Time-Resolved In-cylinder PIV Measurement in a Light Duty Optical Engine under PPC Conditions

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HIGHLIGHTS

• A time-resolved PIV measurement was successfully performed on a light duty optical engine with a re-entrant piston bowl shape, under several different conditions.
• The re-entrant piston bowl shape brings the measurement results closer to reality, while causing severe image distortion, which has been handled carefully during PIV evaluation in this study.
• Results from motored engine condition show a good agreement with literatures.
• Results from fired engine conditions show different influences on the in-cylinder flow from injected fuel under different injection strategies.

ABSTRACT

The understanding of in-cylinder flow field is one of the keys to realize Partially Premixed Combustion (PPC) for internal combustion engines, which has potential to achieve high combustion efficiency with low soot and NOx emissions. In this work, time resolved Particle Image Velocimetry (PIV) was performed to measure the flow field inside the cylinder of a single-cylinder light-duty optical diesel engine.

The engine was modified to Bowditch configuration, and was installed with a quartz piston and a transparent cylinder liner, to allow optical access. The geometry of the quartz piston crown is based on the regular combustion chamber design of mass produced diesel engine, including a re-entrant bowl shape. This causes severe distortion on the obtained images, which has to be handled by a distortion correction method before PIV process.

The in-cylinder flow structures in a vertical plane at the center of cylinder were obtained both within the piston bowl and within the squish volume, during the compression and expansion stroke. Measurements were performed under three different injection strategies as well as motored engine condition. Both the instantaneous flow field from single cycle and ensemble average flow field calculated from 100 cycles at motored engine condition show a well match with previous studies. The results from fired engine conditions show different interaction between injected fuel and in-cylinder air at different Crank Angle Degrees (CADs) with different injection strategies.

All the results in this study can provide a quantitative dataset being useful to model validation of numerical simulation work to investigate PPC engine more.