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HEXAFLY-INT HYPERSONIC VEHICLE THERMAL PROTECTION SYSTEM DESIGN

Abstract

Over the last years, innovative concepts of civil high-speed transportation vehicles were proposed. In this framework, the Hexafly-INT project, funded by European Commission by means of 7th Framework Programme, intends to test in free-flight conditions an innovative gliding vehicle with several breakthrough technologies on-board. This approach will help to gradually increase the readiness level of a consistent number of technologies suitable for hypersonic flying systems. The vehicle design, manufacturing, assembly and verification is the main driver and challenge in this project. Present research describes the aero-thermal design process of the Experimental Flight Test Vehicle, namely EFTV and Experimental Service Module, namely ESM. Considerable accelerations, vibrations, acoustic and shock loads in the launch phase, aerodynamic heating and forces in the re-entry phase are typical loads which a re-entry vehicle encounters during its mission. The vehicle requires a Thermal Protection System (TPS) to withstand such loads and the realization of appropriate TPS is a fundamental activity. The glider aero shape design makes maximum use of databases, expertise, technologies and materials elaborated in previously European community co-funded projects ATLLAS I II, LAPCAT I II, and HEXAFLY. The paper will present results for both CFD and Finite Element aero-thermal analysis, performed in the most critical phase of the experimental flight. Three-dimensional steady state fully turbulent CFD calculations have been carried out at several flight points along with a reference design trajectory and for radiative cooled wall boundary conditions for the glider. This numerical campaign allowed defining the aerothermal loading environment the flying test bed has to withstand during mission, such as the convective heat flux distributions on EFTV aeroshape to feed the subsequent thermal analyses. These analyses lead to a proper material selection. Different classes of materials have been preliminarily selected and analysed for the EFTV structure, namely: titanium alloy, copper, C/C-SiC and zirconia for surface coatings. Titanium alloys exhibit a unique combination of mechanical and physical properties and corrosion resistance, which have made them desirable for critical, demanding aerospace applications, also in high temperatures conditions. Copper is employed as a heat sink to accommodate the thermal energy in some critical components such as the nosetip. C/C-SiC developed at DLR and tested in different high temperatures applications (e.g. HIFiRE and SHEFEX) is considered for ailerons and for the wing leading edges. A zirconia coating layer has been also considered to protect metallic components.