LDV MEASUREMENTS IN AN IC ENGINE USING A SPARK PLUG MOUNTED PROBE

APPLICATION NOTE LDV-006 (US)

An investigation into the application of a spark plug mounted two-component LDV system to internal combustion engine flows was carried out. Data were captured at various engine speeds, throttle positions, and operating conditions. Measurements were made with and without a swirl inducer mounted in the inlet port. The system was easy to set up, and alignment was maintained throughout the entire testing program.

Test Equipment

Experiments were performed in a Kohler CH23 two-cylinder engine coupled to a dynamometer. The engine is air-cooled and has an aluminum block and head, with two-valve head, 80-mm bore, 67-mm stroke, 8.15:1 compression ratio, and 674 cc displacement. The engine features a wedge shape combustion chamber with offset spark plug. Measurements were made through an additional port located adjacent to the spark plug and inlet valve, so that the engine could be fired during testing, if desired. It may be pointed out here that *no modifications* would actually be needed to install the LDV probe, since it utilizes a standard 12 mm or 14 mm spark plug port.

LDV measurements were performed in two dimensions, the first being in the swirl direction (V1, positive counterclockwise) and the second being in a plane containing the inlet valve and LDV probe axes (V2, positive away from the valve). These are termed here as “Swirl” and “Tumble” components, respectively. The measurement location could be varied by translating the probe inwards and outwards inside the EP-14 IC Engine Adaptor, thereby adjusting the position of the beam crossing. Figure 1 shows the EP-14 IC Engine Adaptor installed in the engine.

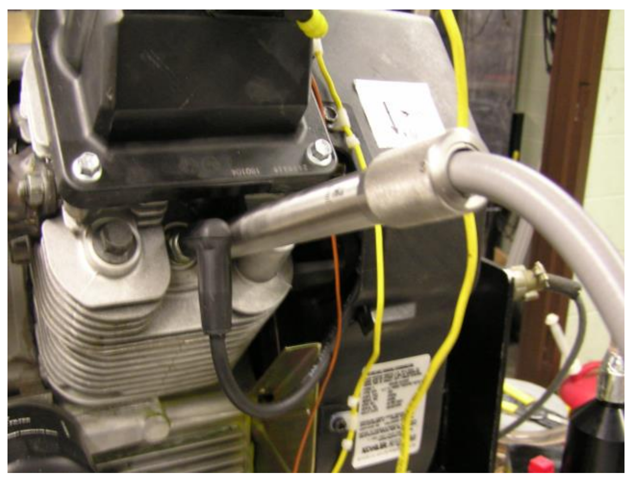

Figure 1. EP-14 and TR210 installed in the engine

A TSI TR210 two-component LDV probe was used with an EP-14 IC Engine Adaptor and 50 mm focal length lens. The light source was a TSI LA-300 argon-ion laser, and a TSI model FSA4000 signal processor was used with the EB external input option and EIC connection box to allow phase-locked collection of data with the engine crankshaft rotation. Flow seeding was accomplished using oil droplets from a TSI Model 9306 6-jet atomizer, which offered good control over the seeding density as engine speed and throttle settings were varied.

Results

Data were taken at 3060 RPM with and without a swirl enhancer plate installed in the inlet port. Various throttle settings were used. Figure 2 shows the point-wise raw data (not phase-averaged) with swirl plate installed. From 0 to 180 deg. is intake, from 180 to 360 deg. is compression, from 360 to 540 deg. is the expansion process. The exhaust stroke is from 540 to 720 deg. Figure 3 shows the point-wise raw data with swirl plate removed. The data in Figures 2 and 3 are for 100% throttle position and at a location 6.8 mm from the head surface in the combustion chamber. Much less in-cylinder motion is noted here compared to the data of Figure 2. Tumble component velocities are significantly higher, however. The swirl inducer blocks about half the inlet port area, which may be responsible for the lower peak velocities in that case.

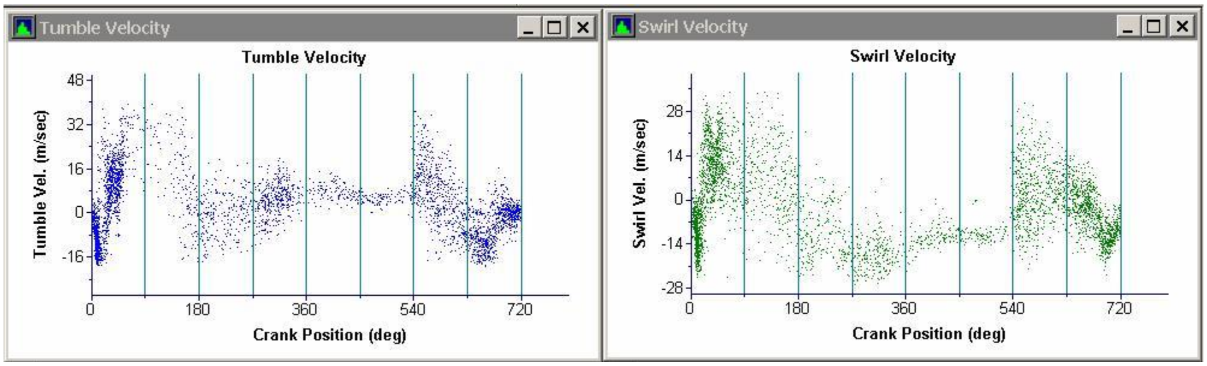

Figure 2. Tumble and Swirl components of velocity with swirl inducer plate installed

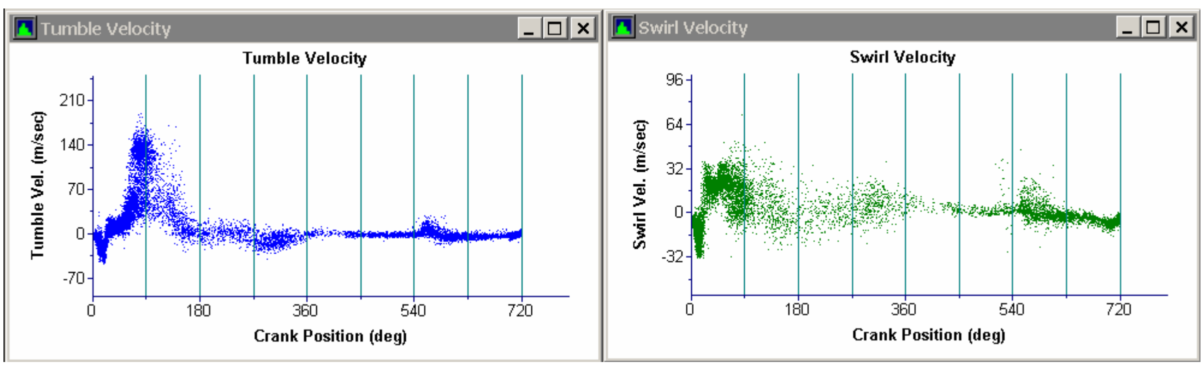

Figure 3. Tumble and Swirl components of velocity with swirl inducer plate removed

Conclusions

LDV measurements using the TR210 LDV probe and the EP-14 IC Engine Adaptor were performed in a motored internal combustion engine. Data were acquired throughout the entire engine cycle, allowing temporal evolution of the flow field to be investigated. Seeding was accomplished by an aerosol generator, and the probe was unaffected by engine vibration. Addition of a swirl inducer dramatically altered the in-cylinder velocity field. Peak velocities were lower during the inlet stroke with the swirl plate, due to the amount of port blockage by the swirl plate. Reverse flow was detected at higher engine speeds, near the inlet valve.

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