Student Research Project / Master Thesis

Design of a Battery Cooling System for Electric-Pump-Fed Rocket Engines

With few exceptions, the propellant pumps of launch vehicles have so far been operated with gas generators. However, gas generators have the disadvantage of low efficiency due to the integrated turbine and the associated power losses. If, in addition, the engine is designed as simply as possible with a bypass gas stream, additional power and efficiency are lost. In contrast, engines with electric fuel pumps have the advantage that the turbine is replaced by a highly efficient electric motor and a bypass stream can be dispensed with while maintaining a similarly low level of complexity. As a result, the overall system consumes significantly less fuel. However, this advantage comes at the price of the additional mass of a high-performance battery.

At GAIA Aerospace, a biopropane/LOX engine is currently being investigated for a reusable air launch system, which will be powered by electric propellant pumps. An active thermal control system is now required for the battery, which is to be powered by the cryogenic propellants. The challenge here is on the one hand to ensure sufficient cooling due to the high heat dissipation of the battery and on the other hand the risk of freezing of the battery by the cryogenic propellants.

For the development of the thermal control system, the work is divided into the following steps:

1. Literature research on the design of heat exchangers and cooling systems, LiPo batteries, cryogenic propellants, cryogenic valves, FEM and CFD analyses.
2. Identification and definition of requirements for the thermal control system and the battery
3. Definition of a preliminary thermal control system using an analysis tool in a Matlab/Simulink environment
4. Creation of a CAD model of the preliminary thermal control system and the battery
5. Performance of FEM and CFD analyses for thermal and fluidic optimization of the thermal control system
6. Optimization of the solution approach based on the analysis results and the previously collected and defined requirements
7. Critical analysis of the final system and presentation of further potential for optimization

Contact: **Kai Höfner, M.Sc.**
Tel. +49 (0) 162 / 656-8462, E-Mail: kai.hoefner@gaia-aerospace.com
Execution only after consultation of supervising university institute