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Hierarchical modelling and optimal control for gas networks

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ABSTRACT

During the last years there has been intense research in the field of simulation and optimization of gas transport in networks. The equations describing the transport of gas in pipelines are based on the Euler equations, a hyperbolic system of nonlinear partial differential equations, mainly consisting of the conservation of mass, momentum and energy. The transient flow of gas may be described appropriately by equations in one space dimension. For the whole network, adequate initial and boundary values as well as coupling conditions at the junctions are needed. [1,2]

Although solving one-dimensional equations does not pose a challenge, the complexity increases with the size of the network. Thus, we present a hierarchy of models that describe the flow of gas in pipelines qualitatively different: The most detailed model we use consists of the isothermal Euler equations (continuity equation and momentum equation). A common simplification of the momentum equation leads to a semilinear model, which is only valid if the velocity of the gas is much less than the speed of sound ($v \ll c$). Further simplifications lead to the steady state model.

In this talk we present a strategy how to decide in which regions of the network which model has to be used to reduce the complexity of the whole problem whereas the accuracy of the solution is maintained. Using sensitivity analysis, we compute the model error of the simplified models, i.e. of the semilinear and the steady state model, with regard to some quantity of interest. This requires the solution of adjoint systems. In addition, we use these solutions to optimize control variables with respect to quantities of interest. [3,4]

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