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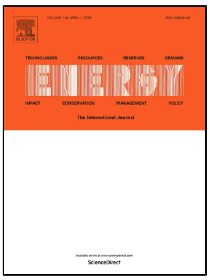

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Optimal retrofitting of natural gas pressure reduction stations for energy recovery

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keywords: natural gas pressure reduction stations; energy recovery; optimal design; system thermal integration; turbo expander; district heating

Highlights

- A novel comprehensive approach for pressure reduction stations retrofitting based on structured procedure.
- An optimization model enabling the maximum energy recovery in natural gas pressure reduction stations.
- Turbo-expander size defining the recovery potential and leading to non-smooth constrained optimization.
- Optimal design of natural gas expansion process for thermal integration with low-temperature processes.

Abstract

In this paper, a structured retrofitting approach (SRA) to the near-optimal design of natural gas (NG) pressure reduction stations (PRSs) is presented. The SRA is designed by considering the waste energy recovery, system integration opportunities and long-term-based objectives to successfully address the entire PRS retrofitting process. The SRA is developed in four phases: pre-retrofit activities, preliminary and executive project design, implementation and commissioning and post-retrofit activities. For design optimization during the preliminary and executive project design phase, a novel mathematical model was developed based on the minimization of the levelized cost of energy (LCOE). The optimization model consists of a non-smooth constrained problem that has been solved by means of different solution methods and has been tested for different thermal peak loads, fuel purchase costs, and natural gas flow rates. Variations of the thermal design conditions from 2,900 kW to 1,300 kW for a constant annual heat demand, fluctuations of the percentage increase of the NG cost by 80-100-120-140%, and reductions of the NG user demand of 30% and 60% were considered. The results highlighted that the proposed optimization technique in PRS retrofitting identifies the best system configuration and turbo expander technology.
