Abstract

Distillation is widely used in chemical and allied industries to separate fluid mixtures into pure components. It consumes a huge amount of energy in an inefficient way and thus, it is a potential candidate for heat integration. In this direction, the dividing wall column (DWC) has emerged as an attractive technology that reduces the energy consumption, cost and installation space. The present work aims at improving the energetic and economic performance of this DWC. To make the DWC more practical, the heat transfer through the internal dividing wall is considered and with this, we have developed a rigorous model. In distillation, the latent heat of the overhead vapor simply gets wasted in the condenser. To utilize the heat content of this vapor, a thermal coupling is made in the classical DWC between the top vapor with the liquid of intermediate tray and reboiler content. A variable manipulation policy at dynamic state is formulated for the proper utilization of internal heat source. There are azeotropes formed in many separating columns. In this regard, a ternary mixture with three (or multiple) binary azeotropes, which is sensitive to column operating pressure, is proposed to separate in a DWC. We have introduced two heat integrated schemes for this, namely vapor recompressed and heat integrated DWC. In the next, we have proposed single-partitioned and double-partitioned extractive dividing wall columns to separate a ternary mixture with two binary azeotropes. An extractive DWC, which has a single bottom reboiler instead of two reboilers (i.e., bottom and side reboiler), is configured for ethanol dehydration. Further advancement is made by thermally coupling the hot solvent with overhead ethanol vapor, intermediate water vapor and fresh feed. The performance of each of these proposed configurations of DWC is compared with their respective conventional counterpart in terms of energy and cost savings.

Keywords: Dividing wall column; heat transfer through the wall; binary azeotropes; extractive double-partitioned DWC; ethanol dehydration; energy and cost savings.