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ANALYSIS OF PRESSURE OSCILLATIONS WITHIN VEGA LAUNCHERS FIRST STAGE SRMS

Abstract

Nowadays aft-fynocil Solid Rocket Motors (SRMs) play an important role in the European space transportation systems, constituting the base architecture of Vega launcher and its evolutions Vega-C and Vega-E. Notwithstanding solid motors usually offer simpler designs than liquid engines, modern SRMs employed in current launchers may still suffer some important issues related to flow instabilities and pressure oscillations during their whole operative time. In particular, two separate scenarios can be addressed: the ignition transient and the quasi-steady-state phase. Regarding the former, the abrupt start-up of the flow motion, prompted by the igniter jets, is responsible for the onset of a wave propagation system that makes the ignition transient a very delicate and crucial phase which turns out to be dimensioning for every SRM. Pressure and thrust oscillations may further develop also once the motor has reached nominal conditions caused by hydrodynamic instabilities related to vortex-shedding and/or combustion instabilities driven by aluminum unsteady reactions.

Vega P80 SRM is a large monolithic aft-finocyl motor prone to develop low amplitude pressure oscillations during both the ignition transient and the steady-state. Vega-C first stage P120C motor is the natural evolution of P80 and represents one of the largest monolithic solid motors ever built. Its development relies on new technologies derived from those of P80, to provide a significant increase in thrust at the liftoff of the new Vega-C launcher. However, like P80, also P120C SRM may arguably present an unsteady behavior that must be characterized to ensure the high performances and safety required to next generations launchers.

This paper is therefore focused on the analysis and comparison of pressure oscillations onset during the operative time of the two first-stage motors of Vega family launchers, i.e. P80 and P120C, in order to investigate which could be the effect brought by the employment of a different propellant and geometry in the P120C SRM on the unsteady behaviour response. In the full paper a thorough study will be carried out by means of in-house Q1D approaches: SPIT model is used to deal with the ignition transient, whereas TAHR model is enforced to cope with PO during the quasi-steady-state phase. Both models have been used in Vega SRMs framework, ensuring the validity of the presented results.