Feasibility Bounds in Operational Optimization and Design of Crude Oil Distillation Systems Using Surrogate Methods

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Abstract

Crude oil distillation systems, comprising distillation units and their associated heat recovery networks, are highly complex and integrated systems. Their function is to separate crude oil into several streams with different boiling ranges for downstream processing. In practice, these systems typically need to be operated efficiently, so that the value added by the separation units is maximized (e.g. by maximizing flows of the most valuable intermediate products while minimizing production costs). Process improvement projects typically seek to increase production and/or to reduce energy consumption in existing crude oil distillation systems.

Recent developments in design and operational optimization of crude oil distillation systems apply surrogate models, together with stochastic optimization techniques, for column design or operational optimization. Column operation is highly constrained by the product specifications and, in existing columns, by physical limitations related to column configuration and size. Column models must capture these constraints. The effectiveness of surrogate modeling of the columns is enhanced in this work by developing complementary screening and filtering correlations and surrogate models (using artificial neural networks and support vector machines) to define feasibility bounds. Applying these feasibility bounds enables more targeted searches, bringing robustness and efficiency to the optimization frameworks.

Examples and case studies illustrate the effectiveness of the correlations and surrogate models for defining constraints in design and operational optimization approaches.