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C1Po1A-03: Effect of helium-neon composition in Brayton refrigeration cycle for hydrogen liquefaction

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A thermodynamic study is carried out to investigate how the composition of helium-neon mixture in Brayton refrigeration cycle affect the liquefaction performance of hydrogen. Two-stage expansion Brayton cycle is proposed for pre-cooling of a Linde-Hampson hydrogen liquefaction system, because the operating pressure of hydrogen can be significantly reduced. As refrigerant of the Brayton cycle, a gas mixture of helium and neon is considered as well as pure helium in order to take advantage of neon in both centrifugal compression and turbo expansion. Based on selected practical simulation basis, a rigorous thermodynamic cycle analysis is performed with process simulator (Aspen HYSYS) and the real-gas properties of mixed refrigerant and hydrogen. The specific energy consumption (SEC) for liquefaction is estimated for a variety of design parameters, such as the pre-cooling temperature, the flow rate, the pressure level, and the composition of mixed refrigerant. It is verified that the helium-neon composition can be optimally determined, taking into consideration the operation of turbo-machinery and the constraint of freezing temperature of neon. Details of design issues are presented and discussed towards the practical development of a prototype liquefier.

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