SOFT X-RAY DIAGNOSTICS OF DENSITY AND DYNAMICS OF DODECANE SPRAYS

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The optimization of vehicle engine injectors has been and is still today a critical issue for the reduction of fuel consumption, the limitation of air pollutant release and the development of alternative fuels. An extended panel of diagnostic techniques is applied for the spray atomisation description in connection with a large effort in modelling works. Dealing with the near nozzle region, i.e. the dense region of the spray, only the X-ray absorption technique was shown to be able to provide valuable data. Very significant improvement of this high density region characterization was recently achieved using unique features of synchrotron X-rays[1].

In this contribution, the development of a table top flash soft X-ray source emitting twenty nanosecond duration X-ray pulses with an equivalent energy of 8.3 keV is described together with its use for the density and dynamics diagnostics of pure dodecane and cerium doped dodecane sprays expanding through serial diesel injectors set in a high pressure chamber inflated up to 30 bars. Time resolved flash X-ray radiography using a high sensitivity Andor X-ray camera was performed 80 cm away from the X-ray spot by averaging the absorption of the spray over a few thousands of injection events synchronized with X-ray shots. While providing less accurate data than reference highly monochromatic and space resolved synchrotron studies, our work allow for the determination of the near nozzle spray density together with the spray angle and propagation velocity in a large range of operating conditions including caviting and non caviting injectors, various chamber or rail pressures, and to the best of our knowledge the first experiments on pure, non cerium seeded, dodecane sprays. The radiograph analysis first confirms that strong mixing between the liquid fuel and ambient gas occurs over the first millimetres downstream the nozzle tip which was up today not fully considered or inferred from the modelling. Second, the spray exhibits two distinct density components propagating with different velocities. Finally, the spray leading edge mean velocity was measured to decrease from 250 $m.s^{-1}$ down to 140 $m.s^{-1}$, as the nitrogen pressure chamber increases from one bar to 25 bars.

1. A.L. Kastengren, C.F. Powell, K.-S. Im, Y.-J. Wang and J. Wang, "Measurement of biodiesel blend and conventional diesel spray structure using X-ray radiography", Journal of engineering for Gas Turbines and Power, 131, 2009, 062802.

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