Interception of Two Equal Turbulent Jets

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Nomenclature

P = pressure
U_M = mean velocity along the x axis
U_0 = mean velocity at nozzle exit plane
u',v',w' = rms of fluctuating velocity components along x, y, and z, respectively
α = angle of interception
ρ = density

Abstract

AN experimental investigation of the interception of two two-dimensional jets is reported. Measurements were conducted with hot-wire anemometry and included mean velocity, turbulence intensities, and Reynolds shear stress. The mean velocity profiles of the combined jet are similar to that of the single jet. The static pressure in the combined jet is negative and increases gradually with downstream distance. The distributions of the three components of turbulent velocity fluctuations show different behavior than that for the single jet. The distribution of Reynolds shear stress and the conservation of momentum flux are discussed in the full paper.

Contents

As part of a research program aimed at the understanding of the confluence of two free-standing jets, the present work was conducted to study the effect of the angle of interception on the characteristics of the flowfield of the two jets. Four interception angles of 30, 60, 80, and 100 deg were studied in this experiment. A schematic representation of the apparatus is shown in Fig. 1. The details of the experimental facility are described in Ref. 1. Different interception angles were obtained by rotating the nozzles about the vertical axis of the slot. The Reynolds number based on the width of the nozzle was 2×10^4.

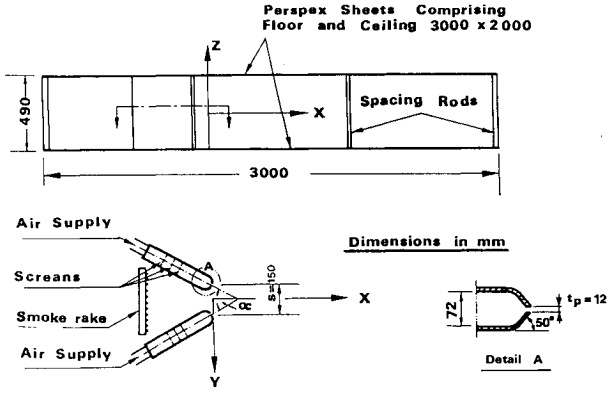

Fig. 1 Schematic diagram of the experimental apparatus.

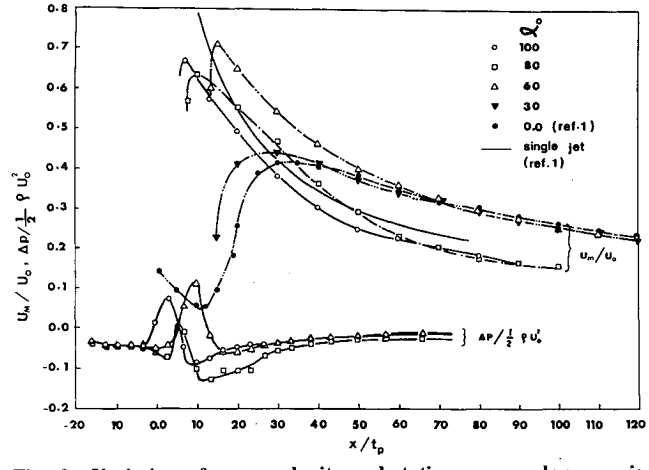

Fig. 2 Variation of mean velocity and static pressure along x axis.

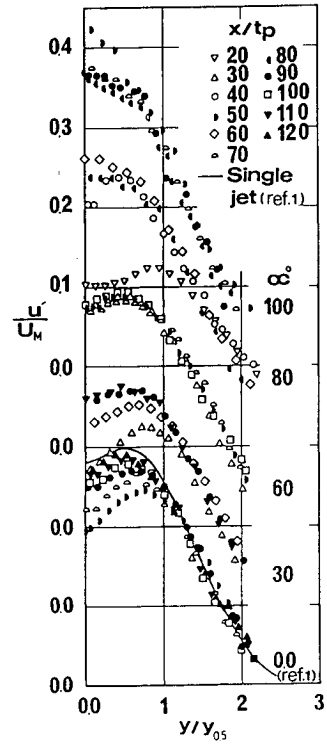

Fig. 3 Axial velocity fluctuations for the combined intercepting jets.

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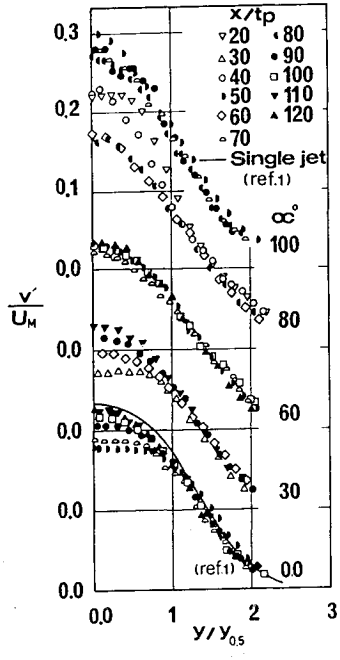

Fig. 4 Lateral velocity fluctuations for the combined intercepting jets.

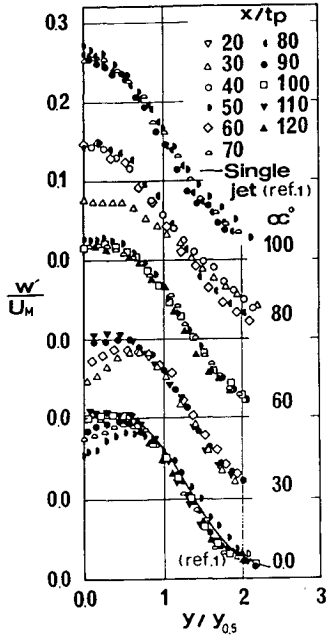

Fig. 5 Transversal velocity fluctuations for the combined intercepting jets.

A recirculation zone surrounded by the two jets and the secondary flow in the interjet passage is observed for all investigated interception angles between 30 and 100 deg. The variation of mean velocity and static pressure along the centerline of the intercepting jets is shown in Fig. 2. As the figure shows, the pressure in the recirculation region and in the secondary flow is subatmospheric. The pressure is then increased by the confluence and attains a maximum value. Downstream of the confluence region, the pressure energy changes again into kinetic energy and a minimum pressure exists at a point where the combined jet has a maximum velocity. In the combined jet, the static pressure is negative and rises gradually with downstream distance.

The mean velocity profiles (reported in the full paper) indicated good agreement with that of the single jet. The axial turbulent intensity profiles are shown in Fig. 3. Most profiles exhibit "saddle-back" shape which tends to disappear at a lower value of x/t_p as α increases. The value of u'_{max}/u'_M decreases and the location of u'_{max} moves toward the centerline as x/t_p increases. For $\alpha=60$ deg the u' profiles are similar with a value of u'_{max}/u'_M of approximately 1.05 at $y/y_{0.5}=0.55$. The profiles of v' and w' are shown in Figs. 4 and 5, respectively. The profiles are not similar except for $\alpha=60$ deg where adequate similarity is found. However, far downstream, the profiles of w' show better similarity than those observed for u' and v'. Likewise, for the u' profiles, the saddle-back shape is depicted in the distribution of w'. Nevertheless, the values of w'_{max}/w'_M are less than those observed for u'_{max}/u'_M.

Acknowledgments

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References

[1]Elbanna, H., Gahin, S., and Rashed, M. I. I., "Investigation of Two Plane Parallel Jets," *AIAA Journal*, Vol. 21, July 1983, pp. 986-991.