Design and Optimization of Modular Biorefinery Supply Chain Under Uncertainty

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Abstract

Biomass supply chain performance is heavily affected by uncertainties stemming from supply, demand, or unexpected disruptions. Unlike petrochemical plants that use crude oil, biorefineries often have to deal with the uneven spatial-temporal distribution of feedstock supply. The modular production strategy provides more flexibility in chemical manufacturing by allowing fast capacity expansion and unit movement. However, modeling and optimizing modular biomass supply chain under uncertainties becomes challenging due to high-dimensionality and the existence of discrete decisions. This work optimizes the multiperiod biomass supply chain using the rolling horizon planning and two-stage stochastic programming framework. We then applied generalized Benders decomposition to reduce the computational complexity of the stochastic mixed integer nonlinear programming (MINLP) supply chain optimization. Furthermore, the solution of the stochastic programming could be used to quantitatively describe the life-cycle assessment uncertainties of the biomass supply chain performance, demonstrating seasonality and random variability.

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