MPEC strategies for optimization of pipeline operations

Ajit Gopalakrishnan [*], B. T. Baumrucker, L.T. Biegler [†]

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Overview

Case studies are presented to demonstrate the MPEC pipeline model. The case studies focus on a large fictitious network with 3 sources, 15 demands, 29 arcs, and 30 nodes based loosely on [1].

The optimization problem is to minimize the power consumed by the compressors at the supplier nodes whilst simultaneously satisfying the customer requirements and respecting the physical constraints of the pipeline network. The partial differential equations describing the material balance are integrated using a multi-period approach. In particular, the trapezoidal rule is used to integrate the material balance PDEs. The momentum balance is a nonlinear differential equation in space and is discretized spatially using orthogonal collocation on finite elements. The nonsmooth absolute value operator used to model flow reversals here requires a complementarity reformulation. Thus the resulting objective function and physical constraints of the pipeline are nonlinear. The complementarities in the constraints arising from the Reynolds number calculation are moved to the objective function by reformulating them as penalty functions with a sufficiently large penalty term of 10^{-3}. This is done through the `reftype penalty` option in the NLPEC solver. CONOPT (with default options) is chosen as the NLP subsolver.

[*]Corresponding Author, Chemical Engineering Department, Carnegie Mellon University, Pittsburgh, PA 15213 USA, agopalak@andrew.cmu.edu

[†]Chemical Engineering Department, Carnegie Mellon University, Pittsburgh, PA 15213 USA

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