J. Fluid Mech. (2003), *vol.* 490, *pp.* 75–98. © 2003 Cambridge University Press
DOI: 10.1017/S0022112003005202 Printed in the United Kingdom

On the use of microjets to suppress turbulence in a Mach 0.9 axisymmetric jet

By V. H. ARAKERI†, A. KROTHAPALLI, V. SIDDAVARAM, M. B. ALKISLAR AND L. M. LOURENCO

Department of Mechanical Engineering, 2525 Pottsdamer Street, Florida A&M University and Florida State University, Tallahassee, FL-32310, USA

(Received 22 April 2002 and in revised form 19 March 2003)

We have experimentally studied the effect of microjets on the flow field of a Mach 0.9 round jet. Planar and three-dimensional velocity field measurements using particle image velocimetry show a significant reduction in the near-field turbulent intensities with the activation of microjets. The axial and normal turbulence intensities are reduced by about 15% and 20%, respectively, and an even larger effect is found on the peak values of the turbulent shear stress with a reduction of up to 40%. The required mass flow rate of the microjets was about 1% of the primary jet mass flux. It appears that the microjets influence the mean velocity profiles such that the peak normalized vorticity in the shear layer is significantly reduced, thus inducing an overall stabilizing effect. Therefore, we seem to have exploited the fact that an alteration in the instability characteristics of the initial shear-layer can influence the whole jet exhaust including its noise field. We have found a reduction of about 2 dB in the near-field overall sound pressure level in the lateral direction with the use of microjets. This observation is qualitatively consistent with the measured reduced turbulence intensities.

1. Introduction

Using various techniques, it has clearly been demonstrated that, for both subsonic and supersonic round jets, the dominant noise producing region is restricted to about two potential core lengths, or up to about $x/D = 20$ (e.g. Laufer, Schlinker & Kaplan 1976; Fisher, Harper-Bourne & Glegg 1977; Schaffer 1979; Norum & Siener 1982). This may be expected, since not only do the mean velocities remain high in this region, but also the turbulence intensities reach a peak (Bradshaw, Ferriss & Johnson 1964). The initial zone of a turbulent jet ($x/x_c \leqslant 2$, where x_c is the length of the potential core), is known to be dominated by organized large-scale (compared to the jet diameter) structures (e.g. Bradshaw *et al.* 1964; Crow & Champagne 1971; Yule 1978; and a review by Hussain 1983). The existence of these structures, which are described by different terminology such as eddies, vortices, coherent structures, instability waves, etc., has not only been inferred from flow-visualization studies, but also from hot-wire and near-field microphone measurements. They are found to exist in high-Reynolds-number jets, both with initially laminar and turbulent boundary

† On leave from Indian Institute of Science, Bangalore, India.