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DEVIANT ABLATION MECHANISM OF NOZZLE THROAT IN SOLID ROCKET MOTORS UNDER ACCELERATION CONDITIONS

Abstract

Based on the serious issue of the significant ablation difference in a solid rocket motor(SRM) during its operation on the ground and in the atmosphere, a study was conducted to reveal the deviant ablation mechanism of nozzle throat under acceleration conditions. A three-dimensional model of the two-phase flow using the Eulerian–Lagrangian method in SRM with lateral and axial acceleration was established and calculated. The changes in the exhaust temperature and pressure near the wall at different accelerations were studied, and the effects of acceleration on the particle concentration, impact velocity and impingement angle were analyzed. A simulation system of a rotating acceleration test was designed and implemented. SRM experiments under specific acceleration conditions were also conducted to analyze the nozzle throat ablation of the carbon-carbon composite. This paper work's results show that the ablation rate of nozzle throat in the acceleration direction is significantly higher than it is in the non-acceleration direction, which is defined as throat deviant ablation. In the case studied in this paper, the nozzle throat's deviant ablation rate in the acceleration direction is 5 times greater than it is in the non-acceleration direction when the lateral acceleration reaches 30g. Moreover, a sharp, and nearly linear, rise in the nozzle throat's deviant ablation is observed as the lateral acceleration increases. Since the lateral acceleration will change the particles' trajectory, the particles will move towards the lateral direction. This will in turn aggravate the chemical ablation and mechanical ablation processes, leading to throat deviant ablation. This means the increase of throat ablation rate under acceleration region is so abominable that it must be taken into account in the design of nozzle and the computation of SRM performance under acceleration conditions.