2011-01-1290

Characterisation of Flow Structures in a Direct-Injection Spark-Ignition Engine Using PIV, LDV and CFD

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ABSTRACT

In-cylinder air flow structures are known to play a major role in mixture preparation and engine operating limits for DISI engines. In this paper PIV was undertaken on in-cylinder flow fields for three different planes of measurement in the intake and compression strokes of a DISI engine for a low-load engine operating condition at 1500 RPM, 0.5 bar inlet plenum pressure (World Wide Mapping Point). One of these planes was vertical, cutting through the centrally located spark plug (tumble plane); the other two planes were horizontal, one close to TDC (10 mm below fire face) and the other one close to mid stroke (50 mm below fire face). Statistical analysis was undertaken on the numbers of cycles needed to determine ensemble average flow-field and turbulent kinetic energy maps with up to 1200 cycles considered. The effect of engine head temperature was also examined by obtaining flow fields using PIV with the engine head coolant held at 20 °C and 80 °C. LDV measurements were also performed and compared to the data obtained by PIV. Finally comparisons were made between the experimental data and results from CFD simulations using two different turbulence models on a grid of 1 million cells.