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Stability analysis applied to the early stages of viscous drop breakup by a high-speed gas stream[1] JUAN C. PADRINO[2], Los Alamos National Laboratory, ELLEN K. LONGMIRE, University of Minnesota — The instability of a liquid drop suddenly exposed to a high-speed gas stream behind a shock wave is studied by considering the gas-liquid motion at the drop interface. The discontinuous velocity profile given by the uniform, parallel flow of an inviscid, compressible gas over a viscous liquid is considered, and drop acceleration is included. Our analysis considers compressibility effects not only in the base flow, but also in the equations of motion for the perturbations. Recently published high-resolution images of the process of drop breakup by a passing shock have provided experimental evidence supporting the idea that a critical gas dynamic pressure can be found above which drop piercing by the growth of acceleration-driven instabilities gives way to drop breakup by liquid entrainment resulting from the gas shearing action. For a set of experimental runs from the literature, results show that, for shock Mach numbers ≥ 2, a band of rapidly growing waves forms in the region well upstream of the drop's equator at the location where the base flow passes from subsonic to supersonic, in agreement with experimental images. Also, the maximum growth rate can be used to predict the transition of the breakup mode from Rayleigh-Taylor piercing to shear-induced entrainment.

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