Direct work exchange networks synthesis of isothermal process based on superstructure method

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Abstract

Properly integrating mechanical energy between high-pressure (HP) and low-pressure (LP) streams via direct work exchangers has been a significantly promising strategy to improve energy efficiency of industrial process, thus achieving energy conservation and emission reduction. This paper presents a mixed-integer nonlinear programming (MINLP) model with the objective of minimized total annual cost (TAC) to synthesize direct work exchange networks (WEN) of isothermal process. Two upgraded stage-wise superstructures with and without stream splits are developed, which explicitly include entire feasible matches, and handle all the parameters and possible network structures. The proposed superstructures are relatively different from that of heat exchange networks (HEN) because it is essential to consider the optimized selection of utility compressors/expanders in each stage, and utility compressors for LP streams prior to entering the superstructure. Ultimately, a case study is conducted to demonstrate the synthesis of direct work exchange networks based on superstructure method can offer vitally considerable savings in TAC. The results indicate that our approach yields a network with 20.0 % lower TAC and 18.8 % lower TAC, respectively, compared with that of transshipment model and graphical method.