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C2Po1H-06 [48]: Thermodynamic Design of Hydrogen Liquefaction Systems to Utilize LNG Cold Energy

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A thermodynamic study is carried out for the design of hydrogen liquefaction systems with pre-cooling to utilize the cold energy of Liquefied Natural Gas (LNG). As liquid nitrogen is commonly used as pre-cooler of hydrogen liquefaction, LNG is proposed as an alternative, since the need of liquid hydrogen and the import of LNG are simultaneously increasing in Korea. Two different liquefaction systems with LNG pre-cooling are considered, including standard hydrogen Claude cycle and He Brayton refrigeration cycle. He Brayton cycle is a good option for small-scale liquefaction of hydrogen to take advantage of simple and safe (low-pressure) operation. Rigorous cycle analysis is carried out with the thermodynamic properties of real fluids, and a process simulator (Aspen HYSYS) is used to calculate the FOM (figure of merit) of liquefaction. The optimal conditions are determined to maximize the overall thermodynamic performance for the purpose of utilizing the cold energy of LNG. Full details of optimized cycle are presented in terms of itemized irreversibility in each component, and the proposed cycle is compared with the existing liquefaction systems with liquid-nitrogen pre-cooling and without pre-cooling.

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