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Dynamics and control of a heat pump assisted extractive dividing-wall column for bioethanol dehydration

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Highlights

- Highly integrated design leading to challenges in process dynamics and control
- Efficient control structure ensuring stable operation of VRC assisted E-DWC
- Disturbances in feed flowrate and composition can be effectively rejected

Abstract

Recently, a novel heat-pump-assisted extractive distillation process taking place in a dividing-wall column was proposed for bioethanol dehydration. This integrated design combines three distillation columns into a single unit that allows over 40% energy savings and low specific energy requirements of 1.24 kWh/kg ethanol. However, these economic benefits are possible only if this highly integrated system is also controllable to ensure operational availability.

This paper is the first to address the challenges related to process dynamics and control of this highly integrated system. After showing the control difficulties associated with the original design owing to thermal unbalance, an efficient control structure is proposed which introduces a by-pass and an additional external duty stream to the side reboiler. The range of the external duty is rather small, about 5% of the combined duty of the reboilers, but sufficient to stabilize the system by controlling the temperature on the pre-concentration side of the column. Two quality control loops ensures product purity when the system is affected by feed flowrate and composition disturbances.

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