MAN Energy Solutions

Developing a reduced order dynamic model for industrial heat pumps

High-fidelity third-party FEA/CAE/CFD models can take hours or even days to simulate. Performing hardware-in-the-loop (HIL) testing, control design, and system-level analysis on such models can present significant computational challenges or sometimes be infeasible. To address these challenges, you can replace high-fidelity component-level models with reduced order models (ROMs) for reducing the computational complexity of a full-order, high-fidelity model while preserving the expected fidelity within a satisfactory error. These ROMs can later be used to create digital twins to make it more computationally efficient and suitable for periodic updates to represent the current state of the operational asset.

We are using Modelon Impact (a Modelica-based simulation tool) to develop dynamic models of our industrial heat pumps. for our physical system level simulation. Modelon has already provided a neural network-based reduced order model feature within its environment. This **internship** project aims develop a **data-driven ROM** from pre-processed simulation data using Modelon Impact. The primary focus will be on using the available ROM environment of Modelon.

The student should have a proficiency in thermodynamics, Modelica-based simulation tools (Modelon or Dymola), programming (Python preferred), and a basic understanding of data analysis and machine learning concepts. Knowledge of ROM algorithms is a plus but not mandatory. The student will be supervised by our team, and will be provided by guidance, support, and domain-specific knowledge throughout the project. Regular meetings and discussions will be held to ensure the project successful completion.

About MAN Energy Solutions

By leading the way in advanced engineering for more than 250 years, MAN Energy Solutions have built a unique portfolio of technologies. MAN Energy Solutions employs about 15,000 people at over 120 sites globally. Large scale heat pumps are one of the competences of our company. Heat pumps are an important technology in the context of successful decarbonization of the heat supply for businesses and communities. In Zurich, we are developing the state-of-art large scale (ca. 40 MW per unit) trans-critical CO_2 heat pump for district heating applications.

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Praktikum

Aufgabenbeschreibung

1. Onboarding and literature review:

Tasks	Comment
Basics of Heat pump cycle and main components function review (Compressors, Subcooler, Recuperator)	
Review the developed models in Modelon Impact	
Web application and ROM methodology of Modelon Team (support from Modelon	
Schedule and work packages definition.	

2. Reduced Order Model Development:

Tasks	Comment
Data processing and Divide dataset into training and validation sets	
Build and validate ROM	
Uncertainty assessment and possible improvements (other suitable ROM algorithms or fine-tuning if needed).	
Applying methodology to various models and components.	
Custom web-app development	

3. Final report and presentation

Tasks	Comment
Writing the Final Report	
Final Presentation	