Paper ID: 89314
oral

IAF SPACE SYSTEMS SYMPOSIUM (D1)
D CATEGORY "INFRASTRUCTURE" - Extra Session (8)

Author: Mr. Angelo Mulas
Politecnico di Torino, Italy

COMPARATIVE STUDY BETWEEN CLUSTERED AEROSPIKE NOZZLE AND OCTAWEB CONFIGURATIONS FOR REUSABLE LAUNCH VEHICLES: PRELIMINARY DESIGN AND TESTS

Abstract

Reusable launch vehicles provide a cost-saving solution for access to space, compared to expandable staged rockets. Their advantages might increase with the adoption of advanced nozzle concepts. The current altitude compensation capability of nozzles has been sought since the beginning of rocket science. The aerospike engine comes as one of the best concepts. In this work, the model of an annular aerospike engine is designed and developed for a comparison with an octaweb configuration of conventional bell nozzles. A Matlab tool has been developed to identify the test case for the following experimental campaign, taking as input the subsonic landing burn of the Horizon 2020 project RETALT1. The tool finds the best combination of the parameters that define the same characteristics factors of retroflow phenomenology, described in detail in this paper, both in the real and the sought experimental case. The radial extension of an aerospike allows for an increase in the expansion ratio and consequently achievement of performance gain all along the ascent and the descent. For this study, a clustered thrust chamber is proposed and designed. A dedicated tool has been developed to design the cell-nozzles that form the cluster, to define their number and choose the truncation length of the spike. Moreover, the operating conditions to compare it with the previously cited octaweb are identified by implementing the first tool. The octaweb baseplate and the aerodynamic disturbances of the rocket model (fins and folded landing legs) designed on SolidWorks have been printed with stereolitographic additive manufacturing technique. Additionally, this manuscript includes preliminary tests conducted for characterising the counter flow of the Vacuum Wind Tunnel at Technische Universitaet Dresden, calibrating the sensors, and verifying the operating conditions of the experimental set up. The results of such test campaign indicate useful insights on foreseeable upgrades for the test bench and the feed line for the upcoming experimental campaign. Additionally, the definition of the reduced penetration length is included, to verify the comparability with the real case considered. The work presented here paves the way for experimental comparisons between the octaweb configuration and the annular aerospike nozzle with clustered thrust chamber to confirm the performance gains achievable by the aerospike through altitude compensation even in far-from-ideal conditions. The interest is also on the differences in the interaction with a counteracting free-stream.