Mixed-integer nonlinear programming models for optimal design of reliable chemical plants

Yixin Ye∗1, Ignacio E. Grossmann†1, and Jose M. Pinto‡2

1Department of Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA 15213
2Business and Supply Chain Optimization R&D, Praxair, Danbury, CT 06810

Motivated by reliability/availability concerns in chemical plants, we propose MINLP models to determine the optimal selection of parallel units considering the trade-off between availability and cost, where single units are given with fixed probabilities of being available. Assuming an underlying serial structure for availability, we assume that for each stage, at least one unit is needed to work properly, and the standby units are started in certain priority orders. A non-convex MINLP models maximizing net profit is introduced. In addition, a convex ε-constraint MINLP model maximizing availability subject to varying cost upper bound is formulated. The models are implemented in GAMS 24.4.1 on an Intel(R) Core(TM) i7, 2.93GHz. Commercial solvers BARON 14.4.0 and DICOPT(based on CONOPT 3.16D and CPLEX 12.6.1.0) were used. The performance of the models on several examples indicate the potential of application on practical problems.

∗yye1@andrew.cmu.edu
†Corresponding Author: grossmann@cmu.edu
‡Jose_M_Pinto@praxair.com