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X-Ray Desk-top Sources and Polycapillary Optic Set-up for Investigating High-Pressure Fuel Sprays

L. Allocca[(1)], S. Alfuso[(1)], L. Marchitto[(1)], D. Hampai[(2)], and S.B. Dabagov[(2)(3)]
[(1)] CNR Istituto Motori, Napoli, Italy
[(2)] INFN Laboratori Nazionali Frascati, Frascati, Roma, Italy
[(3)] RAS P.N. Lebedev Physical Institute & NRNU MEPhI, Moscow, Russia

Abstract

The investigation on fuel sprays is fundamental for an effective air/fuel mixture in internal combustion engines. The knowledge of the droplet fuel sizes as well as their spatial and temporal distributions is fundamental both for the injection design and database for predictive numerical codes (CFD). The measure of spatial densities of the fuel and the droplet dimensions is usually carried out by non-intrusive optical techniques using coherent visible light. It is a quite complicate matter because the sprays are usually very dense of finely atomized droplets and the light experiences multi-scattering in the samples with negligible outputs. Information on the inner structure of these sprays is limited to low injection pressures, wide dispersed sprays and boundary layers of the jets.

Conventional diagnostic procedures have been replaced with high-power laser or non-optical techniques, like X-radiography, to penetrate the hard regions of dense sprays and collect quantitative and time-resolved information. Weak- or no-multiple scattering is produced inside the jets and the emerging beam provides some information on the spray structure. Studies have been performed using brilliant synchrotron X-ray sources. Unfortunately, complexity of plants and high running costs, together with long waiting list, make synchrotron sources not common use.

The employ of especially dedicated optical systems can provide rather high flux beams by laboratory X-ray sources. A solution is realized by polycapillary optic that allows shaping low divergent X-ray beam and can be applied for high contrast imaging of fuel jets.

Preliminary investigations on sprays from a Gasoline Direct Injection by polycapillary X-ray technique are illustrated. A Cu X-ray Source has been used in combination with half polycapillary lens and a Photonic Science CCD detector.

A numerical simulation approach has been pursued jointly to experimental tests, too. A 3D-simulation software, reproducing soft X-ray absorption by a static sample, has been developed. The source produces a parallel (or quasi parallel) X-ray beams in the vacuum and expands from the radiation source to the sample and the detector in a spherical geometry. The phase shift and intensity attenuation of X-rays reaching the detector are very light due to the low deflection (δ) and absorption (β) parameters. Absorption percentage of 10-4 and phase shift around 10-15 radians have been calculated by the simulation.

Agenda

10.30: welcome coffee

10.45: introduction (Allocca)

11.00: X-Ray Imaging by Polycapillary Optics (Dabagov-Hampai)

11.30: injection set-up and high pressure rotating device (Alfuso)

12.00: experimental results (Hampai-Marchitto)

12.30: numerical code and results (Marchitto)

12.50: conclusions and future work

13.00: comments & discussion

Further information:

Luigi Allocca

Istituto Motori CNR
Viale Marconi, 8 - 80125 Napoli - ITALY
Phone +39 081 7177152 Fax +39 081 2396097
e-mail: l.allocca@im.cnr.it
web site: http://www.im.cnr.it

Sultan Dabagov

INFN Laboratori Nazionali Frascati
Via E. Fermi 40 – 00044 Frascati, Roma - Italy
Phone +39 0694032877
e-mail: dabagov@lnf.infn.it
web site: http://www.lnf.infn.it