GLOBAL OPTIMIZATION OF AN INDUSTRIAL GAS NETWORK

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GAS PIPELINE NETWORKS

Pre-existing network of gas pipelines connecting air separation units and consumers

O₂ network

N₂ network

Consumer

Consumer
CHALLENGE

• Numerical characteristics of the model proved a challenge to all solvers

• Difficult to use the results from a numerically unstable model in the RTO application

• It is necessary to develop global optimization facilities to deal with problems with many local solutions
MODEL IMPROVEMENT

• Quality of the model was improved with the following efforts:
  – Elimination of variables
  – Elimination of equations
  – Algebraic reformulations to make model more amenable to optimization
  – Disjunctive reformulations to effectively tackle logic conditions

• Numerical characteristics were improved by statically scaling equations and variables to avoid very large and very tiny coefficients
INFEASIBILITY ANALYSIS

- Combing regression models pertaining to various subparts of the model led to feasibility issues

- Motivated the development of IIS (Irreducible Inconsistent Sets) detection module in BARON

- IIS is an infeasible set with any proper subset feasible

- Isolating an IIS can provide insights into the model and speed up model correction process

- Feasibility in RTO model achieved after 6 iterations of corrections
RESULTS

• The improvements allow for solution of the original model within 5% gap within 1500 seconds, with a 15% improvement in objective value

• Fixing of a few binary variables through heuristics leads to a dramatic reduction in solution time

• Suboptimal solutions can be achieved through fixing of binaries in ~6 seconds