A comparison of non-reactive fuel sprays under realistic but quiescent engine conditions for SGDI

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Abstract

A comparative study on the two most commonly found gasoline direct injectors is presented, where a solenoid driven multi-hole (6 horseshoe hole) and piezo driven outward opening injector were evaluated on liquid penetration, spray width and spray structure within a constant volume chamber. These three variables have been investigated for three typical fuels (iso-octane, gasoline 95 and e100 ethanol) at a fixed calorific delivery value of 389.4 J, typical combustion required value for stratified road-load operation. A first series of tests allowed correlating mass flow and injection duration for each injector and fuel. The chemical properties of the three fuels were used to calculate the injection duration for the target calorific value. This energy value was determined previously by tests in a single cylinder research engine at stratified operation. The non-impinging, non-combusting spray was visualized using back-lit high speed photography. The pressure and temperature values set on the chamber correspond to SOI of 20, 30 and 40 CAD bTDC during engine testing at 2000 rpm and an IMEP of 2.5 bar for an overall lean operation of $\lambda = 4$. The spray visualization was also carried out at ambient conditions (25°C of temperature and 1 and 6 bar of back pressure). The results show that the penetration length is function of ambient temperature and pressure, fuel and injector type. The solenoid driven multi-hole injector produces longer penetration lengths and at a faster rate than the piezo unit under all test parameters. Moreover, there is greater variance in penetration curves for the fuels tested using the solenoid multi-hole injector compared to the piezo actuated outward opening injector. Despite wall-wetting aspects have not been tested, larger variance in penetration curves for different fuels in the solenoid multi-hole injector indicate that it is less suitable for bi-fuel engines. Thus, spray targeting differences will lead to potential increase in combustion stability (COVimep), increase in emissions and increase in wetting of surfaces i.e. sparks plug, bore or piston.

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