Fraunhofer IEG | Brandenburgische Technische Universität Cottbus - Senftenberg | Energie-Innovationszentrum Cottbus

MASTER THESIS (COTTBUS)

Physics-compatible modeling of transient processes in district heating grids

Numerical Fluid and Gas Dynamics, BTU Cottbus-Senftenberg
Scientific Computing Lab, Energy Innovation Center (EIZ) Cottbus
Fraunhofer IEG, Cottbus

Synopsis – The economical modeling of dynamical processes in district heating grids has remained a challenge. In contrast to the short, almost instantaneous, relaxation time scales found in electric power grids, heating grids respond on orders of magnitude slower time scales. Transient processes emerge by imbalances between sources, sinks, and the fluid flow properties in the components of the grid itself. This circumstance, however, can lead to a number of unwanted effects, especially if control is provided on the wrong time scales. The emerging dynamical processes can be complicated, but they are always associated to fluid flows governed by well-known physical conservation principles. Mathematical equations and physics-compatible discretization strategies are utilized in computational fluid dynamics (CFD), which, however, is too costly for heating grids. Nevertheless, advanced control systems can benefit from CFD-based approaches to time-dependent heated pipe flows, also utilizing available data in an economical way, for instance, by reduced-order modeling (ROM) and machine learning (ML). Here, the software tool of choice will be *pandapipes* (`https://www.pandapipes.org`; `https://github.com/e2nIEE/pandapipes`).

Tasks

- Gain an understanding of the model formulation and the numerical algorithm
- Develop a time-dependent formulation based on the physical principles of heated pipe flows, possibly by a reduced-order model (ROM) or machine learning (ML) based approximation
- Develop a CFD inspired, physics-compatible discretization strategy for the transient solver extension
- Implement the extended algorithm into *pandapipes*
- Validate the extended solver for idealized heating grids

Mandatory skills and/or requirements

- Student of a STEM study programme or a closely-related discipline

Desired skills

- Solid knowledge of fluid mechanics and/or computational fluid dynamics (CFD)
- Solid knowledge of numerical methods, preferably for CFD, dynamical, control systems
- Proficiency in Python and/or another higher programming language (C/C++, Fortran, MATLAB, . . .)
- Proficiency in algorithms for data analysis, including Machine Learning (ML)
- Scientific attitude (curiosity, self-motivation, and critical reasoning)

Contact

- **Dr. Marten Klein** (`marten.klein@b-tu.de`)
- **Prof. Dr. Tanja Kneiske** (`tanja.kneiske@ieg.fraunhofer.de`)

`https://www.b-tu.de/en/fg-stroemungsmodellierung`
`https://www.b-tu.de/en/energie-innovationszentrum`
`https://www.ieg.fraunhofer.de/en.html`