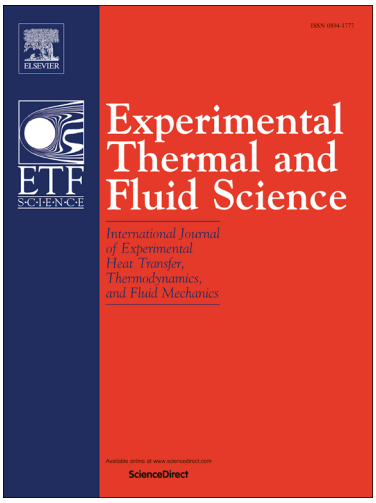

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Droplet clustering and local spray unsteadiness in air-assisted sprays

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Abstract

The clustering of droplets in air-assisted water sprays operating under ambient atmospheric conditions is experimentally studied with the aim to characterize the droplet clusters and study the consequence of clustering on local turbulent mass flux of droplets. Planar measurements of droplet number density and velocity were achieved by application of the PIV technique, while the ILIDS technique was used for sizing individual droplets. Experiments were performed for four different injector operating conditions corresponding to different liquid mass fractions at the radial measurement stations far downstream of the injector exit. The droplet clusters were statistically characterized by the measurement of the D parameter. The clustering of droplets occurs over a range of length scales, however, the largest length scale of droplet clusters (L_c) was found to scale with large eddies of the turbulent air flow around droplets. For higher local liquid mass fraction, the D parameter was also higher, while L_c was smaller, indicating intense clustering. The local turbulent number flux of droplets, which is essentially the correlation between fluctuations of the droplet number density and the droplet velocity ($\overline{nu}$), was found to be non-negligible relative to the steady flux especially towards the edge of the spray, where the tendency of the droplets for clustering was found to be higher. Also, the correlation $\overline{nu}$ was always negative suggesting that locally higher droplet number density due to passage of the clusters of droplets leads to smaller droplet velocity fluctuations.

Keywords: Droplet clustering, number density, length scale, turbulent flux, PIV, ILIDS

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