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# MODELING AND NUMERICAL SIMULATION OF THERMAL EROSION IN A TOROIDAL AEROSPIKE NOZZLE

**Abstract**

Aerospike nozzles have been investigated for the past years in order to enhance the technology of space propulsion. In comparison to the bell-shaped nozzle, they allow an expansion of the exhaust gas until ambient pressure reducing the weight and complexity of the nozzle. In fact, this process happens from the nozzle throat and, as the ambient pressure modifies, the expansion ratio adjusts optimally according to these changes, thereby showing a more efficient performance over the bell nozzle in a wide range of altitudes. In rockets, ablative materials are used to protect the wall surfaces of the nozzles, due to the critical thermal and mechanical conditions that occur. The chemical reactions occurring at the gas-surface interface result mainly in heterogeneous reactions consuming the material of the surface and affecting the performance and efficiency of the nozzle. For this reason, the ability to predict the regression rate as a function of temperature and mass fractions of exhausting is fundamental in designing nozzles, especially if used in reusable rocket engines. The aim of this work is to present a numerical model implemented to simulate the behavior of the erosion process through a thermochemical model of ablation. This model, validated by comparison with experimental results obtained in a bell-shaped nozzle of a hybrid rocket, has been applied to the study of erosion in the throat of an aerospike nozzle of a liquid rocket for different compositions of exhausting gases. Results show a good agreement with the theoretical models present in literature, showing that the model is actually able to predict the rate of consumption of the nozzle materials.