# ***Port-Hamiltonian modelling and simulation of network DAEs***

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We present a port-Hamiltonian modeling of gas networks in form of a partial differential algebraic equation system based on the mass flow balance equation and network element models describing the relation between enthalpy and mass flow. The set of network elements includes pipes, compressors, resistors and valves. We use the pipe model description from [1] that provides perturbation bounds via relative energy estimates.

Using the mixed-finite element spatial discretization part from the pipe discretization presented [2], we derive a port-Hamiltonian differential algebraic equation system. Finally, we present convergence criteria for a waveform relaxation approach for couplings of the resulting network DAEs exploiting the convergence result for coupled DAEs given in [3, Theorem 2.4].

## References

[1] H. Egger, J. Giesselmann: Stability and asymptotic analysis for instationary gas transport via relative energy estimates. *Numerische Mathematik* 153, pp. 701-728 (2023).

[2] H. Egger, J. Giesselmann, T. Kunkel, N. Philippi: An asymptotic-preserving discretization scheme for gas transport in pipe networks. *IMA Journal of Numerical Analysis* 43(4), pp. 2137-2168 (2023).

[3] J. Pade, C. Tischendorf: Waveform relaxation: a convergence criterion for differential-algebraic equations. *Numerical Algorithms* 81, pp. 1327–1342 (2019).

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