Master Theses in Thermodynamic & Process Systems

Fuel cell vehicle

Many car manufacturers today have development programs for hydrogen driven fuel cell vehicles (FCV), such as Toyota. A fuel cell system for a car involves typically a polymer (PEM) stack, hydrogen tank, cooling and water management system and air supply.

The purpose of this master thesis work is to develop an automotive fuel cell system parameterized according to published data and to set up dynamic test cases (load change, start up, others). The work will be based on our product Fuel Cell Library (FCL) where many base components and system examples are found. Ultimately the developed automotive fuel cell system will be incorporated into FCL.

Student profile: One or two motivated and skilled students with interest in thermodynamics, fuel cells, controls, dynamical systems and modeling of physical systems.

Contact: Johan Windahl , Modelon AB

Non-equilibrium fuel tanks

Aircraft fuel systems are an important contributor to aircraft fuel efficiency in modern aircraft. This is the case because with recent fuel efficient aircraft the use of electrical power on-board the aircraft has increased and thermal management on-board the aircraft has become a limiting factor. When using system simulation to predict the behavior of fuel as heat sink, a wide-spread assumption is that of thermodynamic equilibrium. This implies that not only the pressure but also the temperature and the composition of the liquid and the vapor/gas instantaneously approach equilibrium. In reality, there are substantial differences between the temperatures however due to very low ambient temperature at high altitudes, and ever increasing heat loads that are dumped into the fuel. Only if the actual non-equilibrium conditions of the fuel-air mixture are properly modeled and understood the safety, performance and fuel efficiency of aircraft can be pushed further in spite the increasing heat loads.

The task in this Master thesis project is to develop a non-equilibrium dynamic model of a fuel tank based on existing libraries and models from Modelon. The models are implemented in the equation-based modeling language Modelica.

Student profile: One or two motivated and skilled students with interest in chemical process engineering, mathematics, modeling of dynamic systems, and programming.

Contact: Michael Sielemann, Modelon AB

Gas Turbines for Power Generation

Turbines are main devices to convert thermal energy into electricity in the power generation industry. In particular, gas turbines provide higher efficiency and flexibility over steam turbine. Nowadays, flexibility is crucial not only for meeting the transient electricity and heating demand, but also for integration of heterogeneous (renewable) sources onto the grid. Dynamic models of gas turbine will facilitate numerical experiments for technologies like IGCC (Integrated Gasification Combined Cycle) and will enable optimization on control strategies for the whole power plant.

The purpose of this master thesis is to develop a physical, dynamic model of a gas turbine in Modelica using Dymola as the development tool. The gas turbine model will be integrated into a power plant system model. Student(s) will also collect published data to validate the model and benchmark the performance. This work will be based on Modelon's Thermal Power Library (TPL), where many base components and system examples can be found. The developed models will be merged into future release of the product.

Student profile: One or two motivated and skilled students with interest in thermodynamics, power generation, controls, dynamical systems and modeling of physical systems.

Contact: Lixiang Li, Modelon Inc.

Email: student@modelon.com
Web: http://www.modelon.com

Please attach cover letter, CV, and course transcript to your application.

Calibration Workflows for a Diesel Engine Model

Simulation models used in industry normally contain thousands of parameters. A crucial step in using such simulation models for product development workflows is to re-calibrate the parameters when the hardware in the project is modified.

This project will be carried out in collaboration between Modelon and Volvo Trucks. The students will investigate and develop algorithms and workflows to calibrate parameters against measurement data from a detailed Modelica engine model or possibly a real engine. The model to be used is a grey-box mean-value model of a diesel engine that is aimed at control design and validation. Calibration is normally done first in steady-state and then dynamically, and validated first on component-level and then on system-level. An important part of the project is to find creative ways to combine mathematical methods from optimization, statistics, and system identification with sound engineering heuristics and to find appropriate workflows for the engine calibration task.

The engine model is developed in Dymola, the implementation of calibration algorithms will be done in MATLAB using Modelon's Functional Mock-up Interface Toolbox for MATLAB (FMI-T).

Student profile: Two motivated and skilled students with solid background in mathematical models, system identification, and optimization. Knowledge of combustion engines is an advantage, but not required.

Contact: Anders Nylén, Modelon AB

Theme of Choice

Modelon is constantly looking for motivated and skilled master thesis students with strong focus on modeling and simulation of physical systems as well as good knowledge in mathematics and thermodynamics. A suitable theme can always be discussed and agreed upon.

Contact: Mattias Olsson, Modelon AB

Modelon has well established academic cooperation with several departments at Lund Institute of Technology, LTH. Further, Modelon works together with other universities in and outside of Sweden.