Dynamic Simulation and Control schemes of hybrid membrane-distillation process on ethylene-ethane system

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Abstract

Ethylene/ethane separation by cryogenic distillation is one of the most energy intensive separation processes due to the close boiling points of the components. But a hybrid membrane-distillation process is a possibility for energy reduction because gas separation membrane technology has a series of advantages, such as high efficiency, low energy consumption, easy operation and so on. In order to ensure the product quality and system stability by using the new hybrid membrane-distillation process on ethylene/ethane, process characteristics need to be investigated further to develop applicable control schemes combining actual conditions.

This paper presents three control scheme of hybrid membrane-distillation process on ethylene/ethane including temperature control scheme, pressure and temperature control scheme and ratio control scheme, based on distillation-vapor permeation membrane hybrid process on ethylene-ethane system. The efficiency of the three control strategies is examined on the basis of the responses to step changes of the flow rate \( \pm 5\% \), temperature \( +2^\circ\text{C} \) and \( -0.032^\circ\text{C} \) (the heat value equals the value when the temperature rises to \( 2^\circ\text{C} \)). Distillate flow rate, bottom flow rate, ethylene concentration in distillate, ethane concentration in bottom, top stage pressure, top stage temperature, reflux ration and boilup ratio eight parameters are compared to conform the optimal control strategy. The result shows that the stability of ratio control scheme is the best, but the temperature control scheme is frequently-used in the field of industrial applications for its simpler configuration.