SPACE PROPULSION SYMPOSIUM (C4)
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DESIGN OF A HYBRID PARAFFIN-BASED TECHNOLOGY DEMONSTRATOR

Abstract

Within the national HYPROB program, a ground-based demonstrator of hybrid rocket propulsion is under development, with the main goal to validate enabling technologies, design methodologies and manufacturing processes. This 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 increase the TRL of enabling technologies for hybrid propulsion from 3 to 5. The overall development plan defined in order to achieve the objectives will be presented and discussed: the study logic is based on the combination of numerical and experimental activities in small/medium scale facilities. The status of design, based on engineering methods and supported by detailed numerical simulation for the fluid-dynamics and thermo-mechanical analyses, 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. Research activities are currently on going to overcome these drawbacks and to define a technology process to realize large scale grains. 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 analysed through engineering correlations and advance simulation tools.