SHOCK INDUCED FLOW-SEPARATION IN HYPERSONIC INTAKES AT OFF-DESIGN CONDITIONS

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Abstract

High-speed turbulent flow in hypersonic intakes encounters flow-separation due to shockboundary layer interaction. Presence of separation bubble changes the pressure distribution over the surface which can lead to deterioration of aerodynamic performance of intake and thus jeopardize the stability of vehicle. In this study, we employ the physics-based shock-unsteadiness k-ε model to compute separation bubble size in a mixed compression two-ramp intake. The design point Mach number of 6 at 30 km altitude with zero angle of attack is considered. Changes in separation bubble length is analyzed at different off-design conditions by varying the flight Mach number, angle of attack and cruise altitude. The changes observed in the separation length by variation of above flight parameters is studied in terms of the physically relevant canonical parameters of upstream Mach number, Reynolds number Re_δ and the ratio of wall to recovery temperature. CFD simulations are performed for the entire range of canonical and flight parameters. Wall-to-recovery-temperature ratio is found to be an important governing parameter for separation length studies. The largest shock-induced separation is observed for the case of off-design flight Mach number of 8. The corresponding effect on the lift and drag generated by the hypersonic intake are quantified.