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AN ADVANCED HYBRID ROCKET ENGINE FOR AN ALTERNATIVE UPPER STAGE OF THE BRAZILIAN VLM 1 LEO-LAUNCHER

Abstract

The Institute of Aeronautics and Space (IAE), on behalf of the Brazilian Space Agency (AEB), is developing a new launch system called Microsatellite Launch Vehicle (Veículo Lançador de Microssatélites or VLM-1). The development is supported by German Aerospace Center (DLR) and some German industrial companies. Basically, the VLM 1 is planned as a three stage launcher with solid rocket engines, which could deliver up to 200 kg payload in Low Earth Orbit (LEO). To propel the 1st and 2nd stage the launcher will be equipped with solid rocket engines of the type S50, which have for both stages the identical structure. The only exception is a different nozzle expansion ratio. As a 3rd stage basically the solid rocket engine S44 combined with attached RCS system, based on cold gas engines, is planned. To overcome the maneuverability limitations at injection phase of payload into LEO, an alternative hybrid rocket engine (HRE) for the 3rd stage is analyzed by the Institute of Aerodynamics and Flow Technology of DLR Braunschweig.. As a suitable propellant mixture for this Engine High Test Peroxide (HTP) is selected as oxidizer with concentrations higher than 87,5

For the design and optimization of the HRE the DLR software tool AHRES is applied. In the paper results of interior ballistic computations, heat transfer and temperature distribution within the combustion chamber, as well as the properties of pressure feed system are shown and analyzed. The solid fuel grain geometry is designed using the burn-back module STAR (part of AHRES software tool), which is coupled with optimizer NOMAD (based on direct search optimization algorithm). For the moveable nozzle with ablation, gas flow properties, temperature distribution within multilayer structure, radial and tangential stresses as well as structure dilatations for each cutting plane in longitudinal axis direction are presented.