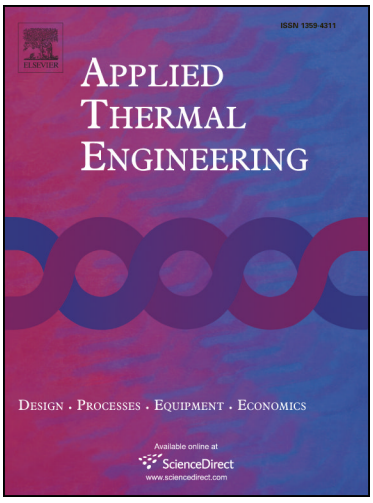

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Dynamic simulation of a single nitrogen expansion cycle for natural gas liquefaction under refrigerant inventory operation

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Abstract

Nitrogen (N_2) expansion natural gas liquefaction technology is wildly used for liquefied natural gas production due to its unique advantages. However, few works have been reported about the detailed unit operating performance of N_2 expansion system under refrigeration inventory operation that is one of the most effective operations for adjusting system refrigeration capacity. In this study, we have comprehensively investigated the dynamic characteristics of a single N_2 expander liquefier under inventory operation. Firstly, system model of the liquefier is developed based on rigorous first principles, valid empirical correlations and accurate physical property. Meanwhile, plate-fin heat exchanger model, as a key component, is reasonably and greatly simplified according to symmetric layer arrangements. Using the system model, the transient system behaviors are identified and evaluated. The primary performance parameters of centrifugal compressor train, e.g. efficiency, surge margin and input power, experience the most dramatic changes during the first several seconds after the operation starts. ±6% variations in total nitrogen refrigerant mass result in −4.5 and +5.6 °C variations in LNG temperature, +8.7% and −8.4% variations in liquefier input power and maximum −7.8% variation in compressor surge margin, eventually. In general, the liquefier exhibits strong nonlinear behaviors.