Paper 10.3

Assessment of particle characterisation via phase Doppler anemometry and automated particle image analysis techniques

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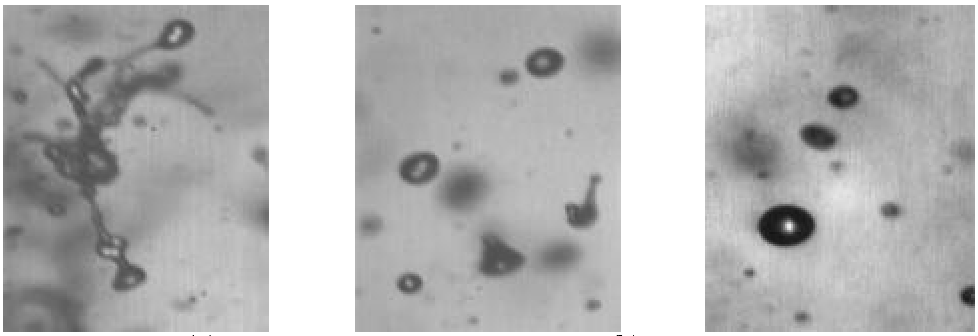
ABSTRACT

A comparison between two droplet sizing techniques has been made. Phase Doppler (PDA) anemometry and particle / droplet imaging analysis (PDIA) have been applied to a hollow cone fuel spray under quasi-steady conditions. Measurements of the arithmetic mean (D_{10}) and volume mean (D_{30}) diameters were made at three locations in the spray. The first location referred to as the 'atomisation' region at Z=5mm from the nozzle exit was found to consist of large coherent and mostly non-spherical liquid masses or ligaments (Fig. 1(a)). Although images revealed the presence of a small number of droplets in this region, their high velocities (up to 40m/s) caused significant motion blur and thus the PDIA method was unable to make measurements. At Z=10mm (Fig. 1 (b)) and without applying any shape constraints to the PDIA data, a comparison of volume mean diameters showed good agreement for the spatial volume mean (D_{30}) estimates between the PDIA (D_{30}=30.9μm) and PDA (D_{30}=32.5μm). Applying progressively more stringent shape constraints with PDIA had the effect of reducing D_{10} and D_{30} as only the smaller (and therefore more spherical) droplets were sized. In the 'dispersed spray' region at Z=20mm, the majority of the liquid mass was in the form of spherical droplets with a significantly lower droplet concentration (Fig. 1(c)). At this location, without applying a DOF correction, a comparison of the PDIA (D_{30}=25.0μm) and PDA (D_{30}=24.3μm) data again showed good agreement. It was observed that the effect of a depth of field (DOF) correction, which accounts for the fact that smaller droplets are less likely to be in focus biases the pdf's by adding smaller droplets such that the D_{10} and D_{30} estimates were significantly reduced. Such deviations were probably due to the DOF calibration which was limited to a minimum D=16μm.



(a) (b) (c)

Fig. 1 Spray images at axial locations of (a) Z=5mm, (b) Z=10mm and (c) Z=20mm corresponding to 'atomisation', 'dense spray' and 'dispersed spray' regions.

The first results from this investigation confirm that the PDIA method can accurately size droplets of D>15μm in moderately dense sprays however it is evident that to analyse sprays of smaller characteristic scales, the calibration is vital for producing more accurate number distributions. PDA measurements at Z=5mm were possible however the PDIA images at this location suggested the presence of very few spherical drops and although it was possible to gather data using PDA under these conditions, one must treat the data measured with a degree of uncertainty.