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Flow Visualization of Coaxial Jet Excited with Varying Phase Differences

Kiwata, T.[1] *and Okajima, A.*[1]

1) Department of Mechanical Systems Engineering, Kanazawa University, 2-40-20 Kodatsuno, Kanazawa, 920-8667, Japan

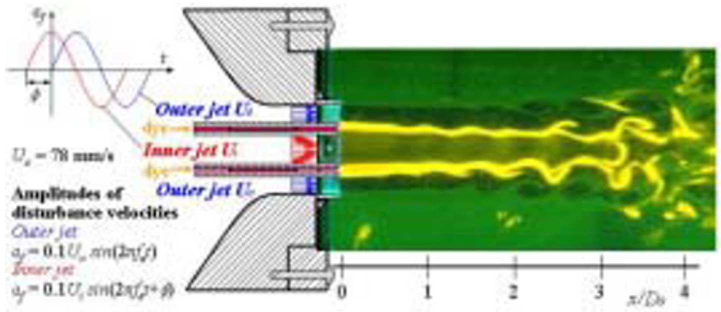

Fig. 1. Flow pattern of the unexcited jet at the mean inner circular jet velocity, U_i, to the mean outer annular jet velocity, U_o, ratio = 0.6. Initial vortex frequency of the unexcited jet in the mixing layer is f_n = 2.96Hz and Reynolds number is 3000

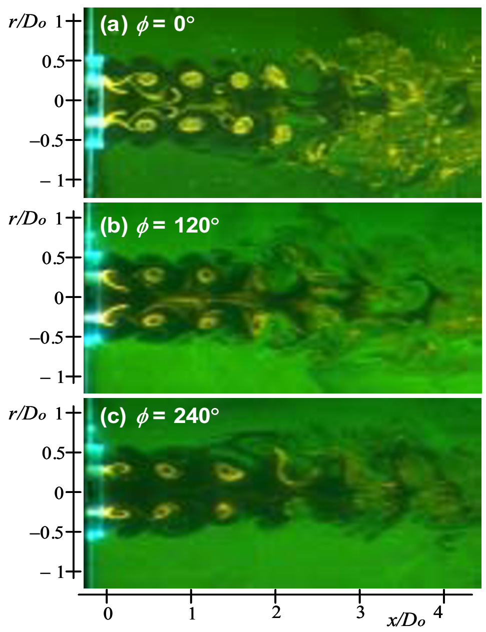

Fig. 2. The frequencies of the excitation f_e and the initial vortex f_n are matched. Here, ϕ is the phase angle difference between the outer and the inner jet perturbations

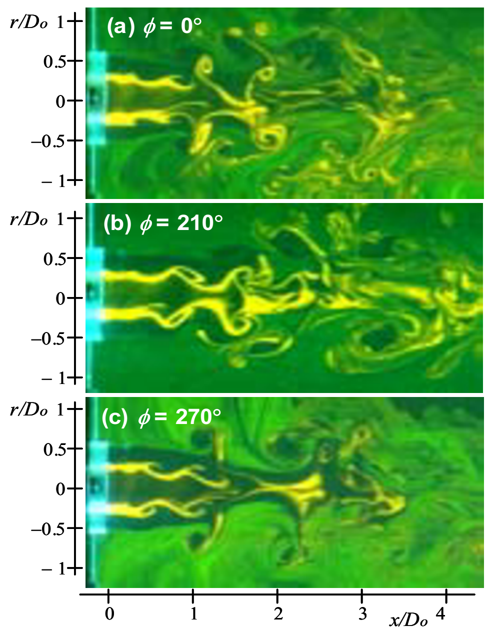

Fig. 3. Dye visualization indicates the effect of the phase angle difference on the development of the flow structure for the excitation frequency ratio f_e/f_n = 0.5

The vortical structures of the excited coaxial jet are visualized by using a laser-induced fluorescence technique. The forced excitations with various phase angle differences ϕ have slight effects on the vortex pattern of the shear-layer in Fig. 2. The center-line velocity increases more than the unexcited jet in all Figures. Vortex-pairing phenomena are performed dominantly in Fig. 3. The merged vortices are convected towards to the downstream without further vortex-pairing in Fig. 3(b). The outer and inner vortices of shear-layer are rolled up each other in the radial direction, and also the width of jet in the near region of the nozzle exit is increased in Fig. 3(c).