



GAIA

AEROSPACE

Student Research Project / Master Thesis **Tank Concept for Air Launch Systems with Cryogenic Propane**

Currently, GAIA Aerospace is investigating an air launch system with a reusable first stage. The rocket is powered by cryogenic liquid propellants in the form of liquid oxygen (LOX) and cryogenic propane. In contrast to vertical-launch rockets, an initial flight period of up to one hour after fueling must be bridged on the carrier aircraft before an air launch system can be launched. During this time, the cryogenic propellants heat up. Due to the associated expansion and gas phase formation, the propellant and gas must be released in a controlled manner in the meantime.

After jettisoning from the carrier aircraft, the gas and liquid phases may then mix during the free-flight phase. Without appropriate propellant settling, gas bubbles can enter the fuel pumps and lead to engine failure. Furthermore, an air launch system must be transferred to climb flight after ignition, whereby the fuel can begin to slosh due to the acceleration and pitching motion. Therefore, within the scope of this work, a concept for an isolated propane tank shall be elaborated, which meets the special requirements for an air launch with liquid propellants.

The work is divided into the following steps:

1. Literature research on air launch systems, thermodynamics of cryogenic propane, insulation materials, slosh baffles and CFD analyses
2. Identification and definition of propellant tank requirements during the mission
3. Definition of transportation, launch and ascent scenarios
4. Design of tank concepts in the form of a CAD model and a mathematical model for thermodynamic operational simulation in a Matlab/Simulink environment
5. Tank sloshing analysis of the tank concepts in the defined scenarios using CFD
6. Modeling, implementation and testing of the sloshing behavior in a pre-defined flight simulation
7. Critical analysis of the final tank design 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 with supervising university institute

