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Experimental Analysis of the Response of a PDA System to a Partially Atomized Spray

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ABSTRACT

This work describes the systematic approach adopted to establish the LDA/PDA experimental technique that would allow measurements to be made over a wide dropsize range with confidence. The analysis considers the sprays generated by different gasoline direct injection (GDI) systems injecting into air under atmospheric conditions. The upper limit to the dropsize measurement range in the fuel sprays was confirmed using Oxford Lasers' VisiSizer and droplets of a known size produced by a mono-dispersed droplet generator.

GDI fuel sprays are highly transient, optically dense and provide a high degree of penetration and atomization. The measurement problem is therefore one of the detection of small, high speed droplets inside a dense cloud of surrounding droplets. Furthermore, under the transients found at the start and end of injection and at high fuel loads, fuel elements in the form of sheets, ligaments and filaments can also be injected. These liquid fuel elements subsequently break-up downstream from the nozzle forming droplets of a much larger size class but with a low number density (Wigley et al 1999).

The co-existence of these liquid fuel elements and the widely different size classes in the spray are considered to pose a problem for dropsize measurements by phase Doppler anemometry (PDA). In particular the wide dynamic range of light intensities scattered by the fuel elements and droplets, the trajectory of large drops through the edges of the PDA measurement volume with its Gaussian intensity distribution (Sanker et al 1992) and the probability of non spherical drops.

The work concludes that the applied LDA/PDA measurement technique is robust. It can discriminate between partially and fully atomized sprays, can accurately measure dropsizes larger than the measurement volume with a high probability as long as the PDA system parameters match the measurement task and give a realistic indication of sizes for non spherical droplets.