Evaluating scales by using slotted correlation in cylinder flow

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The slotted correlation method is tested for calculating auto-correlation and turbulent scales in an in-cylinder flow. The data is obtained by a laser Doppler anemometer (LDA). The paper describes effectiveness of the method. The combination of the slotted correlation method and the FFT is also proposed.

1. Introduction

For calculating the auto-correlation, conventional method is using FFT, but the FFT has to use constant time sampling data. On the other hand, the slotted correlation method provides the auto-correlation directly from random sampling data like as LDA. The slotted correlation method can provide correlation of turbulence from random time sampling data like as LDA measurement. In the present study, the slotted correlation is applied to a steady flow inside a cylinder with model engine head.

2. Experimental conditions

The test section consists of a model engine head and a transparent cylinder. The cylinder head is designed for an SI engine with two intake valves and two exhaust valves. The transparent cylinder is made by acrylic with bore of 75 mm and length of 100 mm. The experiments are conducted by single- or dual- valve open conditions with 8mm valve lift under -1470Pa suction gauge pressure in order to simulate the air flow motion through the intake ports in the actual operating condition. The measurement is carried out by an LDA. The sending optics is fiber optics and it has 7.73 degree of full beam angle. The Doppler signal is received by a photomultiplier (Dantec: 55X08) and it is processed by counter processor (DISA: 55L90a). For comparison, the experiment is also performed by a particle image velocimetry (PIV).

3. Results and discussions

Comparison between the time scales by the FFT and slotted correlation method shows that the FFT has a tendency of the overestimation of the values compared with the slotted correction method. The slotted correlation method presents stable value of the time scale along various sampling frequencies, which is the same as data rate in LDA measurement, is decreasing. On the other hand, the FFT result is sensitive to the sampling frequency. Then, the difference in the time scale becomes remarkable in the low sampling frequency region.

The length scales are estimated from the results of the time scales by Taylor's hypothesis. The results are compared with direct measurement by the PIV. Figure 1 shows the comparison between the length scales between the LDA and the PIV. The results are obtained in 2 valves opening condition. The LDA results are almost the same as the PIV data excepting for the data around x = 0 mm where the velocity is too small and fluctuation is large. In the previous study, the length scale by the LDA is far from that of PIV (Nomura et al., 2004). The present result indicates that the applicable range of the Taylor's hypothesis becomes wider. This is one of the evidences of the usefulness of the slotted correlation method.

In the paper, combination method of the slotted correction method and the FFT is proposed. The FFT is used for dividing mean motion and fluctuation. The scales are calculated by the slotted correction method. The method is effective to analyze flow including cyclic motion.

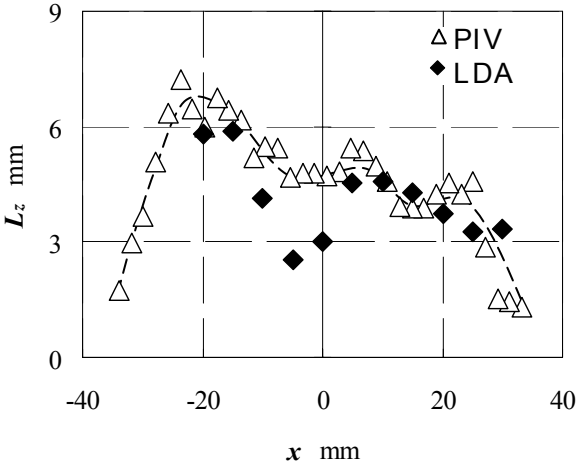

Fig. 1 Comparison of the length scales by LDA with slotted correction method and PIV.

4. Conclusions

The slotted correction method is tested for in-cylinder flow. The results indicate the effectiveness of this method. The combination of the slotted correlation method and the FFT is proposed for analysis of the cyclic flow like I. C. engine.

References

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