Fraunhofer IEG

Brandenburgische Technische Universität Cottbus - Senftenberg

Energie-Innovationszentrum Cottbus

Master Thesis – Advanced Temperature Control of Heat Exchangers based on CFD-Simulations (Cottbus)

In light of the conclusions presented in the Heat Roadmap Europe, it is evident that the collective heat demand across 27 European countries constitutes approximately 50% of the final energy consumption. Consequently, the heat sector takes a pivotal role influencing European CO_2 emissions, underscoring the imperative for a renewable energy driven heat supply to effectively address the challenges posed by global warming.

In this context, district heating grids (DHGs) play a major role since they can realize fully decarbonized heat supply utilizing various distributed heat sources. The principle of operation of a DHG is the transport of water heated by the decentralized producers to the consumers, who extract heat from this water and thereby lower the water temperature across the grid.

A central component that couples a heat source or heat sink to the DHG is a heat exchanger. The applicable heat exchanger technology considered here enables heat transfer between two hydraulically separated mass flows. The heat transfer crucially depends on the mass flow rates and the mechanical design, resulting in complex (highly nonlinear) transfer properties. Precise control of such heat exchangers and the exhibited transfer processes is important for economical DHG operation. Therefore, the aim of this master thesis is to investigate the performance of state-of-the-art heat exchanger control methods on the basis of a physically compatible computational fluid dynamics (CFD) model of the heat exchanger. The CFD model may utilize different layers of fidelity and complexity from which a reduced-order representation of the operational parameter landscape is seeked (e.g. with machine learning tools).

The master thesis will be supervised by Fraunhofer IEG researchers on energy and control engineering topics and by researchers from the Chair of Numerical Fluid and Gas Dynamics from Brandenburg University of Technology Cottbus-Senftenberg regarding CFD-related topics.

If you are interested in this master thesis within an open and diverse team, and in bridging the gap from applied to fundamental research, apply now!

What you will work on

- Literature review on heat exchangers and internal transfer processes in district heating, mathematical modeling of heat exchangers based on CFD simulations of plate heat exchangers. (~1,5 month)
- Implementation of a CFD model with appropriate fidelity describing thermal and hydraulic dynamics of water-to-water plate heat exchangers, followed by CFD-data-based model reduction (~1,5 month)
- Design and software implementation of promising temperature control strategies for water-to-water plate heat exchangers (~1 month)
- Simulation case study to evaluate performance of designed temperature control strategies for heat exchangers when tested with the CFD-based reduced order model as Software-in-the-Loop approach (~1,5 month)
- Documentation of the results (~0,5 months)

Your skills

- Student in Engineering, Mathematics, Energy technology, or other STEM programs
- Good knowledge of fluid dynamics or/and heat and mass transfer or/and mathematical modeling or/and simulation of dynamical systems
- User experience with CFD simulation tools, preferably ANSYS Fluent or OpenFOAM
- Good programming skills, e.g. Python, Julia, C++
- Additional skills in data analysis and/or machine learning, in particular multidimensional regression and interpolation, are desirable but not mandatory

What you can expect

- Flexible working hours and possibility to work remotely
- Open and friendly teamwork
- Being paid as a student assistant

We value and promote the diversity of our employees' skills and therefore welcome all applications - regardless of age, gender, nationality, ethnic and social origin, religion, ideology, disability, sexual orientation and identity. The remuneration is based on the company-wide agreement for the employment of student assistants.

Interested? Apply online now. We look forward to getting to know you!

Please apply online only at: (link will be inserted when call is published)

If you have any questions, please contact:

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Further information on the institution can be found at: www.ieg.fraunhofer.de