C3MR LNG PROCESS OPTIMIZATION: PARALLEL GENETIC ALGORITHM INTERFACE

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Environmental protection and sustainable development, emissions, energy efficiency, and economic profits have become important considerations in the present industrial studies. These considerations are now being simultaneously included as multiple optimization objectives. To this day, the non-dominated sorting genetic algorithm (NSGA-II) is the most widely utilized multi-objective optimization algorithm in real-word applications. A great effort has been made to connect the NSGA-II algorithm with modern process simulators such as Aspen Plus. However, Aspen Plus-based genetic optimization suffers from extensive computation time. To tackle this problem, a novel approach, the Parallel Genetic Algorithm Interface, is proposed. As opposed to the traditional approach, the PAGAN algorithm makes use of the fact that fitness functions can be vectorized in Matlab-based GA, and that Aspen Plus simulations can be run asynchronously. Thanks to the accelerated algorithm, extensive optimization studies were made possible. For our studies, the propane-precooled mixed-refrigerant (C3MR) liquefaction process was chosen. A standard C3MR 3.5 MTPA LNG production process scheme was set up in Aspen Plus environment with 18 process parameters selected for single- and dual-objective optimization of both the processing costs and the associated CO_2 emissions, with the process parameter deviation range of ±75%. The PAGAN algorithm achieved a seven-fold decrease in the computation time which enabled increasing the number of individuals in the optimization runs up to 1000, while achieving a 12% decrease in processing costs and 14% decrease in CO_2 emissions. The difference in the Pareto front position between the runs led to the conclusion that the number of individuals needed to approach the optimal conditions in C3MR LNG production is much higher than the 200 commonly used in studies.

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