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Lock-in and Sinusoidal Control of Mixing for Jets in Crossflow[1] TAKESHI SHOJI, ANDREA BESNARD, ELIJAH HARRIS, ROBERT M'CLOSKEY, ANN KARAGOZIAN, UCLA — These experiments explore the effect of axisymmetric sinusoidal jet excitation on instability, structure and mixing characteristics for the gaseous transverse jet. Such forcing is applied for several different jet-to-crossflow momentum flux ratios J, in regimes of both absolutely unstable and convectively unstable upstream shear layers (USL) in the absence of excitation. For sinusoidal excitation, the USL instability becomes "locked-in" to the forcing frequency f_f, overtaking its natural frequency f_o at two critical conditions $f_{f,cr}$ for each amplitude, one below and one above f_o. Lock-in characteristics are observed for the absolutely unstable USL, as expected, but also for the convectively unstable USL, although with slightly different scaled frequency ranges. Acetone planar laser-induced fluorescence (PLIF) imaging shows that lock-in, especially with forcing frequencies close to f_o, enhances cross-sectional symmetry as well as molecular mixing for the convectively unstable USL at large J, e.g., $J = 41$, but with reduced jet penetration. For the absolutely unstable USL at a low J value, e.g., $J = 5$, lock-in is observed to have a lesser impact on structure and mixing, but with the same general trends as for convectively unstable conditions.

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