論文の要旨

題目　Droplet size and velocity characteristics of Diesel spray injected by common rail injection system
（コモンレール噴射系から噴射されたディーゼル噴霧の粒径と速度の特性）

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When a Diesel spray is injected into the cylinder with high injection pressure, it will form small droplets after spray breakup. Droplet size distribution and its spatial distribution directly determine the droplet evaporation speed and spatial concentration difference, which will further influence the engine working and emission performances. The imaging-based technique is adopted in this study to capture the droplet images before and after the end of fuel injection. Droplet characteristic parameters, such as droplet velocity, droplet diameter and distance between droplets can hereafter be obtained through imaging processing method. In addition to the experimental analysis, simulation study of Diesel spray is also conducted.

The main points and conclusions of this study can be summarized as the following aspects:

In Chapter 2, the experimental setup and investigation methods are introduced. The method adopted in the microscopic droplet imaging is a kind of imaging-based technique, compared with LDSA and PDPA, can capture the original images of spray droplets, and the droplet size can be obtained without any empirical functions. Besides, the droplets captured through imaging-based technique are considerable, which ensures the reliability of subsequent analysis results such as droplet size distribution curve.

In Chapter 3, the variations of droplet size, droplet velocity and *We* number of spray droplets in the spray tip region and spray middle periphery region within a short duration before and after the end of injection under different injection pressure and ambient pressure are studied to find out their influence on the spatial droplet characteristics. For a certain spray, the droplet velocity in Y direction will be more pronounced than the velocity in X direction over time. Increasing ambient pressure and will speed up the spray momentum dissipation. Besides, spray droplets in the spray tip region have a wider range than the middle periphery region. The droplet size distribution difference of different measurement locations in the spray tip region will become more obvious if injection pressure or ambient pressure increases. But in the spray middle periphery region, increasing injection pressure or ambient pressure will weaken the difference between spatial droplet size distribution curves. This is accounted for the interaction between droplets and ambient gas. In a certain region, either droplet inertial momentum or vortex of air flow is dominant, the spatial variation in this region will become evident. Compared with the change in injection pressure, altering ambient pressure will make greater change in the spatial droplet size distribution.

In Chapter 4, the spray droplets along spray axis at 10 ms ASOI are studied to better understand droplet distribution characteristics of the whole spray. Droplet size analysis is the focus

since the droplet velocity at this timing is fully dissipated. It can be found from comprehensive analysis that increasing injection pressure will promote spray atomization but increasing ambient pressure will deteriorate spray atomization. The droplet size distribution curve along spray axis under higher ambient pressure first changes from unimodal to bimodal, then shifts back to unimodal. However, the droplet size distribution curve along spray axis under near-atmospheric pressure remains unimodal. Correspondingly, the SMD along the spray axis first increases, then stabilizes for a certain range, and finally decreases under higher ambient pressure. But the variation in the SMD along the spray axis under near-atmospheric pressure tends to be linear. This indicates under higher ambient pressure, high concentration mixture is likely to form in the spray middle region, while under low ambient pressure, it tends to form in the spray tip region. In addition, among the three droplet size distribution functions R-R, N-T and L-N, L-N is the best one in predicting droplet size distribution. What is more, the SMD calculated from the modified SMD empirical formula is in good agreement with experimental results.

In Chapter 5, the simulation of Diesel spray development is conducted and compared with the experimental results. Though the simulation result cannot be completely consistent with the experimental result, it can describe the spray development process, and the change regularity of spray tip penetration and SMD along spray axis under different injection pressure and ambient pressure. In the KHRT model, changing the constant which determines the breakup time of KH-WAVE model will make great impact on the simulation result. Poor agreement between experimental and simulation results is the most obvious in the spray tip and tail regions. This is owing to fuel spray introduction method that cannot match the reality and the idealized model in determining the interaction between spray droplets and ambient gas.