THE EFFECT OF MICROJET CONTROL ON AEROACOUSTICS OF SUPERSONIC TWIN JETS

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A method of mitigating the acoustic and aerodynamic fluctuations of ideally expanded twin jets has been proposed. As a means of control microjets were used at the nozzle exit. The effect of the controlling method on the flow field and acoustic field was investigated. Particle Image Velocimetry was used as the main tool for flow field diagnostics. The results show that the predominant unsteady character of the twin jets were reduced considerably due to the elimination of large scale organized structures with the introduction of the control. The turbulence levels show 50% decrease in turbulent kinetic energy in the mixing region of the jet. Consequently, up to 4 dB reductions in Over All Sound Pressure Level of jet noise was observed. The reduction in noise and turbulence was accompanied by a decrease of 20% in the entrainment of the ambient fluid around the jet.

1. INTRODUCTION

Experimental studies relating to jet flows representative of aircraft with twinjets have been carried out in our laboratory to provide a basic understanding of the flow phenomena involved. Focus of present work has been on the role of flow-generated noise, in particular, at supersonic exhaust velocities and the effect of a control method to reduce the jet noise and surface pressure fluctuations to avoid structural fatigue failure.

The problem becomes more severe when the jets operate at a supersonic speed, which is the case in the current and future generation, fighter aircraft (e.g. the Joint Strike Fighter). The unsteady flow being the source of noise generation, it is of practical interest to devise a technique to mitigate the coupled jet behavior. A novel control technique using microjet injection at the nozzle exit that was proven to be quite effective in large-scale eddy suppression in single supersonic impinging jet is also used in this study[1]. Large-scale structures have long been thought to be the significant contributor to the noise production in the high-speed jet flows. The evidence for the relation between these large-scale structures and noise generation has been investigated in many studies by experimental methods.

Seiner *et al.*[2] conducted experiments on two closely spaced supersonic free jets, operating at off-design conditions. Such jets are known to produce intense screech tones and the dynamic loads associated with them can reach levels that could result in damage to structures placed at the nozzle exit. Tam & Seiner[3] found that the screech tone frequency of the twinjets was slightly different to that of a single jet and the acoustic intensity in the region between the nozzles exceeded that of the direct sum of two non-interacting screeching jets. A similar investigation using twin rectangular supersonic jets was carried out by Raman & Taghavi[4] to explore the role of nozzle spacing on the determination of different oscillatory modes (symmetric and antisymmetric) of the jets. The close coupling of multiple rectangular free jets is examined by Krothapalli *et al.*[5] using an edge tone generation in one of the jets. This experiment clearly showed that a discrete sound generated by one jet can interact with neighboring jets to create a coupled oscillatory flow resulting in large eddy generation, thus producing enhanced mixing of multiple jets.

The subject of this paper is the investigation of the noise and flow field characteristics of twin supersonic jets with the configuration shown in figure 2a. This particular configuration is similar to that used in single jet studies carried out earlier and the results of which are reported in reference 6. A method of controlling the acoustic and aerodynamic characteristics of ideally expanded twin jets has been proposed. As a means of control microjets were used at the nozzle exit. The effect of the controlling method on the flow field and acoustic field was investigated. Particle Image Velocimetry was used as the main tool for main jet and entrainment flow field diagnostics.

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