

Tight MILP formulation for pipeline gas flow with linepack

D.A. Tejada Arango; G. Morales España; S. Wogrin; T. Klatzer

Abstract-

In integrated power and gas energy system optimization models (ESOMs), pipeline gas transmission with linepack is a particularly complex problem due to its non-linear and non-convex character. For ESOMs based on mixed-integer linear programming, piecewise linearization is a well-established convexification approach for this problem, which, however, requires binary variables to model feasible combinations of linear gas flow and pressure segments and thus can quickly become computationally challenging. In order to improve computational performance, this paper proposes a piecewise linearization method specifically designed to be tight, resulting in a reduced problem space a solver can explore faster. We provide numerical results comparing the proposed formulation against two piecewise linearizations from the literature, both from a theoretical point of view and in terms of practical computational performance, with results showing an average speed-up of 2.57 times for our case study. Test cases are carried out on a modified 24-bus IEEE Reliability Test System and a 12-node gas system, considering discrete unit commitment decisions.

Index Terms- Integrated energy system modeling; Gas flow; Linepack; Piecewise linearization; MILP

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Citation:

Klatzer, T.; Morales-España, G.; Tejada, D.A.; Wogrin, S. "Tight MILP formulation for pipeline gas flow with linepack", International Journal of Electrical Power & Energy Systems, vol.169, pp.110734-1-110734-12, August, 2025.