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NUMERICAL STUDY OF IMPACT OF GRAIN PROFILE ON THE INTERNAL BALLISTICS OF SOLID ROCKET MOTOR

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Abstract

Solid Rocket Motors (SRM) are engines that use solid propellants for generating thrust in a rocket. SRM plays a crucial role in rocketry. SRM is in widespread use nowadays not only for space purposes but also for the development of missiles and sounding rockets. SRM uses aluminized propellants to improve the efficiency of the rocket motor due to its high heat of combustion and density [1]. On combustion, aluminium gets converted to aluminium oxide (alumina - Al_2O_3), and the condensed-phase droplets of alumina act on the submerged and nozzle region's insulation during SRM manoeuvring flight which can cause abnormal ablation of the thermal protection system. This work presents the numerical simulation of the flow field and particle dynamics in SRMs using the Computational Fluid Dynamics (CFD) tool. Simulations were carried out for a typical SRM by studying the effect of various geometrical parameters on motor performance. Important parameters addressed in this paper include (1) the effect of the ratio of port area (A_p) to throat area (A_t) and (2) the length of the grain on flow velocity and related particle impingements. Results show that for this study as A_p/A_t increases, velocity inside the submerged region decreases which in turn points to the fact that the particle impingements in this region decrease. However, this depends on various parameters like particle loading in the propellant, A_p/A_t, the geometry of the propellant, length of the motor, propellant formulation, geometry of the submerged region and so on. Hence, we cannot generalize this conclusion and one has to perform a detailed study.

Keywords: Solid Rocket Motor, CFD, Alumina, Rosin-Rammler, Bartz