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A Phase Doppler System for High Concentration Sprays

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ABSTRACT

Various peculiar aspects of drop sizing in a dense spray, using the phase Doppler technique, are considered. In order to ensure that only one drop exists in the probe volume at any given time, the laser beams need to be focused to a very small spot, such as 50 µm. This may lead to deviations from the normally assumed Gaussian beam optics on the transmitting side. Hence, theoretical estimates of the probe volume dimensions are not reliable and may lead to erroneous measurement of liquid volume flux. In this report, a method of experimentally qualifying the phase Doppler probe volume is described for accurate volume flux measurements.

The small probe volume results in the so-called trajectory effect becoming important; i.e. a dependence of the measurement upon the particle trajectory, some signals may be based predominantly on reflection mode of scattering instead of refraction. Simply processing these signals (or allowing them to be processed) results in incorrect drop diameter measurements. The challenge for the instrumentation developer is to not only eliminate these erroneous signals, but also collect good signals from a well-defined region in space, so that the measured data can be correctly reduced to liquid volume flux and droplet concentration.

The above objectives are achieved in this work using a combination of signal amplitude discrimination and phase-ratio discrimination. The signal amplitude based discrimination is further developed by introducing an automated procedure to find the intensity limits. This procedure is implemented in the Dataview NT software of TSI/Aerometrics.

The phase ratio based discrimination is also improved upon by implementing the half-integer phase ratio that is shown to be particularly effective in eliminating the large reflecting particles, which may otherwise appear as small refracting particles.

Droplet path lengths are used to determine the effective dimensions of the probe volume. Two methods—based on the second moment and the mode of the path length distribution—are examined. The mode-based method is found to be more reliable in practical situations.

Preliminary experimental results are reported to support the above concepts.