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Alterative Recuperative Heat Exchanger Design and Operating Results for Distributed-Scale Natural Gas Liquefiers

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Abstract

Natural gas liquefaction plants with cooling capacities on the order of 100 kilowatts (kW) are expected to play a roll in the development of a distributed energy infrastructure. Liquefaction plants of this scale must carefully balance delivery time and capital costs with performance. These requirements place special design requirements on many of the system components including the main recuperative heat exchanger that transfers heat between the cool low-pressure and warm high-pressure refrigerant streams in the refrigeration cycle.

This paper discusses how distributed-scale natural gas liquefiers may utilize either a single brazed aluminum plate-fin heat exchanger typical of the air separation industry or multiple stainless steel brazed plate heat exchangers typical of the refrigeration industry. Heat exchanger design, specification, and performance are compared for three plants using modified-Brayton cycle refrigeration systems. First, the recuperative heat exchangers in two liquefiers developing 20 kW and 90 kW of cooling power are described. These heat exchangers consisted of multiple stainless steel brazed plate heat exchangers assembled in series and/or parallel. The larger system is then compared to a 100 kW liquefier utilizing a single more traditional brazed aluminum plate-fin heat exchanger. The performance, capital costs, delivery time, integration costs, reliability, and additional intangibles of both heat exchanger designs are considered as they relate to refrigeration system scale and thermodynamic cycle. Operational experience shows that either brazed plate heat exchangers or brazed aluminum plate-fin heat exchangers may work well for natural gas liquefiers. Selecting the appropriate heat exchanger configuration depends primarily on the required performance, scale, and refrigeration cycle.