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LARGE-EDDY SIMULATION OF AIR ENTRAINMENT DURING DIESEL SPRAY COMBUSTION WITH MULTI-DIMENSIONAL CFD

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Large-Eddy Simulation (LES) was used to perform computations of air entrainment and mixing during diesel spray combustion. The results of this simulation were compared with those of Reynolds Averaged Navier Stokes (RANS)
simulations and an experiment. The effect of LES on non-vaporizing and vaporizing sprays was evaluated. The validity of the grid size used for the LES analysis was confirmed by determining the subgrid-scale (SGS) filter threshold on the turbulent energy spectrum plot, which separates a resolved range from a modeled one. The results showed that more air was entrained into the jet with decreasing ambient gas temperatures. The mass of the evaporated fuel increased with increasing ambient gas temperatures, as did the mixture fraction variance, showing a greater spread in the profile at an ambient gas temperature of 920 K than at 820 K. Flame lift-off length sensitivity was analyzed based on the location of the flame temperature iso-line. The results showed that for the flame temperature iso-line of 2000oC, the computed lift-off length values in RANS matched the experimental values well, whereas in LES, the computed lift-off length was slightly underpredicted. The apparent heat release rate (AHRR) computed by the LES approach showed good agreement with the experiment, and it provided an accurate prediction of the ignition delay; however, the ignition delay computed by the RANS was underpredicted. Finally, the relationships between the entrained air quantity and mixture fraction distribution as well as soot formation in the jet were observed. As more air was entrained into the jet, the amount of air-fuel premixing that occurred prior to the initial combustion zone increased, upstream of the lift-off length, and therefore, the soot formation downstream of the flame decreased

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