Disretization and model adaptivity for the simulation and optimization of Euler equations arising in gas transport and district heating

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Abstract

We discuss the simulation and optimization of gas and hot water flow in pipe networks. The behavior of the hot water flow is modeled using the incompressible 1D Euler equations and that of the gas flow via the compressible Euler equatios expressed as a dissipative Hamiltonian system. By applying different simplifications to the models, we derive catalogs of models. The simulation and optimization is based on these catalogs and adaptively controls where in the network which model is used and the granularity of the applied discretization is controlled in a similar adaptive manner. We are able to obtain optimal solutions at low computational costs that satisfy a prescribed tolerance w.r.t. the most accurate modeling level. To adaptively control the switching between different levels and the adaptation of the discretization grids, we derive error formulas and a posteriori error estimators. Under reasonable assumptions we prove that the adaptive algorithm terminates after finitely many iterations and we are able to produce solutions for problem instances that have not been solvable before.

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