MIXING BEHAVIOR OF ABSOLUTELY UNSTABLE AXISYMMETRIC SHEAR LAYERS FORMING SIDE JETS

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1. Introduction

Recently it has been shown that low-density axisymmetric jets can become absolutely unstable and develop highly coherent vortical structures in the near-field shear layer [1],[2],[3]. These jets have several unusual properties when compared to jets which are convectively unstable. The vortical structures grow quickly with downstream distance and rapidly develop three-dimensional structure. Intense pairing of alternate structures is observed. Perhaps the most interesting of all behaviors is the observation of strong ejections of jet fluid, termed "side jets", into the ambient surroundings [1],[4],[5]. Their formation is attributed to the generation of strongly coupled pairs of longitudinal vortices in the developing shear layer [5],[6].

To our knowledge, there has been only one detailed investigation of near-field real-time mixing in jets subject to an absolute instability and forming side jets. Richards et al. [7] have reported aspirated hot-film concentration measurements for downstream distances of two to five diameters for several helium jets. Here we summarize the findings of real-time concentration measurements in the developing shear layer and side jets. The results discussed are part of a broader effort to be described in detail elsewhere [8].

2. Experimental

Axisymmetric jets displaying absolute instability behavior were formed by flowing helium through a contoured 6.35 mm diameter nozzle [9]. Honeycomb, screens, and beads placed upstream of the nozzle exit smoothed the flow. The velocity profile had a uniform "top-hat" contour with fluctuations of less than 0.15%. A mass-flow controller was used to establish the helium flow. The nozzle was mounted on a computer-controlled positioning system which allowed it to be moved relative to the fixed Rayleigh light scattering system described below.

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