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Author: Mr. THILLAIKUMAR T
Indian Institute of Technology Kharagpur, India, thillaikumart97@gmail.com

Mr. Tamal Jana
Indian Institute of Technology Kharagpur, India, tfortamal@gmail.com
Prof.Dr. Mrinal Kaushik
Indian Institute of Technology Kharagpur, India, mkaushik@aero.iitkgp.ac.in

EXPERIMENTAL STUDIES ON THE EFFICACY OF TABS AS SUPERSONIC JET CONTROL

Abstract

To improve the stealth capability of a military aircraft, the reduction of core length is essential in order to reduce the heat signature of the engine exhaust. The tabs are increasingly being used due to their superior mixing effectiveness which in turn reduces the supersonic core. Indeed, the plain are found to be efficient in producing the counter-rotating vortices, which help engulf the surrounding fluids. However, from vortex theory, it can be envisaged that the mixed size vortices are efficient mixing promoter than the vortices of uniform size. One way of producing the mixed size vortices is to provide corrugations along the tab edges. Keeping these aspects in mind, in the present study the two tabs of aspect ratio 1.5, mounted at diametrically opposite locations at the exit of a Mach 1.75 nozzle, have been investigated at underexpansion condition (NPR 8). To shed the vortices of mixed size, three types of corrugation geometries namely; rectangular, triangular and semi-circular are configured along the tab edges. Considering this, the current study is divided into three parts. Firstly, the jet core length reduction is quantified by measuring the total pressure decay along the jet axis. Secondly, the jet spread rate in both the lateral directions perpendicular to the jet axis is investigated through the pressure profiles. Lastly, the shock-waves prevailing in the uncontrolled and controlled jets are visualized using the Shadowgraph technique. It is observed that, the tabs with triangular corrugations at an aspect ratio of 1.5 is found to be the better mixing promoter compared to the tabs of other geometric configurations. Surprisingly, jet spreading in the direction normal to the tab for semi-circular corrugations is found to be the maximum. But, the spreading is least for this corrugation geometry when the pressure is measured along the tab direction. For the uncontrolled jet, three prominent shock cells structures are observed from the Shadowgraph images. However, when the corrugated tabs are introduced, except the first shock cell, the subsequent cells become comparatively weaker and shorter. This clearly confirm the efficacy of tabs in weakening the waves and promoting mixing. Essentially, more number of sharp corners, as associated with rectangular and semi-circular corrugated tabs, results in additional interactions of azimuth vortices with each other, which eventually leads to a higher reduction in their strength. Hence, the triangular tabs (less number of sharp corners) is the most efficient one in better mixing and reducing the core length.