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Step-wise synthesis of work exchange networks involving heat integration based on the transshipment model*

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Abstract: Due to the deterioration of serious energy dilemma, energy-conservation and emission-reduction have been the strategic target in the past decades, thus people have indentified the vital importance of higher energy efficiency and the influence of lower carbon development. Since work exchange network is a significant part of energy recovery system, its optima design will have dramatically significant effect on energy consumption reduction in chemical process system. With an extension of the developed transshipment model in isothermal process, a novel step-wise methodology for synthesis of direct work exchange network (WEN) in adiabatic process involving heat integration is first proposed in this paper, where a nonlinear programming (NLP) model is formulated by regarding the minimum utility consumption as objective function and optimizing the initial WEN in accordance with the presented matching rules to get the optimized WEN configuration at first. Furthermore, we focus on the work exchange network synthesis with heat integration to attain the minimal total annual cost (TAC) with the introduction of heat-exchange equipment that is achieved by the following strategies in sequence: introducing heat-exchange equipment directly, adjusting the work quantity of the adjacent utility compressors or expanders, and approximating upper/lower pressure limits consequently to obtain considerable cost savings of expanders or compressors and work utility. Finally, a case taken from the literature is studied to illustrate the feasibility and effectiveness of the proposed method.

Key words: work exchange network, transshipment model, adiabatic process, trade-off between work and heat, economic analysis

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