3-D scanning PIV of the flow within a two-stroke water analogue combustion engine

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Goal of this work is to characterize the cylinder scavenging process in a water analogue, backward scavenging, two-stroke internal combustion engine (ICE). The measurements are performed using time resolved 3D scanning particle image velocimetry (3D SPIV). The result is 2C-3D dataset. Stagnation flow is typical for the two-stroke IC engine. It is induced by the transfer and the booster ports, resulting in a complex three dimensional flow. Due to the stagnation flow high frequency fluctuations of the flow direction can occur.

In order to maintain the two-stroke IC engine competitive in its different applications it is necessary to obtain a better insight of the three dimensional scavenging process. Therefore, 3D measurement techniques are necessary. Recent developments like tomographic PTV allow the reconstruction of 3D velocity fields. However, a plurality of optical accesses is necessary. Furthermore, the long processing time for data evaluation is a disadvantage of this technique. Hence, it is unsuitable for the two-stroke engine, due to a limited optical access. Instead, a single camera set-up combined with a scanning light sheet is used. This method is also suitable to investigate the cycle to cycle fluctuations.

As Bown et al. (2007) showed, it is possible to calculate the third velocity-component from the velocity fields of the scanned planes, using conservation of mass for incompressible flow. The result is a complete three dimensional velocity field (3D 3C) for every scanning cycle of this procedure. Brücker (1997) demonstrated the working principle on IC engines in specific regions of the combustion chamber.

With this time resolved measurement technique it is also possible to investigate fluctuations of the flow direction discovered by Hauke et al. (1998). This phenomenon was called flip-flop. The results of the time averaged measurements can qualitatively be compared with experiments in an external driven engine (Britsch 2010). The time averaged flow measurements show a typical tumble motion. Thereby, the flow leaves the transfer and boost ports upwards to the cylinder head, where it moves in direction of the exhaust port and back down. The time resolved three dimensional flow fields are similar to the time averaged results. However, the clearly structured tumble motion of the averaged results is blurred in the time resolved measurements, due to the fluctuations induced by the stagnation flow.

References