

論文 / 著書情報  
Article / Book Information

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種別(和文)	論文要旨
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(博士課程)  
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## 論文要旨

THESIS SUMMARY

専攻 : Department of	Mechanical and Aerospace Engineering	専攻	申請学位 (専攻分野) : Academic Degree Requested	博士 Doctor of	(Engineering)
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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words )

The current trend of heavy-duty diesel engine introduces high boosted pressure to achieve high engine efficiency and reduce soot emission. Under this circumstance, the physical process of liquid fuel spray is expected to be different compared with that of the conventional one. It is as a consequence to the combustion and emissions. The purpose of this study is to visualize the liquid-gas phases of diesel spray at 20-mm near field and to investigate the relation between that near-field fuel spray and combustion including emission characteristics which is mainly focused on high boosted surrounding gas conditions.

In chapter 1, the recent trend for heavy-duty diesel engine development was reviewed including improvement of fuel/air mixing and the change in the combustion chamber shape to enhance combustion performance. The research objectives and outline of the thesis were introduced in this chapter.

In chapter 2, imaging techniques used to visualization diesel spray and combustion flame were given. For spray imaging, the simultaneous scattering and shadowgraph imaging technique was used. The scattering technique was verified validity that the light only scatters from liquid portion inside spray. In classical shadowgraph, a shadowgraph of diesel sprays includes both shadows of liquid and vapor phases of fuel and entrained gas. Advantage of using this simultaneous technique is only a single high-speed camera needed, spray structure and several characteristics including both liquid and vapor phase data such as liquid length, liquid and vapor cone angles can be detected. In diesel combustion, the flame luminosity is dominated by soot radiation. The high-speed direct photography was used for diesel flame imaging. After imaging the combustion flame, the black body calibration and two-color method calculation processes are necessary for analysis of flame temperature and KL factor which is related to soot volumetric fraction inside the flame.

In chapter 3, it was focused on spray formation process. In experiment, four nozzle specifications with variation of nozzle hole lengths and nozzle orifice diameters were used to observe the effect of nozzle specifications on spray formation. The computational fluid dynamics (CFD) was introduced to help predict the flow behaviors such as cavitation formation and velocity profiles inside the injector nozzle hole. This is because internal nozzle flow is supposed to significantly influence the near-field spray characteristics and atomization. As the surrounding gas density is the factor that affects spray dispersion, breakup and entrainment processes, wide range of surrounding gas condition of 11.7-46.8 kg/m<sup>3</sup> were prepared before fuel injection. The taken spray images were then digitalized and several data were extracted such as liquid length, liquid and vapor cone angles. Sequentially, the fraction of entrained gas, fuel in liquid and vapor phases contained in spray at 20-mm near-field region were calculated based on one dimensional spray model and the measured spray data. Liquid cone angle noticeably increased with increasing gas density at low gas temperature of 534 K. It was relatively unchanged at gas temperature of 712 K and 890 K since dispersion could possibly be suspended at higher gas temperature. Vapor cone angle was observed to increase with L/D ratio decreased. The widest vapor cone angle was found at D=0.180 mm (L/D=2.77) corresponded to the highest mass of fuel in vapor phase and entrained gas amount. At constant gas temperature of 890 K, fuel mass in liquid phase considerably decreased with increasing gas density. Hence, atomization was stimulated by increasing gas density, then consequentially to promote liquid vaporization. With identical orifice diameter of 0.180 mm, the smaller L/D=2.77 which corresponds to shorten nozzle hole length achieved mixing process, shorten liquid length and superior entrainment compared with L/D=4.44.

In chapter 4, combustion and emission characteristics were described and correlated with spray characteristics in near-field region which had intensively been analyzed and discussed in chapter 3. At the last part of this chapter, NO<sub>x</sub> formation correlated to flame temperatures and equivalence ratio of vapor fuel/air mixture at start of combustion was presented. The result showed that with identical orifice size nozzle of D=0.180 mm, the shorter hole length nozzle of L=0.5 mm (L/D=2.77) provided higher entrained gas amount and higher vapor fuel/air mixture was achieved at near-field region. This near-field mixture was found to consistently behave throughout the injection period as it was responsible for shorter ignition delay

and combustion drastically promoted with shorter combustion duration. At high boosted gas condition, the lower amount of soot produced by the shorter hole length nozzle was prominently exhibited due to strong combustion resulting in higher flame temperature and soot oxidation performed intensively during late combustion phase. Additionally, NO<sub>x</sub> emission was found to be a function of equivalence ratio of vapor fuel/air mixture at start of combustion and strongly related with flame temperature. The combustion and emission showed significant correlation with near-field spray characteristics.

In chapter 5, it was an overall conclusion of this research work including the key findings. Future research developments and recommendations were also given.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

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