LOCCIONI mobility

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FUEL SPRAY ANALYZER TEST BENCH

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INJECTORS

The high pressure direct fuel injection for both diesel and gasoline engines enhanced the need of even more accurate experimental analysis tools for the product design and development, also at industrial research level. Especially in GDI engines applications, a fine matching between the combustion chamber shape and flow characteristics of the spray evolution represent a milestone in order to obtain the desired performance in terms of low fuel consumption and pollutant emissions control. To cope with these necessities, Loccioni Mobility has designed and manufactured a test bench for the Analysis of Fuel Spray Characteristics for conventional gasoline low pressure, GDI and PIEZO injectors up to 250 bar. It is also possible to modify the bench for the application of common rail diesel injectors up to 2000 bar.

The system features the following main performances: non-intrusive methodology, high flexibility in terms of mounting capability of different injector types, high pressure operation (for both fuel feeding and test chamber pressure), easy and safe results storage, capability to be used in two different ways as basic test in short testing time or detailed analysis in longer testing time, bench room suitably designed for further expansion of the diagnostics to the analysis of other spray parameters. The injectors can be tested in air or in a test chamber at nitrogen back pressures up to 20 bars. Two different techniques have been implemented to obtain the spray images: the Shadowgraphy technique and the Mie-Scattering technique. An image analysis software application has been developed to characterise the spray.

MEASUREMENT PRINCIPLE

The conventional Shadowgraphic technique based on the use of a back-light stroboscopic lamp is used as the first method. The back-light stroboscopic lamp, driven by an external trigger, emits short light flashes (about 11 ns) at a maximum frequency of 50 Hz. The flashes permit to “freeze” the images of the spray at pre-determined delays from the start of the injection. The light source, located in the back of the jet, is focalised by suitable lens on a CCD camera. The digital camera acquires the jet shadow on the white background of the lamp.

MIE-SCATTERING TECHNIQUE

Secondary, the mie-scattering technique based on an Nd-YAG laser sheet is implemented. The rig uses an Nd-YAG laser (200mJ, = 532nm) emitting short pulses (about 6 ns) to obtain images of the spray. The laser beam goes through two lenses, which open it in a vertical plane of a thickness lower than 0.15mm in the measuring field. When the plane crosses the spray cone, the particles of the liquid-phase of the spray generate a scattering radiation of light; this allows to “freeze” them and to acquire the images by the synchronised CCD camera. A special electronic board that generates all the triggers for CCD, Laser, Strobe-light and injector under the software control guarantees the synchronisation of all the events.

ANALYSIS SOFTWARE

The images acquired by a CCD camera are stored in a PC and processed by an image analysis tool. The automatic image analysis software application has been developed to characterise the spray. These procedures allow determining the geometrical characteristics of the average spray in terms of penetration, bend angle and cone angle. It is also possible to obtain the probability of presence of the spray in a region of the space and study particular phenomena like the maximum opening pressure, the “bounce effect” or the position of the recirculation of the more finely atomised spray portion.
The software interface is shown, for the spray angles evaluation. The spray opening angle is calculated for each image acquired according to three different angle definitions, the spray bend angle with the injector axis is also calculated.