Plateau-Rayleigh Breakup of Supercooled Refrigerant Droplets

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ABSTRACT

This paper presents a new method to produce monodisperse supercooled refrigerant droplets, comparing the breakup mechanism to the Plateau-Rayleigh instability. Formulations of highly volatile species, HFA134a and HFA152a, are cooled to 230K to form a steady unstable liquid column. The breakup of this column is shown to produce a monodisperse droplet stream through back illuminated high-speed imaging (BIHSI) near the tip of the liquid ligament. Theoretical estimates of the most unstable surface jet oscillation frequencies disagree by an order of magnitude. The low surface tension of refrigerant jets may be responsible for the relative amplification of forcing frequencies to critical amplitudes when compared to the theoretical most unstable wavelength and frequency. Near the ligament, volumetric calculations from area projections should be corrected to account for the dominant axial oscillations rather than assuming spherical droplets. Ligament jet velocity estimates from projected droplet area are also shown to agree with experimental results.