Schlieren visualization of transient vapor penetration and spreading angle of a prototype diesel direct-acting piezoelectric injector

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Abstract

In this research work, a prototype diesel common rail direct-acting piezoelectric injector has been employed to study the influence of the fuel injection rate shaping on spray behavior (vapor phase penetration) under evaporative non-reacting conditions. This state of the art injector allows a fully flexible control of the nozzle needle lift through a parameter referred to as piezo stack charge level, enabling various fuel injection rates typologies under a wide range of test conditions. The tests have been performed employing a novel continuous flow test chamber that allows an accurate control of temperature and pressure up to 1000 K and 15 MPa respectively. The transient evolution of the spray has been studied recording movies of the injection event with a fast camera in a controlled 2-pass Schlieren visualization setup.

The effects of ambient temperature, injection pressure and piezo stack charge level have been studied and results are presented. Data obtained is correlated to previous liquid length and injection rate measurements of the same injector. Results show, as expected for all cases, that instant vapor penetration rate is closely related to the instant injection rate. Also for all cases, results show that the piezo stack charge and injection pressure affect the vapor penetration and spreading angle in a similar way. Ambient temperature alone seems not to have an important effect on vapor penetration and spreading angle, mainly because the two temperatures evaluated are close enough not to cause an important variation in ambient density. From the results, this needle control feature has proven to be a very versatile tool to control the injection process.

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