Effect of gas properties on Diesel spray penetration and spreading angle for the ECN injectors

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Abstract

The detailed knowledge of the Diesel spray formation is a key factor for the development of robust injection strategies able to reduce the pollutant emissions and keep or increase the combustion efficiency.

In this work, three similar single-hole injectors from engine Combustion Network (ECN) were compared measuring spray penetration and spreading angle under a wide range of test conditions. Several combinations of injection pressures (50 to 150 MPa) and ambient density (7.6 to 22.8 kg/m^3) have been tested in non-evaporative conditions in different gases: Nitrogen and Sulphur Hexafloride (SF_6); moreover, in Nitrogen atmosphere has been executed a temperature sweep from 300 to 550 K, while the same gas densities have been kept.

The single-hole nozzles from the ECN Working Group have been employed and n-dodecane has been used as fuel. The tests have been performed in two different test rigs: one designed for the recirculation of high density gases, like SF_6, at relatively low pressures (max 1 MPa); the other able to control both gas temperature and gas pressure over a wide range (300 – 1000 K and 0.1 – 15 MPa, respectively). Mie scattering imaging technique has been performed using a fast camera and a Matlab routine has been built for the image processing.

The experimental results pointed out some differences in spray penetration for the three injectors related mainly to start of injection transient and differences, spray orifice outlet diameter and spreading angle. A consistent effect of the type of the gas employed on spray penetration and spreading angle has been observed, while ambient temperature appears to have very small effect up 400K; above this temperature some reduction in penetration is appreciable due principally to limitation in the sensitivity of the technique when fuel evaporation is increasing. The non-complete momentum transfer between spray droplets and entrained gas as well as difference in sound speed probably are within the causes of the effect observed.

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