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Title

Large Eddy Simulations of injectors near-field and heat transfer in rocket combustion chambers

Authors

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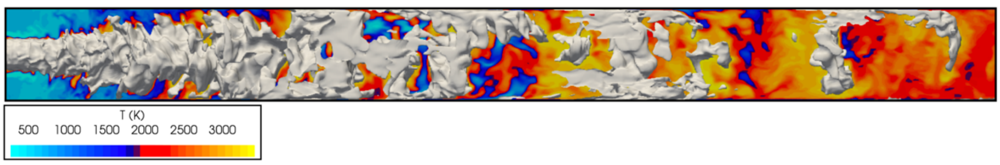
Abstract

The combustion chamber of a Liquid Rocket Engine (LRE) has to withstand extreme conditions in terms of temperature and pressure, therefore the experimental investigation of such devices is complex and often limited to indirect measurements of the reacting flow field. State-of-the-art experimental tests still do not provide high fidelity data for localized heat fluxes investigation, in particular for the injectors near field. In this framework, the interest toward high-fidelity computational fluid dynamics (CFD) simulations is rapidly increasing. In fact, high-fidelity simulations such as large eddy simulations (LES) and direct numerical simulation (DNS) can provide data and information which are typically hindered to experiments. In addition, the interaction of the two modeling strategies can support and validate the development of low-order models for simulations at the system level. The aim of this contribution is to present LES calculations to characterize the injectors near-field region of rocket combustion chambers. The starting point for the validation of the LES approach, for the conditions of interest, is the simulation of a well-known single injector combustion chamber [1], with particular attention to the recirculation zone close to the injector. Then the geometrical characteristics of the chamber are modified following the work of Remiddi et. al [2] based on unsteady RANS simulation with thermal wall-functions, to assess if the increased fidelity of the LES approach has a relevant impact on the overall heat flux evaluation in the injection region. The simulations are carried out with the OpenFOAM-based LES solver developed by Indelicato et al. [3] and the non-adiabatic flamelet-based turbulent combustion model described in [4].



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