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Irrotational analysis of the early stages of break-up of a viscous drop in a high-speed gas stream JUAN C. PADRINO, DANIEL D. JOSEPH, University of Minnesota - Department of Aerospace Engineering and Mechanics —

The early stages of the break-up process of a liquid drop suddenly exposed to a high-speed gas stream behind a shock wave are considered. A linear analysis of the stability of the gas-liquid interface is conducted including the tangential component of the gas velocity near the interface and drop acceleration. The interfacial dynamics is thus governed by the combined mechanisms of Kelvin-Helmholtz and Rayleigh-Taylor instabilities. Visualizations of drop break-up by a gas stream at high Weber numbers reported in the literature reveal that in this regime instabilities driven by the shearing action of the gas play a role in the disintegration of the drop; this feature is central in developing the theory presented here. The dispersion relation for the growth rate and wave speed resulting from the stability analysis is written in terms of the density ratio, gas Weber and Reynolds numbers, and the liquid Ohnesorge number, which are typically used to specify an experimental run, and the Bond number, which contains the drop acceleration. Predictions from the stability analysis are discussed in the context of observations of experimental runs described in the literature for different values of the governing dimensionless parameters.

Juan C. Padrino
University of Minnesota - Dept of Aerospace Engineering and Mechanics

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