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Dynamics of Transient Liquid Injection[1]

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Start-up transients and steady injection of liquid through round and annular orifices into ambient gas are examined. Various relevant hydrodynamic instabilities are examined together with their synergisms; capillary instability; vortex-ring (Widnall) instability; Kelvin-Helmholtz (i.e., shear-driven) instability; and Rayleigh-Taylor instability. Studies of both full jets and liquid segments of the jet are considered. Different instabilities and synergisms of instabilities produce different wavelengths on the jet interface. Surface waves, cone and sheet formations, and liquid-sheet tearing are examined. The breakdown of axisymmetry is related to the various instabilities. Accelerations of both the exit jet velocity and the liquid in the cones and ligaments are examined for Rayleigh-Taylor instabilities. Identification is sought of the length scales related to eventual breakup and droplet or ligament formation. Cavitation at high pressures is explained. Bubble growth and collapse in the internal orifice flow are discussed. Numerical problems with prediction of liquid stream breaking are discussed. Analysis and computations are emphasized but some experiments are discussed.

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