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C2Po1H-03 [45]: Process analysis and optimization of 1000L/h medium-scale hydrogen liquefaction cycle

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With the rapid development of world economics and increasing environmental problems caused by the harmful gaseous emissions, the low or zero emissions and frequently reused resources, renewable energies are regarded as sustainable replacements to fossil fuels. Hydrogen, as a kind of clean and efficient energy, would play a key role in future energy systems of the world and possible to become main chemical energy carriers. Among all the storage method of medium and large-scale hydrogen utilization, liquid hydrogen is regarded as one of the best storage methods in terms of highest energy storage density. In this paper, the detailed simulation and analysis of the process are carried out by using Aspen HYSYS for the preliminary design of 1000L/h hydrogen liquefaction process adopted liquid nitrogen precooling and helium gas turbine expansion refrigeration. The genetic algorithms are selected in the present paper for the multi-parameter optimization by considering the specific energy consumption as the objective function of the system parameters. The simulating results show that the specific energy consumption of the optimized system is 8.526 kWh/kgLH2, which is 2.53% lower than that prior to the process optimization and the exergy efficiency is 0.4497, which is 2.60% higher than that prior to the process optimization. Comparing the mixed refrigerant cycle (MRC) and the process of this paper, the results show that the specific energy consumptions (SEC) of the MRC is smaller, on the other hand, the process of this paper is more dominant in security.

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