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C2Po1C-01: Thermodynamic and exergetic evaluation of CO2 liquefaction for ship transport

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As a crucial component of carbon capture, utilization and storage (CCUS) projects, CO2 transport makes sense for expanding the scale of CO2 utilization. And CO2 liquefaction is significant to ensure transportation safety and improve efficiency. In the demand for long-distance transport on the sea, using ship instead of pipeline is considered more competitive. Aiming at the temperature and pressure required for ship transport, this paper studies four liquefaction schemes including the compression refrigeration system, the Linde Hampson system, the precooled Linde Hampson system and the Claude system. The thermodynamic and exergetic ananlysis models are established primarily and then the relevant design parameters are determined through simulations and optimizations by HYSYS software. Total power consumption, liquefaction efficiency and exergetic efficiency of the four systems are calculated and compared. The precooled Linde Hampson system shows the best performance with the three indicators of 391.74kJ/kg, 97.97% and 55.86%, respectively. Additionally, exergy destruction among the system components are analyzed for Linde Hampson system and precooled Linde Hampson system. The maximum exergy destruction stem is form compressors. And the proportion of the total exergy destruction with J-T valves are 19.38% and 2.63%, respectively. Furthermore, the replacement of the J-T valve by a liquid expander is studied. For these two systems, 9.35% and 0.94% of the power consumption could be reduced. The pressure drop before and after the J-T valve directly determines the effect of this change. The research results could provide some vital reference for choosing proper CO2 liquefaction methods and reducing energy consumption during the process.

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