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DESIGN OF A COPV FOR LIQUID STORABLE PROPELLANTS OF 4TH STAGE VEGA LAUNCHER

Abstract

This paper shows the feasibility study to manufacture the 4th stage VEGA launcher liquid propellant tanks with the filament winding technique. The 4th stage is equipped with four liquid propellant tanks, filled with UDMH and NTO. A positive expulsion device (bladder) provides the desired pressure level to the fluids. In the actual configuration, these tanks, and the equatorial flange to join the tanks to the main structure, are fully made of titanium alloy. The use of composite materials with polymeric matrix, may lead to important mass saving, but the chemical compatibility problem must be faced. In the proposed design, the sealing function is accomplished by a metallic liner, while the structural function is devoted to the filament wound material. In order to optimize the final structure, different optimization areas have been considered: a) domes shape b) metallic liner material c) composite part (winding trajectories and material) d) equatorial flange design (geometry and material). All the considered dome shapes have been preliminary verified with respect to filament winding technique constraints. The selection of the best choice has been based on the stress status (obtained by simplified 3D FEM analyses). Different metallic materials, with the same compatibility level with respect to the liquid propellants (titanium alloy, aluminium alloy, stainless steel), have been considered for the liner choice, and evaluated on the basis of their maximum deformation during the pressurized phase. The filament winding process itself, since induces load on the liner, has been taken into account for liner dimensioning. Composite materials, belonging to the carbon/epoxy family, have been considered for the liner overwrap, due to their specific combinations of high specific strength and stiffness. Finally, an aluminium alloy has been selected for the equatorial flange. The developed design considers the presence of a rubber shear ply between the flange and composite shell, with the aim to reduce the local stress peaks at the metal/composite interface b) to dampen the acceleration peaks dangerous for the structural integrity. The proposed architecture, leads to a potential saving of the 25