA of 99.974 mol % purity and bottom product contains water-ethylene glycol mixture. Sharmila and Mangaiyarkarasi carried out investigation

on binary distillation column. [3] Their focus was on modeling and process control. These two aspects become important as it is well known that high amount of energy is consumed in the distillation operation. It is always envisaged to have a process which is energy efficient. They used energy balance equations for a mathematical model and simulation for a binary distillation column.

Mueanmas et.al. carried out an investigation on reactive distillation column for trans-esterification of palm oils. [4] They found that the existing methods for trans-esterification need almost 100 percent excess alcohol. This alcohol needs to be recovered after the process. The cost of the process increases significantly due to this. They explored the use of reactive distillation column for reduction in cost. Huynh et.al. investigated extraction of essential oil from melaleuca alterfornia. [5] In their investigation they observed that at different moisture and speed steam, the productivities were nearly equal. They carried out the research in two steps, steam distillation (essential oil extraction) and vacuum distillation (essential oil refinement). Idris et.al. carried out investigation on advanced distillation process using MOSAIC. [6] By using MOSAIC, they developed an equation oriented modeling of advanced distillation process. Chorpita et.al. carried out investigation on distillation and matching model. [7] Minh and Rani studied modeling and control of distillation column in a petroleum process. [8] In their studies they introduced a calculation procedure for modeling and control simulation of a condensate distillation column. They carried out modeling and simulation in three phases namely the basic nonlinear model of the plant, the full-order linearised model, and the reduced-order linear model. They used the physical laws from the process for the calculation of the mathematical model building and the reduced order linear adaptive controller. Mustapha et.al. carried out an investigation on modeling and simulation of high pressure distillation. [9] They identified externally controlled variables by carrying out degree of freedom analysis. Their studies indicated that continuous stirred tank model accurately represented the behavior of a theoretical tray. They felt need of model sensitivity analysis as the interactions between the different parameters were very strong. Ghaee et.al. carried out an investigation on optimization of the benzene extractive distillation unit. [10] They calculated the equilibrium and thermodynamic properties of the mixtures by using the non-random two-liquid model (short NRTL equation).

Studies were carried out by Starkey et.al. on distillation curves of waste lubricant oils and resourced crude oil. [11] Main objective of their work was waste reduction and energy utilization. For this purpose, they put reprocessing steps on a more fundamental and concrete footing. In their investigation, they presented measurements on four unused automotive crankcase oils and four samples of used oils. They used advanced distillation curve for gaining information about valuable information regarding the presence or absence of low-boiling contaminants in the recycled automotive oil. Medugu and Ndatuwong carried out studies on solar still distillation. [12] Glass cover provided the greenhouse effect. The solar radiations were used to evaporate the water inside the solar steel. Their results indicated that there was instantaneous increase in the efficiency with increase in the solar radiation and feed water temperature. Gill et.al. carried out investigation on the kinetics of mentha oil extraction from mentha leaves. [13] They studied hydrodistillation process. Their studies indicated that hydrodistillation process was time consuming and also the oil recovery by this method was less. They also observed that, with respect to oil extracted by differently pretreated mentha leaves, there was not much variation in properties such as acid value, refractive index, specific gravity, saponification values and solubility. Bekiaris carried out studies on multiple steady states in distillation. [14] In their work, they analyzed the simplest case of

ternary homogeneous azeotropic mixtures. In their work, they derived a necessary and sufficient condition for the existence of the multiple steady states. Further, they also extended the homogeneous mixture results to ternary heterogeneous mixtures. In their analysis they identified the entire mixture classes for which multiplicities are inherent and robust.

Ahmad and Lone carried out review on the hybrid pervaporation-distillation method. [15] They found that hybrid method exploits the advantages of pervaporation and adsorption while disadvantages or negative aspects are minimized. Distillation is energy intensive and more so in case of close boiling mixtures. Huss et.al. investigated methyl acetate production by using reactive distillation. [16] Their studies indicated existence of minimum and maximum reflux in the limit of reaction and phase equilibrium. Also their investigation indicated multiple steady states. Walton et.al. carried out investigation on use of membrane distillation for solar and waste heat desalination. [17] They observed linear increase in the flux with trans-membrane temperature drop. With increase in salinity, they observed drop in flux. They found the flux to be heat transfer dependent. They concluded that the degree of wetting of the membrane decides the distillate quality. Simple drying method can be used for restoring the hyperbolic properties of the membrane. Kumar et.al. used steam distillation for extraction of essential oil. [18] They extracted oil from various sources like eucalyptus leaves, curry leaves, hibiscus leaves, lemon leaves, marigold flowers, rose flowers, orange peels etc.

CONCLUSION

Distillation is energy intensive and more so in case of close boiling mixtures. Efficient and effective use of the operation depends on efficiency and economy. Almost all the separation processes have some advantages and disadvantages. In many cases it is possible to combine more than one operation and minimize drawbacks and maximize the positive aspects. Distillation can be coupled with membrane operations, extraction, and solar energy in order to make it effective.

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