第５号様式

論文審査の要旨

博士の専攻分野の名称	博　士　（　工学　）	氏名	ZHANG Gengxin
学位授与の要件	学位規則第４条第[1]・２項該当		

論　文　題　目

Characterization of Free and Wall-Impinging Fuel Spray under Cross-Flow Condition

（横風気流中での自由噴霧および壁面衝突噴霧の特性）

論文審査担当者

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〔論文審査の要旨〕

Direct injection technology is widely used owing to its low fuel consumption and high thermal efficiency. However, the highly transient characteristics inside internal combustion engines (ICEs) can result in cycle-to-cycle variations (CCVs), which are reflected in various behaviors of fuel spray. All these CCVs are coupled with each other significantly during engine operation, and a significant CCV can results in low thermal efficiency, high fuel consumption, and exhaust emissions. Therefore, it is of great significance to investigate the spray CCVs inside the ICEs cylinder. In addition, it is known that a high fuel injection pressure and small cylinder volume result in the impingement of fuel spray on the surface of the piston and cylinder wall. Wall-impingement fuel spray usually affects atomization and combustion effectiveness, resulting in excessive hydrocarbons (HC) and soot emissions. As various countries have recently pursued carbon neutrality targets, the mechanism behind the spray wall-impingement phenomenon and fuel adhesion characteristics requires further investigation. Moreover, these two issues are inevitably affected by the in-cylinder airflow. Generally, cross-flow is applied to simulate the airflow movement in the cylinder. Therefore, it is necessary to study the cross-flow effect, which plays a significant role at the end of exhaust period. As mentioned above, the novelty of this study is the characterization of free and wall-impinging fuel spray under cross-flow condition. The dissertation is organized as follows:

Chapter 1 is a review of the previous work such as the spray mixture formation under cycle-to-cycle conditions, the air-flow in cylinder, the spray/jet in cross-flow, the spray/wall interaction, and the optical diagnostic techniques.

Chapter 2 introduces the experimental setups and the optical diagnostic technologies

adopted in this work. The experimental setups mainly consist of the high-pressure wind tunnel and the systems of trigger control, fuel supply, signal acquisition, images acquisition and injection rate measurement. The main optical diagnostic technologies mainly include DBI and Mie scattering for spray behavior, PIV for velocity field in spray, LDSA for droplet size distribution, and RIM for film adhered on the wall.

Chapters 3 shows the characteristics of free spray measured using DBI and LDSA methods. The effects of injection pressure on the CCV characteristics of free spray under cross-flow conditions are statistically analyzed.

Chapter 4 continues to show the statistical variation characteristics of free spray with different ambient pressure condition.

Chapter 5 illuminates the structures of wall-impingement spray, especially the characteristics of wall-jet vortex under cross-flow conditions, which is measured by CW laser diagnostic method.

Chapter 6 gives the fuel adhesion characteristics measured by RIM diagnostic method under cross-flow conditions.

Chapter 7 investigates the fuel adhesion characteristics under cross-flow conditions by numerical simulation, which are compared to the present experiments.

Chapter 8 is the main findings of this study and the future work.

以上，審査の結果，本論文の著者は博士（工学）の学位を授与される十分な資格があるものと認められる。

備考：審査の要旨は，1,500 字以内とする。