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Finite time thermodynamic optimization for heat-driven binary separation processes

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ABSTRACT

The performance of heat-driven binary separation processes with linear phenomenological heat transfer law ($q \propto \Delta(T^{-1})$) is optimized by using finite time thermodynamics. Two performance indexes, the dimensionless minimum average entropy production rate and dimensionless minimum average heat consumption of the heat-driven binary separation processes, are taken as optimization objectives, respectively. The separation processes are viewed as heat engines which work between high- and low-temperature reservoirs and produce enthalpy and energy flows out of the system. The temperatures of the heat reservoirs are assumed to be time- and space-variables. The convex optimization problem is solved using numerical method, and the average optimal control problem is solved using Lagrangian function. The major influence factors on the performance of the separation process, such as the properties of different materials and various separation requirements for the separation process, are represented by dimensionless entropy production rate coefficient and dimensionless enthalpy flow rate coefficient. The dimensionless minimum average entropy production rate and dimensionless minimum average heat consumption of the heat-driven binary separation processes are obtained, respectively.

Keywords: Linear phenomenological heat transfer law; Heat-driven separation; Binary separation process; Heat consumption; Entropy production rate; Finite time thermodynamics
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