An Analysis of the Surface Breakup Mechanism of a Liquid Jet in Cross-flow

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Abstract

The surface breakup of a liquid jet injected into a gaseous cross-flow is observed in moderate to high gas Weber number conditions which normally occur in the combustion applications. Although many experimental studies on the breakup regimes, the mechanism of jet surface breakup has not been fully understood because of difficulties to capture the near nozzle breakup phenomena. This study aims at providing useful observations regarding the fundamental physics involved in the surface breakup mechanism of a liquid jet in cross-flow in relatively high Weber number, using detailed numerical simulations. The results show that infinitesimal disturbances are excited immediately after the jet is exposed to the gas flow. As the disturbances are transported along the jet trajectory, they start to grow due to the shear instability. Subsequently a two-stage mechanism causes the jet surface to break up. In the first stage, the cross-flow drags the crests of waves in the downstream direction, which results in formation of sheet-like structures protruding to the leeward of the jet. In the second stage, the sheet surrounded by a thick rim, disintegrates into ligaments and finally droplets due to the propagation of span-wise waves.

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