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A HYBRID-ELECTRIC FLYING WING AS AN ATMOSPHERIC CARRIER OF LAUNCHERS FOR SMALL SATELLITES DEPLOYED IN LEO

Abstract

Recent years have seen a significant increase in the demand for and use of low earth orbit satellites, often for commercial purposes. This trend highlights the need to consider more adaptable and cost-effective launch systems. This paper presents the results of a conceptual investigation into the development of a low-cost 'carrier-launcher' configuration to facilitate Low Earth Orbit space missions. Based on a preliminary study, the integration of a hybrid-electric propulsion system and the adoption of a curved wing configuration for the flying wing are considered in this study. The carrier, a remotely piloted unmanned flying wing, is designed to serve as the first stage of a multi-stage rocket to launch payloads into Low Earth Orbit.

The unmanned flying wing aircraft carries, on its wing upper surface, a rocket which is released into orbit after a parabolic zero-g manoeuvre. It integrates a parallel hybrid-electric propulsion through a retrofit procedure applied to an aircraft designed in previous research on atmospheric carrier of launchers. Hybrid-electric propulsion offers a number of advantages, such as a reduction in the weight of the engines due to the high power density of the electric motors, which supply power, together with the thermal engines, during the phases of highest power demand. This makes it possible to install a propulsion system on board whose thermal part is optimised for nominal conditions, thereby also potentially reducing fuel consumption. Furthermore, the use of hybrid-electric propulsion allows a reduction of pollutants in area close to the airport. The performance of the components of the electrical chain (motors and batteries) assumed in this study is based on current forecasts in the literature. Once the propulsion system had been redesigned, the structural components of the aircraft were analysed by means of static and aeroelastic analyses using the NASTRAN code. In addition, the aerodynamic and aeromechanical performance of the aircraft was assessed using the Athena Vortex Lattice aerodynamic potential code, and the performance in terms of fuel consumption and electrical energy request was estimated.

The results of this conceptual study show how a weight saving is achieved compared to traditional solutions based on the use of carrier aircraft adapted for the purpose. The hybrid-electric propulsion guarantees a surplus of thrust especially during the parabolic manoeuvre. Finally, the adoption of a curved planform shape of the flying wing further reduces the aerodynamic drag in transonic flight.