IAF SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (3) (10)

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MAXIMIZING SIDE FORCE GENERATION IN AEROSPIKE NOZZLES FOR ATTITUDE AND TRAJECTORY CONTROL

Abstract

In this contribution numerical analyses are conducted to optimize a set of parameters for thrust vectoring control of a truncated, linear aerospike nozzle through secondary injection. The flow features of the injection are considered to be similar to those of a sonic jet injected into a supersonic crossflow, a canonical flow for which previous experimental and numerical data exist. Based on the sonic jet in supersonic crossflow over a flat plate multiple two-dimensional numerical analyses are conducted to investigate the ability of different one and two-equation turbulence models to predict the characteristic flow features, such as bow shock and separation length. To obtain relevant data for the generated side force on the aerospike it is essential to accurately reproduce the pressure distribution on the spike contour. In accordance to this the turbulence models are assessed with regard to their reproduction of experimental data of the wall pressure distribution. The one-equation Spalart-Allmaras algorithm is then employed for the simulation of the aerospike with secondary injection. Although the literature provides a multitude of parameters, the presented work is limited to the influence of momentum flux ratio, the slot width and the injection position on the truncated spike. The influence of each parameter on the generated side force is considered separately and a configuration is determined which combines all parameters for maximum side force. This contribution is embedded in our research on secondary injection thrust vector control (SITVC) for aerospike nozzles in the framework of the ACTiVE project. 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 orthogonal to the primary nozzle flow. As shown in previous works, this concept provides advantages over traditional gimballing and other mechanical control techniques.