# Abstract

The flow discontinuities in the form of oblique and normal shock waves are ubiquitous in high speed flows ranging from transonic to hypersonic regimes. These shock waves on interaction with the viscous boundary layer, cause severe aerodynamic losses along with the heat transfer and structural losses at high Mach numbers.

In aircraft engines operating at high Mach numbers, it is exigent to reduce the magnitude of flow speed from supersonic to subsonic, before entering the burner, so as to accomplish proficient ignition. Compression is accomplished by a progression of oblique as well as normal shock waves in supersonic intakes. However, the advantage of shock enabled compression in intakes does not come independent but with tremendous losses due to shock-boundary layer interactions (SBLIs), which includes abrupt thickening/separation of boundary layer, intake buzzing, intake unstart and so on. Thus, a necessity to control these interactions arise in order to minimize the associated losses and also to improve the performance of the intake. With this in mind, an attempt is made in the present study to control the interactions at the shock impinging point in a Mach 2.2 mixed compression intake. The uncontrolled and controlled intakes are studied for five varied intake contraction ratios, under both intake start and unstart conditions. Two forms of control devices are designed, deployed and experimentally investigated in the supersonic intake. These controls methods are essentially classified into shock and boundary layer controls.

A shallow cavity covered with porous upper surface as a shock control technique is placed in the region of SBLI. A parametric study based on the porosity of the surface over the cavity is carried out by varying the diameter of the pores and the pitch distance between them. Though all the tested porosity cases of 10%, 10.6%, 15.7%, 18.8% and 22.5% have a profound upstream effect in reducing the wall static pressure in the isolator region, the 22.5% porous surface provides a higher boundary layer suction effect in the interaction region. The boundary layer suction is large enough to start the intake at higher contraction ratios, even when the uncontrolled intake is not started.

In addition, Micro-Vortex Generators (MVGs) as boundary layer control technique to control the momentum prior to the interaction, are placed in the region of adverse pressure gradient. In this study, two types of MVGs; a conventional and an innovative ramped-vane configuration were quantitatively and qualitatively investigated. In both the configurations, the height of the MVGs are varied as 600 $\mu m$, 400 $\mu m$ and 200 $\mu m$. It has been observed that, in both the tested MVG configurations, the shorter MVG (200 $\mu m$) has produced greater flow mixing in the near wall region. However, in comparison to their conventional counterpart, the innovative MVG of height 200 $\mu m$, shows the stronger momentum re-energizing

effect that is felt even in the farther downstream locations from the interaction region. Also, by reducing the static pressure inside the isolator region, the innovative micro-vortex generator of height 200 $\mu m$ reduces the colossal aerodynamic losses due to shock-boundary layer interaction.