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Experimental and Numerical Characterization of the Fuel Distribution by a GDI Multi-Hole Injector for Spark Ignition Engines

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Abstract

The capability of the new generation gasoline multi-hole injectors to operate in the so-called jet-guided combustion mode allows an accurate control of the fuel distribution in the engine combustion chamber, adequate to the whole range of engine operating conditions.

In this paper an experimental and numerical investigation of the spatial-temporal distribution of gasoline issuing from a six-hole injector with a hollow-ellipsoid footprint structure is presented. Commercial gasoline is delivered at different injection pressures and several total mass in an optically-accessible vessel at controlled conditions of the gas pressure and ambient temperature. Images of the spray, lightened by high intensity flashes, are collected at different instants from the start of the injection by a synchronized high-spatial resolution CCD camera. The captured frames are processed off-line using a professional dedicated software to extract the main parameters characterizing the spray evolution. The fuel injection rates are also measured by a fuel injection rate meter operating on the Bosch tube principle.

The numerical simulation is performed by means of the AVL Fire™ code. A first set of computations is effected in order to reproduce the actual experiment, by considering the evolution of the gasoline spray in a controlled environment. Measured injection flow rates and cone angles are used as input variables. Comparison between the achieved numerical results and the experimentally evaluated penetration length allows the establishment of a break-up model and initial droplet size distribution better approximating the experiment.

In a second part of the paper the assessed model is employed to simulate the mixture formation process in a high speed four-stroke spark ignition engine, exhibiting a pent-roof cylinder head and four valves per cylinder. Different positions of the injector are considered within the constructive constraints.

Key words: gasoline spray, engine, numerical simulation, droplet distribution

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