Fundamental Investigation of Diesel Spray-Spray Interaction for Cluster-Hole Nozzles

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Abstract

Nozzles with more and smaller orifices have contributed significantly to the improvement of Diesel engine performance and emissions in recent years. However, for equispaced orifice configurations, minimal or no improvement is recorded for when the number of holes is increased above a certain threshold. This is considered to be primarily due to an increased spray-spray interaction for an increased number of holes. One way to avoid interference between adjacent sprays, enhance engine performance, and reduce emissions by the usage of more sprays per nozzle is to abandon the equispaced design and to cluster/group the orifices. The benefits of such an arrangement of nozzle holes are yet to be fully explored. In this study, sprays from such nozzles are investigated with Schlieren photography and Phase-Doppler Anemometry (PDA) in a pressurized chamber at Diesel engine-like conditions of 800 K ambient temperature and 50 bar ambient pressure. Different geometric arrangements of the clustered orifices are compared with the conventional hole arrangement for nozzles of the same flow number. The comparisons include liquid and gaseous spray penetration, as well as radial velocity profiles. In addition to the experimental measurements, numerical simulations are carried out to compliment experimental observations. The commonly used discrete droplet model (DDM) is applied in the numerical simulations. The simulations pro-vide insight into the interaction between adjacent sprays in regard to the mixture formation process and subsequent combustion.

Key words: Cluster-hole nozzles, Diesel spray-spray interaction, schlieren photography, Phase-Doppler Anemometry (PDA), DDM model

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