Paper ID: 60855
oral
student

IAF SPACE PROPULSION SYMPOSIUM (C4)
Liquid Propulsion (2) (2)

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# ACTIVE USE OF SIDE FORCES ON AEROSPIKE NOZZLES

**Abstract**

Within the ACTiVE project, numerical and experimental investigations are conducted at Technische Universität (TU) Dresden regarding aerospike nozzles with thrust vector control (TVC) through secondary fluid injection. The main objective of the project is to derive a mathematical model to accurately predict the generated lateral forces through fluidic injection. An integral part of this project is a cold-fow test bench with a six degree of freedom (6-DOF) force measurement set up. This test bench is mounted into a vacuum chamber to achieve higher pressure ratios between chamber (up to 1 MPa) and ambient (down to 5 kPa).

In this contribution, numerical analyses are performed to predict the asymmetrical pressure distributions on the surface of truncated aerospike nozzles as well as the derived forces and torques due to aerodynamic thrust vectoring. Furthermore, the occurring flow features such as separation shocks and the penetration height of the developing Mach disk within the primary flow field will be analysed. The presented parameter study covers a variety of fluidic thrust vector control configurations for linear and annular plug nozzle setups. The examined parameters are in detail: the injection position, injection angle with respect to the primary nozzle flow and the orifice geometry. The numerical analyses will then be verified against experimental data using equivalent geometric and fluidic boundary conditions. The corresponding cold gas flow experiments are performed at the cold flow test bench at TU Dresden and feature 6-DOF force measurements as well as background oriented Schlieren data for visualisation. Based on the results, design guidelines for optimal lateral force development are derived.

This research project is supported by Sächsische Aufbaubank (SAB) with funds from the Ministry of Science and Arts of the State of Saxony. It is embedded in the ambitious endeavour at TU Dresden to establish a profound knowledge base for aerospike nozzles with thrust vector control through secondary fluid injection.