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SPACE PROPULSION SYMPOSIUM (C4)
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HYBRID PARAFFIN-BASED TECHNOLOGY DEMONSTRATOR IN THE FRAMEWORK OF THE ITALIAN HYPROB PROGRAM: STATUS OF DESIGN AND DEVELOPMENT ACTIVITIES

Abstract

Within the HYPROB program, a ground testing demonstrator of hybrid rocket propulsion is under development, with the main goal to validate enabling technologies, tools and design methodologies. The technological demonstrator, with a thrust class of 30 kN, is based on nitrous oxide and paraffin and will have most attractive capabilities of hybrid systems compared to solid or liquid engines, namely throttability and re-ignition. The project targets to achieve, within 2016, a TRL of enabling technologies for hybrid propulsion equal to 5. The status of design, based on engineering methods and supported by detailed simulation tools for the fluidynamics and thermo-mechanical verification, will be reported in the full paper. High performance solid propellant, based on paraffin, is being developed within the project in order to define a proper formulation able to achieve the requested value of regression rate, to match the performance requirements of the demonstrator, and to show suitable resistance and mechanical properties. As matter of fact, paraffin is considered as a good propellant for hybrid rockets due to the high performances achievable, in combination with nitrous oxide or liquid oxygen, even though the poor mechanical properties of grains of wide dimensions still require further developments, therefore research activities are carrying out in order to overcome these drawbacks. The general architecture of the engine is constituted by the injection plate, the igniter, the thrust chamber and the expansion nozzle; each sub-system has been defined and analyzed through engineering correlations and advance simulation tools for fluid-dynamics and thermo-mechanical simulations which will be shown in the full paper. In parallel, a numerical demonstrator able to simulate the physics in a combustion chamber of a hybrid rocket engine is also under development in order to be used for the rebuilding of the test campaign on the technological demonstrator and as support to the design activities. Numerical models to be implemented have been selected taking into account accuracy issues to support the design and computational times therefore a trade-off analysis has been performed; the numerical code will be validated through experimental data acquired in the frame of the current project or available in literature. The full paper will report the study logic defined to achieve the goals of the project and the status of the technical activities related to the design of the engine and numerical demonstrators.