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SHALLOW WATER TESTS OF SECONARY INJECTION THRUST VECTOR CONTROL OF AEROSPIKE NOZZLES

Abstract

In this contribution the setup and results of shallow water flow tests are described. These tests are conducted to verify numerical CFD simulations using the TAU code. Their purpose is to investigate the Secondary Injection Thrust Vector Control (SITVC) of aerospike engines. The examinations include two-dimensional planar nozzle expansion flows, quasi-stationary nozzle flows at different pressure ratios, transient flow behavior while injecting an orthogonal secondary flow into the primary flow and four-dimensional measurements of the flow including pressures and velocities according to the shallow water analogy. Therefore, the assessment of conventional measurement techniques and the development of a test setup will be presented, followed by a discussion of its validation with pre-defined simulation tests.
This contribution is embedded in our research on SITVC for aerospike nozzles. While thrust vectoring for aerospike engines with combustion chamber segments can be achieved with differential throttling, a different solution must be found for smaller single-chamber engines. A promising approach is aerodynamic thrust vectoring – diverting the main exhaust flow by injecting a secondary fluid flow orthogonally to the nozzle axis. As shown in previous works, this concept provides advantages over traditional gimballing and other mechanical control techniques. While the model presented here focuses on the mechanical aspects of static and dynamical stability and controllability, future steps will establish a direct link to CFD analyses to implement flow field characteristics for a variety of mission parameters. At the final stage a closed-loop control of the SITVC is envisaged.