Mixed-Integer Nonlinear Programming Models for the Optimal Design of Multi-product Batch Plant

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Overview

In this optimization problem we develop models for the optimal design of multi-product batch chemical plants problem. The objective is to minimize the total investment cost in the design of a chemical plant that produces multiple products and includes a few processing stages and a number of parallel units in each stage. The models simultaneously determine the number and size of processing units in each production stage of a given plant, as well as the batch sizes and cycle times for each product manufactured in this plant.

Two mixed-integer nonlinear programming (MINLP) formulations of this problem are presented. The first formulation is a nonconvex MINLP with a nonconvex objective function and several nonconvex constraints, whose relaxation corresponds to a geometric program with posynomials. The integer variables for the number of processing units are modeled through a binary expansion. Using exponential transformation of the variables, we obtain the second formulation, which is an MINLP with a convex objective function, linear constraints and with only one nonlinear constraint, which is also convex. Two examples are solved to illustrate the application of the models and compared their computational efficiency using MINLP solvers including Alpha-ECP, BARON, Bonmin, DICOPT and SBB.

Reference

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