SPACE PROPULSION SYMPOSIUM (C4)
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THE PERFORMANCE ANALYSIS OF THE SARA HYBRID ROCKET MOTOR

Abstract

The Hybrid Propulsion Laboratory of the University of Brasilia successfully designed, manufactured and tested the engineering model of the hybrid rocket motor, which meets the requirements of the platform SARA – Satellite Atmospheric Re-entry System. The propulsion system operates during 12. . . 50s with the average thrust of 1kN, delivering the necessary impulse for the re-entry capsule. The hybrid motor has the modular structure, which allows the test various configurations of the motor components, such as injectors, pre- and post-combustion chambers, fuel cases, nozzles and allows to use various types of solid fuels. The design of the hybrid motor was made using the engineering methods, analytical calculations and verified by the numerical simulation methods. The numerical simulation was provided using the commercial and non-commercial software. The results of the numerical simulation by the non-viscous model allowed to provide calculations of the various motor geometries and showed the flow distribution and thermal loads in the combustion chamber. The obtained results allowed to determine the necessary sizes of the pre- and post-combustion chambers, choose the heat protection materials. The main goals of the SARA test motor design are the optimization of the performance and operational characteristics, such as thrust, specific impulse, combustion stability, reliability of the ignition, etc. Some problems were solved in the cooperation with the Brazilian industry and research institutions, such as: - Reliable ignition system; - The composite nozzle, which includes including the ceramic and polymer heat resistant layers. The first phase of testing of the motor included the pressure tests of the propulsion system, cold flow and ignition tests. The second phase of tests included the performance verification tests. Performance characteristics of the motor were determined in wide range of the oxidizer specific mass flow range, including the thrust, specific impulse, efficiency and regression rate of the fuel. Tests were provided for the nominal motor operation and throttle modes, regulating the mass flow rate with the feedback control system. Having the modular test hybrid rocket motor for the SARA platform, operating in the wide range of characteristics, our group successfully executed the research activities, including the development and testing of multiple ignition system, heat insulation and cooling system of the nozzle. These research activities were supported by the Brazilian Space Agency and play an important role in the educational and research processes at the Aerospace Course of the University of Brasilia.