論 文 の 要 旨

題 目　Effects of Split Injection on Adhered Film Formation of Flat-Wall Impinging Fuel Spray

（平板壁面に衝突する燃料噴霧の液膜形成に及ぼす分割噴射の影響）

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In this study, the impinging spray of split injection by single-hole gasoline injector under non-evaporation and evaporation conditions were detected experimentally. The Refractive Index Matching (RIM) and Mie scattering method were adopted under conditions similar to the actual engine operating conditions to visualize the fuel film and spray morphology, respectively. The characteristics of fuel film such as mass, area and thickness of split injection were investigated and compared during the injection process and the evolution of fuel film such as mass, area and thickness were analyzed after the injection processes in detail. The effect of split injection (single, double and triple injections) and ambient temperature (298 K, 433 K) were investigated firstly, and then the effects of different injection mass ratios on the fuel film were investigated to acquire a deep understanding about the impinging spray under non-evaporation and evaporation conditions. Furthermore, the microscopic characteristics of the free and impinging sprays were obtained and compared along penetration direction. Moreover, droplets behaviors after impingement in the near wall region were discussed deeply by Particle Image Analysis (PIA) technique.

In Chapter 3, the fuel film characteristics under split injection were investigated using the RIM method. The differences in fuel film under non-evaporation and evaporation conditions were also analyzed. Under the non-evaporation condition, split injection decreases the fuel film obviously compared to that of single injection. Two possible reasons are responsible for this decrease. One is the effect of "suction". The other reason is the effect of "splashing". Compared with the non-evaporation condition, the fuel film mass increases slightly. The possible reason for this increase is the "heat transfer" effect. Even though the effects of "suction" and "splashing" still exist, the effect of "heat transfer" has the advantage over the effects of "splashing" and "suction".

In Chapter 4, the fuel film characteristics under different injection mass ratios were

investigated and compared. The mechanism in fuel film of different injection mass ratios under non-evaporation conditions were also analyzed. Fuel film mass of D50-50 increases obviously compared to that of D25-75 and D75-25. Two possible reasons are account for this difference. One is the effect of "fuel film thickness". The other reason is the effect of "momentum energy". The two effects lead to the fuel film mass of D50-50 is the maximum. The effects of different injection mass ratios on the uniformity of the fuel film have a big difference under non-evaporation condition. The fuel film uniformity of D50-50 is the worst compared to that of D25-75 and D75-25.

In Chapter 5, PIA technique was applied to compare the microscopic characteristics of the free and impinging sprays at different capture locations (P = 32, 37, and 42 mm), and different injection pressures (10, 20 and 30 MPa). The droplet parameters such as diameters, velocities, and *We* were obtained by image processing method. Spray impingement would cause an energy loss to the spray plume, delaying the arrival timing of spray tip at the capture location.

In Chapter 6, the microscopic behavior of the impinging spray was investigated. The droplet diameter and velocity of the spray tip are observed after inclined impingement at different locations. The difference in droplet behavior between different injection pressures was detected. The instantaneous velocity of the droplet after impingement determines the location where the droplet can reach. The droplets with high V_y are more likely to fly away from the impinging wall after impingement. Some droplets with a downward velocity are more likely to redeposit on the flat wall. The wall guides the droplet to move tangentially to the wall. The ligaments under high kinetic energy are inclined to break up into more droplets with large size and high velocity, which is mainly caused by the air entrainment resulting from the high injection pressure. By comparing different injection pressures, the high injection pressure greatly increases the velocity of the droplets and intensify the breakup process. It is found that the droplets locating at the downstream of the impinging spray tip have a longer average minimum distance, indicating a smaller droplet number density.