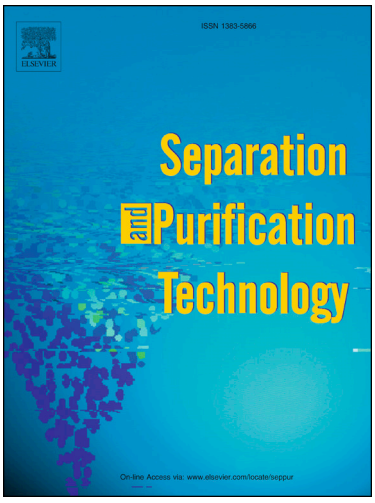

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Design and economic evaluation of energy-saving industrial distillation processes for separating close-boiling cyclohexanone-cyclohexanol mixture

Hongdan Wang[1], Chengtian Cui[1], Hao Lyu, Jinsheng Sun[*]

School of Chemical Engineering and Technology, Tianjin University, Tianjin, 300072, P. R. China

Abstract

In this study, several heat-integrated distillation processes are compared to separate the close-boiling cyclohexanone (CHON)-cyclohexanol (CHXA) for improving energy efficiency. A 4-column scheme, including two light ends columns in DRP (distillation with recycle process), a CHON column and a CHXA column, is introduced as the prototype scheme. To make improvement, light and heavy split DRP – are compared for energy optimization upon the prototype. The light split DRP turns out to be superior and thus used for subsequent steps. Four heat-integrated schemes including double-effect distillation (DED), heat pump assisted distillation (HPAD), DED plus HPAD (DEHP) and double HPAD (DHPAD) are sequentially suggested and evaluated based on total annualized cost (TAC). The results show TAC reductions from the prototype of 32.2%, 23.6%, 29.2% and 10.8% for DED, HPAD, DEHP and DHPAD, respectively. The DED scheme requires the lowest TAC due to the 48.4% operating cost and 8% capital cost saving, whereas the DEHP scheme has the lowest 56.3% operating cost reduction with 11.1% more capital investment. The line of thinking in this work will benefit in other close-boiling systems for higher energetic efficiency and economic profit.

Keywords: Cyclohexanone-cyclohexanol; Double-effect; Heat pump; Economic evaluation; Distillation with recycle process

Nomenclature

Acronyms

AOT	Annual operating time
CDiC	Conventional distillation column
CHON	Cyclohexanone
CHXA	Cyclohexanol
CS	Cold stream
DED	Double-effect distillation
DRP	Distillation with recycle process
DEHP	Double-effect plus heat pump distillation
DHPAD	Double heat pump assisted distillation
FS	Feed split
HE	Heat exchanger
HIDiC	Heat integrated distillation column
HPAD	Heat pump assisted distillation
HSDRP	Heavy spilt distillation with recycle process
HPC	High-pressure column
HS	Hot stream
LSDRP	Light spilt distillation with recycle process
LPC	Low-pressure column
LSF	Light split forward

[*]Corresponding authors.

E-mail addresses: jssun2006@vip.163.com (J. Sun).

[1]These two authors contributed equally to this work.