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Title

Hybrid Rocket Engines Design for Materials Characterization

Authors

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Abstract

Hybrid Rocket Engines (HRE) have generated positive interest in the scientific community due to their ability to combine the special characteristics pertaining to solid and liquid propulsion. Eligible as promising technology enablers for the future of space industry, HRE are valuable for their safe and controlled design nature, simplified architecture with respect to liquid engines, able to provide throttling, start/stop capabilities and in general less hazard than solid ones. One of the most profitable potentials, which is explored in this work, involves exploiting HREs as test demonstrators, particularly for materials characterization.
The aim of this work is the development of a numerical tool, whose objective is the design of lab-scale HREs for materials characterization in a specific required target application. The numerical tool is tailored on propulsion laboratory of University of Naples "Federico II" (located in military airport in Grazzanise) considering HREs ranging from 200N to 1kN thrust.
Starting from a target material application in terms of chemical environment, pressure, heat fluxes and temperature inside the combustion chamber and nozzle, the model allows to obtain a real motor configuration meeting the aforementioned constrains, analysing the following design variables: mixture ratios O/F, mass flow rates, pressures, propellant mixtures, solid grain dimensions and engine scale. To complete the numerical setup and making it viable for the target material characterization, the model is paired with a routine which allows the evaluation of a suitable cost function, including several synthesis parameters that can be used globally to choose the design of the most representative lab-scale HRE. Results have been compared with CFD analyses to validate the numerical tool, especially in the evaluation of wall heat fluxes in post-chamber and nozzle throat sections and in the choice of test samples position within the rocket.
The output of this process is represented by the design of a lab-scale HRE in University of Naples "Federico II" and the production of a test matrix for specific material characterization based on suitable cost function. Thanks to its versatility, the model proposed in this work lends itself to being easily modified to study different types of materials working on different applications.

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