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Contribution of enhanced heat transfer in individual droplet impact cavities to overall heat transfer in spray cooling[1] JOHN KUHLMAN, NICHOLAS HILLEN, West Virginia University, Mechanical & Aerospace Engineering Dept. — The thickness of the thin liquid film beneath the cavity formed by impact of an individual water droplet into a static liquid film over an unheated, horizontal surface (termed the sub-cavity liquid film thickness) was measured using a non-contacting optical thickness sensor, versus both time and radial distance away from the impact cavity centerline. Sub-cavity liquid film thickness data were obtained for ranges of Reynolds and Weber numbers expected for a commercial spray nozzle of interest, based on PDPA velocity and diameter data. These film thickness data were numerically integrated to determine the sub-cavity liquid volume time variation. The measured liquid film thickness decreases away from the cavity centerline over much of the cavity lifetime, for all test conditions. Computed sub-cavity volumes are typically between 50% to 100% of the droplet volume, and remain near this plateau value over much of the cavity lifetime. The measured sub-cavity liquid volume and cavity lifetime are used to estimate values for both the local cavity heat flux and the overall heat flux, averaged over the heater surface, that would be required to dry out the cavity prior to cavity fill in. These computed overall average heat flux values are compared with measured overall critical heat fluxes from the literature.

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