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Mechanisms, role of vorticity, and time scales for planar liquid sheet breakup ARASH ZANDIAN, WILLIAM SIRIGNANO, University of California, Irvine, FAZLE HUSSAIN, Texas Tech University — The 3D, temporal instabilities on a planar liquid sheet are studied using DNS with level-set and VoF surface tracking methods. λ_2 contours relate the vorticity to the surface dynamics. The breakup character depends on the Ohnesorge number (Oh). At high Oh, hairpin vortices form on the braid and overlap with the lobe hairpins, thinning the lobes, which puncture creating holes and bridges. The bridges break, creating ligaments that stretch and break into droplets by capillary action. At low Oh, lobe stretching and thinning is hindered by high surface tension and splitting of the original Kelvin-Helmholtz vortex, preventing early hole formation. Corrugations form on the lobe edges, influenced by the split vortices, and stretch to form ligaments. Both mechanisms are present in a transition region that shifts in Oh values based on the liquid/gas density ratio. Different characteristic times exist for the hole formation and the lobe and ligament stretching, related to surface tension and liquid viscosity, respectively. In the transition region, both times are of the same order. Streamwise vorticity triggers the 3D instabilities. Vorticity stretching and baroclinicity dominate, while the spanwise and cross-flow vorticity tilting are less important early in the breakup.

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