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COMPARISON BETWEEN A 400N ELECTRIC PUMP FED HYDROGEN PEROXIDE/ETHANOL THRUSTER AND THE MMH/NTO LEGACY SYSTEMS

Abstract

Current upper stages and in-space propulsion mostly rely on pressure-fed engines powered by storable, bi-propellant combinations. With MMH/NTO as its preferred combination, this technology has matured and nowadays represents a well-established and reliable solution. However, this fact also leaves little leeway for improvement. New space is calling for a new vision in terms of performance and sustainability, and this paper seeks to embrace this trend by presenting an alternative within the 400N range: an H2O2/Ethanol electric fed thruster. The advantages of the proposed system lay in two cornerstones: the utilisation of green propellants and the implementation of electric pump feeding. While green propellants reduce operational costs thanks to their reduced toxicity, electric pump feeding can further leverage their appeal by enhancing their propulsive capabilities and reducing the inert mass. Nonetheless, this technology also presents some hurdles, such as pump efficiency or battery thermal control, which must be reviewed carefully.

After reviewing the pros and cons of both green propellants and electric pump feeding, this paper compares the proposed system with the state of the art. As discussed in the previous paragraph, the expected benefits of electric pump feeding are better performance and mass saving. Thus, the comparison criterion is based on the specific impulse and mass as key parameters. The paper first investigates which set of design and operational parameters allow H2O2/Ethanol to provide the same performance as the legacy ones. Based on this input, we then offer a comparison between the following feeding systems: an MMH/NTO pressure fed, an H2O2/Ethanol pressure fed and an H2O2/Ethanol electric pump-fed. This study estimates the overall feeding system mass as a function of the chamber pressure, burning time and initial pressurant gas pressure. Finally, we analyse the results and conclude if the proposed system could meet the expectations and, thus, be a feasible alternative to the legacy systems. This action is part of the ASCenSIon framework, a European Union project funded by a Marie Skłodowska-Curie agreement. The project seeks to go beyond the current space transportation state of the art and advance novel launcher technologies for the European sector.