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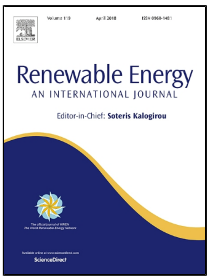

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Energy efficiency improvement of a bioethanol distillery, by replacing a rectifying column with a pervaporation unit

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Abstract

Separation methods for ethanol production are among the most energy consumption in chemical industry. The design of efficient process is part of challenges faced by process engineering. The aim of this work is to reduce the operating energy and cost of a Moroccan distillery process. The separation process of this distillery consists of a distillation, purification and rectifying column under vacuum. In this study, a hybrid distillation-pervaporation process was proposed by replacing the rectifying column, which requires more than half of the total energy of the process, with the pervaporation unit. The pervaporation unit was modeled and simulated using appropriate model. Afterwards, the design of the hybrid process has been performed coupling the obtained pervaporation model with a simulator of the separation columns. The performance of the hybrid distillation-pervaporation process has been evaluated by simulation. A reduction of about 64.5 % can be obtained for the operating energy and cost compared to the industrial distillation process.

Keywords: Energy efficiency; Design; Vacuum distillation; Pervaporation; Hybrid process.

Nomenclature

A	Area (m^2)
B	Second virial coefficient (m^3/mol)
C	Cost (€)
Con	Concentration (mol/m^3)
D	Diffusion coefficient (m/h)
E	Energy (kWh)
F	Molar flow rate (mol/h)
J	Diffusion flow rate (mol/h.m^3)
h	Enthalpy (J/mol)
L	Membrane thickness (m)
N	Number of module
P	Pressure (bar)
Q	Power (kW)
R	Gas constant
T	Temperature (K)
V	Volume (m^3)
x	Molar fraction of liquid
y	Molar fraction of vapor

Subscripts

c	Condenser
$dist$	Distillation
i	Component i
inl	Inlet
j	Component j
mem	Membrane
n	Number of cell
o	Operating
out	Outlet
$perv$	Pervaporation
reb	Reboiler
$repl$	Replacement

Superscripts

N	Number of component
$perm$	Permeate
Ret	Retentate