Rigorous design of combined process for CO$_2$ capturing and compression in RNGRCs using surrogate models

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Abstract

Raw natural gas treating processes remove enormous CO$_2$ and consume a lot of energy. The CO$_2$ can be further compressed for storage or utilization to promote environmental protection. For the purpose of economic design of the combined process of raw natural gas treating and CO$_2$ compression, a new superstructure combining CO$_2$ removing and compression processes is presented. In the superstructure, the rich solvent is not regenerated in the distillation column but through a series of flash separators at different operating pressures and temperatures. The removed CO$_2$ with varying pressures is then compressed to meet the transportation pressure separately. The optimal process structure and operating conditions are determined by minimizing the total annual cost (TAC). To obtain a good trade-off between calculation accuracy and efficiency, a surrogate-based optimization framework is presented to address the NLP problem. The complex unit operation models are represented by the Kriging surrogate models, which are built from training data generated via Aspen HYSYS. The surrogate models are then incorporated into the mathematical superstructure framework for optimization. The case study results indicate that the proposed process achieves a significant TAC decrease (9% - 21%).