ICLASS 2009, 11th Triennial International Annual Conference on Liquid Atomization and Spray Systems, Vail, Colorado USA, July 2009

GDI Multi-Hole Injector: Particle Size and Velocity Distribution for Single and Jet-to-Jet Evolution Analysis

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Abstract

In this study the spray from a multi-hole GDI injector has been characterized applying the Imaging and the Phase Doppler Anemometry techniques. The requirement of quantitative information for validation of atomization and break-up sub-models, to be used in CFD numerical codes, has focused the attention on the whole and local characterization of sprays injected by the innovative multi-hole nozzles. The multi-hole approach makes possible provide a useful distribution of the fuel in the combustion chamber of the engine in order to control precisely the spatial displacement of injected fuel useful for the mixing process.

The present investigation has the objective to explore the spatial and temporal behaviour of the jets, in terms of overall fuel distribution (penetration, cone angle) and local fluid-dynamic structure (droplet size and velocities) that may be indicative of important factors for the mixture formation process to target the engine optimization and emissions control.

In this paper a multi-holes injector, with a hollow-ellipsoid footprint structure, has been used. The spray pattern evolution has been analyzed injecting commercial gasoline ad different injection pressure (10 and 20 MPa). Pictures of the spray sequence have been captured, injecting the fuel in an optically accessible vessel at quiescent air conditions, ambient temperature and atmospheric backpressure, at different instant from the start of injection. The spray has been illuminated by high intensity flashes, synchronized with the injection system, that have allowed to capture the emerging fuel by a CCD camera, 1370 x 1048 pixels, 0.5 μs shutter time. The images have been processed by Image ProPlus software for extracting the main parameters of the spray evolution.

Local characteristics of the spray has been investigated by the phase Doppler anemometer in order to provide the size and two components of the droplets velocity: the axial and the radial ones . Measurements have been performed at different locations on a single jet and within the spray-core in order to investigate the effect of jet-to-jet interaction on size and velocity distribution. Data have been analyzed using the ensemble averaging technique in order to provide mean and dispersion values. Additionally, the effect of different size class on the droplets velocity has been evaluated as well the Weber number in order to provide further details of the atomization process.

Key words: GDI spray, atomization process, droplet sizing and velocity, imaging

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