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EXPERIMENTAL INVESTIGATION OF A 10 KN CLASS HYDROGEN PEROXIDE - PARAFFIN WAX HYBRID MOTOR DEMONSTRATOR

Abstract

Hybrid motors have received little attention during the cold war period, with solid and liquid propulsion playing the major role in the field of rockets and launchers. Consequently, only a handful of studies have been carried out in the direction of developing large-scale hybrid motors. Over the last decades, the need for a safer and simpler technology has driven more developments towards hybrid propulsion. However, mainly small-scale hybrid motors have been designed and tested, with limited work done at larger scale. The PHAEDRA (Paraffinic Hybrid Advanced Engine Demonstrator for Rocket Application) program, funded by the Italian Space Agency, aims to design manufacture and test a Technological Demonstrator that can experimentally validate the concept of hybrid propulsion, based on paraffinic fuel, on a significant scale for an application identified as a 50 kN class hybrid propulsion system for the third stage of a small launch vehicle. The motor will be based on H202 as oxidizer and a special blend of paraffin wax as fuel. As an intermediate step towards an envisaged flight application, a 10 kN class hybrid test bed -DEMO- has been designed as technology demonstrator serving as the connecting link between smaller laboratory motors and the larger launcher applications. One of the DEMO motor most important aims is to verify the scaling effects, which have not been thoroughly investigated in the literature so far. Understanding these

laws will allow the transposition of the laboratory scale results into an actual sized hybrid rocket motor. To finally establish hybrid propulsion as a competitive player, the motor has been studied and specifically designed in its thoroughness: the fuel grain is a special blend of paraffin wax; the vortex injection has been tuned to obtain the desired fuel regression rate; a post chamber has been added to increase the overall motor efficiency. All these aspects have been first studied in a small-scale motor and are crucial to the design of the 50 kN class motor, highlighting the importance of the intermediate DEMO motor as a forward step for hybrid propulsion. In this paper the design of the DEMO motor is analyzed, emphasizing the relations that have been defined with the small-scale motor. The test campaign is introduced, specifying the reasons for its phases and the main parameters under study. Then, the preliminary results of the tests are described, pointing out the main achievements and the similarity and scaling laws with the small-scale tests.