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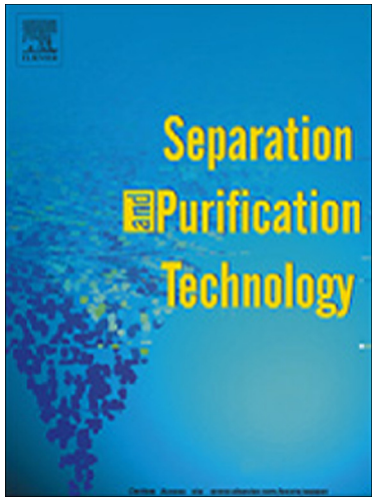

Bioethanol Recovery and Purification using Extractive Dividing-wall Column and Pressure Swing Adsorption: An Economic Comparison after Heat Integration and Optimization

Y.Y. Loy, X.L. Lee, G.P. Rangaiah

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Bioethanol Recovery and Purification using Extractive Dividing-wall Column and Pressure Swing Adsorption: An Economic Comparison after Heat Integration and Optimization

Y.Y. Loy, X.L. Lee, G.P. Rangaiah*
Department of Chemical & Biomolecular Engineering, National University of Singapore, 4 Engineering Drive 4, Singapore 117585
*chegpr@nus.edu.sg

Abstract

Extractive dividing-wall column (E-DWC) is a promising alternative to current bioethanol recovery and purification processes, garnering interest from the research community. In this study, E-DWC and pressure swing adsorption (PSA) processes are studied on a consistent basis, and an economic evaluation of both processes is made after heat integration and optimization. For this, realistic feed stream of 10 wt% ethanol, 89.9 wt% water and 0.1 wt% carbon dioxide is considered, and both processes are simulated in Aspen HYSYS v8.2. PSA process involves distillation for removing most of water, before dehydration by PSA. Results indicate that, while E-DWC process has advantages over PSA process in terms of capital cost and thermal energy demand, PSA process still has 33% lower cost of manufacture per unit product than E-DWC process, mostly because of solvent loss. This shows that it is not sufficient to consider only energy requirement in assessing the feasibility of a promising technology; rather, an overall economic evaluation under realistic conditions should be performed. In addition, this work has investigated economies of scale and identified the optimal production capacity for PSA process.

Keywords: Bioethanol; Pressure swing adsorption; Extractive dividing-wall column; Optimization; Economies of Scale

1. Introduction

As countries continue to develop and technologies continue to advance, the world demand for energy is on the rise. According to the United States (U.S.) Energy Information Administration, global energy requirement will increase by 56% between 2010 and 2040 [1]. Currently, the world depends on fossil fuels as its main energy source, but they are depleting rapidly and will not be able to sustain total energy requirement in the long run. Improvements in refining technologies have opened up the possibility of refining heavy oils, but it will only extend world fossil fuel reserves for another 50 years at most [2]. In addition, the usage of fossil fuels has adverse impact on the environment. Burning fossil fuels produces massive amount of carbon dioxide (CO_2) that is released into the atmosphere, and this is suspected to be the main cause of global warming, which has caused the polar caps to melt and average sea levels to rise, changing global climate [1]. In the face of such a predicament, alternate sources of energy have to be explored to satisfy world energy demand. An increasingly popular idea is the production and use of renewable energies that are self-sustaining and do not contribute much to environmental pollution. Examples of renewable energies are solar energy, wind energy, hydroelectric energy and bioenergy.

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