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Energy Efficient Retrofitting and Optimization of Dual Mixed Refrigerant Natural Gas Liquefaction Process

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Abstract : Globally, liquefied natural gas (LNG) has drawn interest as a green energy source in comparison with other fossil fuels, mainly because of its ease of transport and low carbon dioxide emissions. It is expected that demand for LNG will grow steadily over the next few decades. In addition, because the demand for clean energy is increasing, LNG production facilities are expanding into new natural gas reserves across the globe. However, LNG production is an energy and cost intensive process because of the huge power requirements for compression and refrigeration. Therefore, one of the major challenges in the LNG industry is to improve the energy efficiency of existing LNG processes through economic and ecological strategies. The advancement in expansion devices such as two-phase cryogenic expander (TPE) and cryogenic hydraulic turbine (HT) were exploited for energy and cost benefits in natural gas liquefaction. Retrofitting the conventional Joule–Thompson (JT) valve with TPE and HT have the potential to improve the energy efficiency of LNG processes. This research investigated the potential feasibility of the retrofitting of a dual mixed refrigerant (DMR) process by replacing the isenthalpic expansion with isentropic expansion corresponding to energy efficient LNG production. To fully take the potential benefit of the proposed process retrofitting, the proposed DMR schemes were optimized by using a Coggins optimization approach, which was implemented in Microsoft Visual Studio (MVS) environment and linked to the rigorous HYSYS® model. The results showed that the required energy of the proposed isentropic expansion based DMR process could be saved up to 26.5% in comparison with the conventional isenthalpic based DMR process using the JT valves. Utilization of the recovered energy into boosting the natural gas feed pressure could further improve the energy efficiency of the LNG process up to 34% as compared to the base case. This work will help the process engineers to overcome the challenges relating to energy efficiency and safety concerns of LNG processes. Furthermore, the proposed retrofitting scheme can also be implemented to improve the energy efficiency of other isenthalpic expansion based energy intensive cryogenic processes.

Keywords : cryogenic liquid turbine, Coggins optimization, dual mixed refrigerant, energy efficient LNG process, two-phase expander
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