Applying Composite Disturbances to Control Breakup of Capillary Circular Liquid Jets

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Abstract

In this paper, we attempt to control the breakup characteristics of a circular liquid jet issuing from a 100 micron orifice. The breakup of the stream is investigated for different jet velocities and a composite disturbance is applied as the voltage signal to modify the breakup. The voltage signal applied to the piezoelectric terminals generates a vibration appearing in the form of an axial perturbation at the orifice exit which manifests as a radial disturbance on the surface of the jet. The perturbation grows along the jet and results in disintegration of the stream. At some frequencies and velocities, uniform breakup occurs and the droplets pinch off the liquid column at a constant rate. However, even in a uniform breakup, very small droplets (i.e. satellites) can form between the main droplets, which are not desired in many applications involving atomization and spray. The breakup is investigated experimentally over a frequency range of 4-18 kHz. In most previous experiments, a pure sinusoidal wave is applied to the piezoelectric and thereby the jet. In this work, we compare the breakup results from a single frequency disturbance with the results from a composite perturbation. The knowledge coming from this comparison is used to demonstrate how the breakup characteristics are controllable by adding extra modes to the driving disturbance. The experimental results corresponding to the jet subjected to a combination of disturbances also shows that the amplitude ratio of perturbation modes influences both the satellites merging and the breakup length.

Key words: droplet breakup, satellites, composite disturbance, droplets merging

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