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Vorticity dynamics for a spatially developing liquid jet within a co-flowing gas WILLIAM A. SIRIGNANO, ARASH ZANDIAN, University of California, Irvine, FAZLE HUSSAIN, Texas Tech University, UCI COLLABORATION, TTU COLLABORATION — A three-dimensional transient round liquid jet with coaxial outer gas flow is simulated and analyzed via $_2$ vortex dynamics. Two surface-deformation types separate at an indentation of the jet stem. Local vorticity explains the deformations in the recirculation zone behind the cap that affect the cap dynamics. The Kelvin-Helmholtz (KH) instability dominates the deformation region upstream of the cap (UR), unaffected by the behind-the-cap region (BCR). Different three-dimensional UR atomization mechanisms are delineated on a gas Weber number (We_g) versus liquid Reynolds number (Re_l) map, consistent with temporal studies and limited experiments, in a frame moving with the liquid velocity to portray better the similarity, avoiding the common misuse of velocity ratio. Vorticity distributions show periodic vortex development and surface deformation in the UR, with lost periodicity closer to the BCR. For practical density ratios and early times in the process, axial vorticity is mainly generated by baroclinicity while streamwise vortex stretching becomes more important later only at lower relative velocities with reduced pressure gradients. Pressure and viscous forces cause azimuthal acceleration. Azimuthal viscous forces are important even at high Re_l.

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