Spatial Analysis of Fuel Density from Automotive Transient Sprays by Polycapillary X-Ray Imaging

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Abstract

Attempts to study fuel density distributions inside transient high-density fuel sprays by X-ray based techniques have been carried out in several laboratories around the world. Synchrotron radiation as X-ray sources are mainly adopted due to their high intensity and pulsed nature. On contrary, this sources have the intrinsic limitations of high costs, beamlines with dedicated instrumentation, poor duty cycles.

In this paper laboratory desk-top X-ray techniques based on polycapillary optics has been used for investigating the structure of a gasoline pulsed spray for automotive applications flowing from a GDI injector. Polycapillary optical elements enable shaping divergent X-ray beams as well as getting high contrast image of the samples due to the suppression of radiation multiple scattering. A Cu Kα X-ray source in combination with a polycapillary halflens (semilens) has been used while the extinct radiation by the sample has been collected on a CCD detector. Two injectors, a single-hole hollow-cone and a six-hole, worked at 8.0 MPa injection pressure and sprayed gasoline at atmospheric backpressure in a Plexiglas chamber. This has been vented to prevent fuel fog accumulation and sheltered by Kapton foils 25 μm thick on the optical beam line to avoid droplet/vapor leakage. The injector-pressure pump coupling has been realized through a complex fuel reservoir composed of two parts: fixed and rotating. The last one permitted the rotation of the injector body around its axis by mean of a stepping motor so enabling to irradiate the spray under different angles. Off-line tomography reconstruction has been made with the images with an acquired angular steps of $\Delta\theta = 1°$. Measurements have been carried out close to the nozzle tip and the computed tomography has permitted average reconstruction of the fuel downstream the nozzle tip.

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