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論文審査の要旨

博士の専攻分野の名称	博　士　（　工学　）	氏名	DONG PENGBO
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論　文　題　目

Characterization of Internal Flow, Spray Evolution and Mixture Formation of Multi-Hole Nozzle for Diesel Engine

(ディーゼル機関用多噴孔ノズルの内部流れ，噴霧挙動，混合気形成に関する研究)

論文審査担当者

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〔論文審査の要旨〕

The multi-hole nozzles, which simultaneously inject several spray plumes, are generally applied in modern practical Diesel engines. However, there is rarely research that focuses on the spray properties emerging from the realistic multi-hole nozzle injectors. One of the determining factors that can greatly influence the quality of the fuel atomization and mixture homogeneity inside the chamber is the nozzle geometry. In the current study, the differences in the internal flow and spray evolution between the traditional single-hole nozzle injector and the realistic multi-hole nozzle injector (10 holes) were investigated experimentally and numerically. Furthermore, the characteristics of spray morphology, evolution processes, and evaporation characteristics emerging from the practical diesel multi-hole nozzles were compared and analyzed during the transient injection processes in detail. The high-speed video observation method and Laser Absorption Scattering technical were implemented under different engine dynamic operation and various nozzle geometrical conditions to visualize the non-evaporating and evaporating spray evolution, respectively. Moreover, the relationship between the different nozzle internal flow properties and the corresponding spray behaviors was investigated by the numerical simulation method systematically. The detail arrangement of this dissertation is summarized as following.

Chapter 1 is entitled “Introduction”. First of all, the background and motivation of this study was introduced in this chapter. And then, a review of previous work was also presented in this chapter.

Chapter 2 is entitled “Experimental Apparatus and Measurement Method”. It introduced the experimental apparatus implemented in this study, such as injection rate meter, fuel injection system, high pressure and high temperature constant volume vessel, and the spray observation techniques.

Chapter 3 is entitled “Models and Theoretical Basis Applied in Numerical Study”. The theoretical basis and computational model applied in the numerical study was described here.

Chapter 4 is entitled “Spray Evolution of Multi-Hole Nozzles under Non-Evaporation Conditions” A comparison between the traditional single-hole nozzle and the modern practice

multi-hole nozzles was conducted firstly, including the injection rate, spray behaviors and so on. After that, the characteristics of spray evolution of multi-hole nozzles under different engine operation and nozzle geometrical conditions were investigated and discussed in detail in this chapter. The empirical equations for the spray tip penetration of different nozzles were also improved in this chapter.

Chapter 5 is entitled “Internal Flow Characteristics of Multi-Hole Nozzles”. In this chapter, the internal flow characteristics inside single-hole and multi-hole nozzles was compared firstly, after that, the multi-hole nozzles were paid more attention to. The dynamic operation conditions and nozzle geometrical effect were investigated under the same condition with that in Chapter 4. Finally, the internal flow and experimental result are correlated with each other.

Chapter 6 is entitled “Numerical Computational Study of Multi-Hole Nozzle Spray”. The spray simulation results were introduced in this chapter, and the internal flow simulation results were inserted to the break up models as the boundary conditions. The comparison of single-hole and multi-hole nozzles spray was firstly discussed. The effect of rail pressure and hole diameter on the multi-hole nozzle spray evolution was also analyzed in detail.

Chapter 7 is entitled “Spray Evolution and Mixture Formation of Multi-Hole Nozzles under Evaporation Conditions”. The spray evolution processes of the multi-hole nozzles under the evaporating conditions were discussed in this chapter. Firstly, the spray evaporation characteristics of single-hole and multi-hole nozzle was compared under the normal and micro hole diameter conditions. Furthermore, the multi-hole nozzle spray evaporation characteristics were investigated under different dynamic engine operation and nozzle geometry conditions. Finally, the spray evaporation properties and nozzle geometry design were correlated with the numerical results in the previous chapters.

Chapter 8 is entitled “Conclusions”. The main findings of this study and general conclusions on the characteristics of internal flow, spray evolution, and mixture formation of multi-hole nozzles for diesel engine are summarized, and some recommendation of future work in this theme was conducted as well in this chapter.

The combustion process, emission formation, and the resulting engine performance in Diesel engines are well known to be governed mainly by the spray behaviors and the consequent mixture formation quality. One of the most determining factors that affect the spray development is the nozzle configuration. The result presented in this study was able to make contribution to improve the geometrical design and spray modeling accuracy of diesel multi-hole nozzles.

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。