Technische Universität Braunschweig

Student thesis announcement (BA/SA/MA)

Modelling and simulation of a broad area cooling system for zero boil-off storage of cryogenic propellants

Propellant depots are posited to play a significant role in the future space economy, enabling increased reusability, reduced launch costs, and extended satellite operational lifetimes through in-orbit servicing (IOS). This architecture represents a departure from traditional point-to-point mission profiles. Instead, satellites may be launched into a designated parking orbit and subsequently transferred to their final mission orbit by dedicated orbital transport vehicles (OTVs) that operate by refueling at strategically placed orbital propellant depots.

Due to their high efficiencies there is increased interest in making cryogenic propellants available for in-space transportation. Previously, utilization of cryogenic propellants has mainly been limited to short duration applications in launchers, due to exessive boil-off losses when stored over long durations. Eliminating those boil-off losses requires the development of active refrigeration systems to intercept or remove heat leak into the storage tanks.
The objective of this thesis is to implement a refrigeration and tank model in Modelica, capable of performing an initial sizing of hardware components. To do this, various refrigeration cycles have to be considered.

Tasks:

- Literature research on the usage of cryogenic propellants for in-space transportation, refrigeration cycles, advances in cryocooler technology and the Modelica programming language
- Implementation of a depot model for promising cooling cycles in Modelica
- Preliminary sizing and optimization of hardware components for an exemplary depot architecture
- Critical evaluation of results and sensitivity study

Requirements:

- Capable of working in a reliable and self-motivated way
- Basic knowledge in Modelica or Simulink advantageous

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