論　文　の　要　旨

題　目：

Characterization of Mixture Formation, Ignition and Combustion Processes of Ethanol-Gasoline Blends Injected by Hole-Type Nozzle for DISI Engine

（直噴火花点火機関用ホールノズルから噴射したエタノールーガソリン混合燃料の混合気形成，点火，燃焼過程に関する研究）

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Automobile industry is now playing more attention to the development of fuel direct injection in a spark ignition (SI) engine in order to lower fuel consumption and reduce pollutant emissions. Thanks to the development of injection, combustion and engine control system, the direct-injection spark ignition (DISI) technology has made a great progress. Spray-guided concept (namely the narrow spacing between the injector and spark plug) and the multi-hole injector are currently receiving considerable attention due to their great potential to achieve the favorable fuel consumption and engine-out emissions. However, the ever growing demands for the fossil fuel and increase of CO_2 emission in the atmosphere from automobiles make it necessary to develop alternatives of conventional fuels. Moreover, gasoline and diesel have high carbon atom and long chemical chain, which produce more carbon dioxide. Future researches may focus on the using of renewable fuel, such as ethanol which is well known as the most promising substitute of gasoline in SI engine. Therefore, it is worth providing added insight into (1) whether or not ethanol-gasoline blends can be accepted by the DISI engines, especially the spray-guided concept, and (2) how the DISI engines fed by ethanol-gasoline blends perfectly works, and (3) the mechanism/behavior of spray and combustion characteristics under DISI-like conditions using ethanol-gasoline blends.

This study focuses on the clarification of spray mixture, ignition and combustion characteristics injected by a hole-type nozzle in a constant volume vessel. The quiescent-steady conditions were set to simulate the typical thermodynamic environment of near top dead center (TDC) in DISI engines.　The fuels with different ethanol blending ratios, E0 (100% gasoline), E85 (85% ethanol and 15% gasoline) and E100 (100% ethanol) were used in this study.

The mixture formation of spray, especially the different components in the E85, was quantitatively measured by a dual-wavelength ultraviolet-visible laser absorption scattering (LAS) technique which was able to simultaneously measure the liquid and vapor phase distributions. Different spray mixing characteristics of fuel composition in ethanol-gasoline blends were investigated. In addition, the non-vaporizing and vaporizing spray of E85 also were tested by using Mie scattering to clarify the spray characteristics, such as penetration length, spray angle and liquid volume, during the spray development based on the momentum theory. Furthermore, the impinging spray of different impinge distance (30 and 45mm) and wall temperature (273 and 298K) were investigated by the LAS measurement to clarify the mixing process of ethanol-gasoline blends spray under cold-start condition.

Thereafter, different ignition strategies, consisting of ignition position and timing, were conducted in the combustion experiments. The range of ignition probability for ethanol-gasoline blends was clarified using the Z-type shadowgraph, and the comparisons of those were made. Also, the effect of spark energy on the flame development was studied. Moreover, the flame visualization and development, such as flame color, flame radius, ignition delay and combustion variability were qualitatively and quantitatively characterized by the high-speed imaging of OH* chemiluminescence and natural luminosity. Also, the effect of spray evaporation on the combustion performance was examined. Soot formation during the combustion was analyzed based on the natural luminosity. A further discussion of using E85 in DISI engines was conducted and compared with other previous studies. The result showed that the optimal ignition strategies proposed by this study was able to achieve the favorable combustion performance.