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PRELIMINARY DESIGN OF A THIRD STAGE LIQUID PROPULSION SYSTEM FOR FUTURE VEGA EVOLUTION

Abstract

The Community of Ariane Cities' Summer School is an annual programme designed for university students and young engineers from space industry. The 2011 edition was hosted at the University of Rome La Sapienza and one of the tasks was the definition of the most promising upper-stage liquid propulsion system architecture for the future evolution of the VEGA launcher. VEGA, the European Advanced Generation Carrier Rocket, is an expendable launch system developed by the European Space Agency (ESA), in which Aviogroup is in charge of the design and manufacturing of the whole system. The launcher, which shall be launched from the ESA launch site in French Guiana, is capable of injecting an admissible payload of 1500 kg into a circular polar orbit of altitude 700 km. Since the successful maiden flight of the VEGA launcher on 13th February 2012, several studies are underway to address its future evolution with specific interest towards replacing its current third solid stage Zefiro 9 and fourth liquid stage AVUM with a single bi-propellant liquid engine. The results from this study shall help to further bridge the small market gap between VEGA and Soyuz launchers. As a starting point for the study, a reference mission was considered where two payloads with a total payload mass of 2600 kg stacked in double payload configuration shall be injected into their orbits at ΔV of 1500 and 3500 m/s respectively. The size of double payload configuration is limited to a diameter of 2.36 m and a height of 4.0 m. At the same time any impact on the existing VEGA launcher shall be minimized and European technologies with high Technology Readiness Levels utilized. During the study, three possible oxidizer-fuel combinations were identified as propellants for the single stage bi-propellant liquid engine – NTO-MMH, LOX-LH2 and LOX-CH4 – followed by trade-off studies. These propellant combinations were analyzed and compared both qualitatively and quantitatively using a specialized propellant performance prediction software and the optimum ratio of constituents for each combinations were determined. At the end of the study a theoretical prediction of performance was made and suitable system architecture outlined.