TOWARDS A DATA-DRIVEN MODEL FOR THERMAL CHARACTERIZATION IN ROCKET COMBUSTION CHAMBERS FIRING PLATES

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Abstract
Thermal characterization is an aspect of paramount importance in the design process of propulsion systems for space transportation. Liquid Rocket Engines (LREs) are, in particular, characterized by the interplay of a plethora of physical pheno-mena ranging from the turbulent mixing and combustion to the convective and radiative heat transfer, representing the ideal problem to be efficiently tackled by numerical investigation through Computational Fluid Dynamics (CFD). The pre-sent contribution proposes a data-driven model for the heat transfer characte-rization of a generic multi-injector firing plate in LRE-like operating conditions. The approach is based on two databases of two-dimensional axis-symmetric simu-lations of single-injector combustors with variable confinement length, i.e. transverse dimension, mimicking respectively the flame-wall interaction and the flame-flame interaction between neighbouring injectors [1]. The database is built using a unsteady RANS (uRANS) solver developed in the context of OpenFOAM and OpenSMOKE++ [2], based on a flamelet approach for turbulent non-premixed combustion accounting for non-adiabatic and non-equilibrium effects [3] and on a wall-modeled description of the boundary layers [4]. The heat transfer data collected from such a database are mapped on a generic multi-injector geometry on the basis of geometric criteria and then interpolated, resulting in a topological reconstruction of the faceplate that is found to be well-representative of the main morphological features of the three-dimensional heat flux field. The proposed algorithm is applied to a 37-injector chamber, featuring a plate geometry based on the layout of a real-existing subscale combustor [5]. A three-dimensional simu-lation of the same geometry is eventually presented and used for comparison.

References
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