Passive Enhancement of Pressure Oscillation in Cavity-Induced Supersonic Mixing

Long Abstract

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Introduction

In scramjet combustor, the flow residence time is very short, and that short residence time limits the amount of time for completing the heat addition cycle. Hence, efficient mixing between air and fuel remains to be an important problem because it directly affects the engine thrust and efficiency. Moreover, the compressibility effect [1~3] can adversely be affected to the fuel-air mixing. Thus, it is important to study mixing enhancement techniques for reducing the characteristic mixing time. There have been numerous mixing enhancement techniques that utilize a variety of physical mechanisms to increase the rate of mixing over a wide range of flow length scales, with either demonstrated or potential improvements in volumetric combustion efficiency [4]. It is also important to examine the feasibility of using them in practical settings. The cavity-induced pressure oscillation is one of the promising mixing enhancement techniques generating large-scale coherent structures in the shear layer for faster mixing. In the present numerical work, a passive technique was used to enhance the cavity-induced pressure oscillations modifying the cavity edge configuration.

1. Methods

The unsteady flows over a shallow rectangular cavity at Mach 1·73 were modified at the leading edge by changing the leading edge geometry. The schematic view of the cavity configuation is shown in Fig. 1. The length-to-depth ratio was kept constant at L/D=2.0 throughout the work.

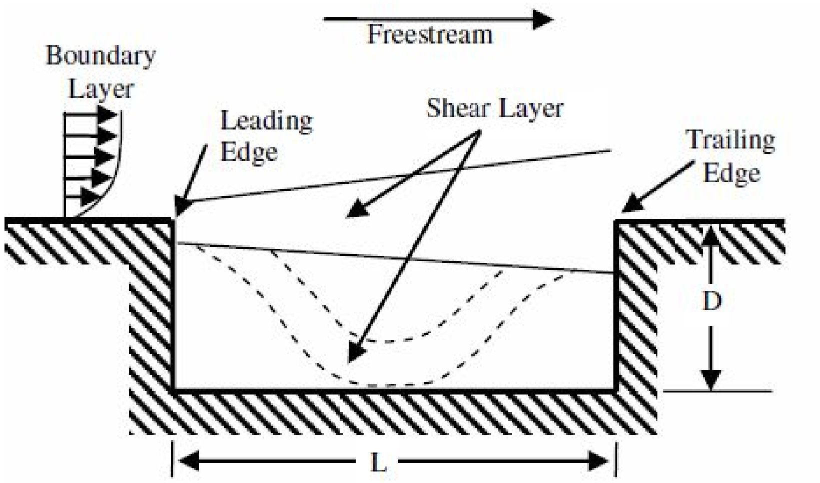

Figure 1. Cavity flow field operating in open configuration (solid line) and closed configuration (dotted line) [5].

The study was performed through solutions of unsteady Reynolds-Averaged Navier-Stokes equations (URANS). The density-based algorithm in ANSYS Fluent 13.0 was used to solve the governing equations. The SST k-ω model was used for modeling the turbulence within an unstructured mesh solver. The validation of numerical code was accomplished and the results showed a good agreement between the numerical simulation and experimental data. The study comprised the analysis of pressure oscillations in and after the cavity. The modification of cavity leading edge shown influencing to the pressure oscillations.

References

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