MASTER THESES IN AEROSPACE AND FLUID POWER

Contents

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

Chemical Equilibrium Analysis in Gas Turbines

Modelon's Jet Propulsion Library provides a foundation for the modeling and simulation of jet engines, including the model-based design of integrated aircraft systems.

The jet engine, a key source for power on-board aircraft, couples the opportunity for substantial performance improvements with the challenge of mastering the underlying physics. Modelon's Jet Propulsion Library includes a comprehensive set of components that empower cycle performance analysis and optimization of all types of aerospace gas turbines.

Higher burner temperature becomes more common in jet engines and adds additional requirements when modelling the thermodynamic process. This chemical phenomenon is called dissociation and occurs at high temperatures in which molecules separate into smaller ones. Taking this into account becomes crucial for high accuracy in the results. CEA (Chemical Equilibrium Analysis) is a well-established methodology to capture such effects.

The task is to first develop a stand-alone implementation of the methodology using the modelling language Modelica. In a second stage, the code should be integrated in Modelon's Jet Propulsion Library for commercial use. Recent work on calculation of thermodynamic properties also suggests using a methodology called SBTL (spline-based table look-up) to increase the computation speed even further.

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

Contact: Jim Claesson, Modelon AB

Next Generation Aerospace Systems

Aerospace engineers are continuously faced with the challenge of designing aircraft and vehicle sub-systems to meet ever-increasing performance and efficiency needs.

Virtual development and the latest simulation methods are essential for delivering substantial improvements in the industry.

- Possible topics include but are not limited to:
- Propulsion
- Flight performance
- Thermal management
- Fuel system
- Secondary power
- Actuation

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

Contact: Jim Claesson, Modelon AB