論文 / 著書情報
Article / Book Information

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Title(English)	Study on Wear/Deformation and Deposit Formation inside Nozzle of Diesel Fuel Injector
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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

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要旨（英文 800 語程度）
Thesis Summary (approx.800 English Words)

The improvement of the fuel injection common-rail system has become an important issue. With the changes in injection conditions, wear and deformation and deposit of the nozzle were found. It occurs at the injector nozzles, thereby affecting fuel injection and spray characteristics. In this study, the effects of temperature, test duration, and tempering on nozzle body seat were investigated. Also, the effects of additives, ambient gas, and time between injections on nozzle hole deposit were studied using an injector testing device.

In chapter 1, the recent trend for wear/deformation and deposit formation in diesel engine was reviewed, including the fundamental of diesel combustion process and fuel injection system. The research objective and outline of the thesis were introduced in this chapter.

In chapter 2, the specification and principle of the test rig and test equipment developed specifically to simulate the operation of the actual engine were described. The testing machines used in this study are those fabricated based on the common rail fuel injection system used in commercial diesel engines. The main parts are primarily a common rail, an 8-hole injector, injector holder, and an electric heater, which can raise the nozzle's temperature up to 350 ° C, and an accumulator for the pump and its drive motor. The imaging techniques are used to observe the nozzle's surface morphology, characteristics, and material properties. In addition, techniques for studying deposit characteristics, fuel injection, and spray characterization were used.

In chapter 3, this study focused on wear and deformation on nozzle body seat. The effects of body seat temperature, test duration, temperature increase duration, tempering temperature, and tempering duration on nozzle body seat wear and deformation were investigated using an injector testing device. Surface roughness measurements using a nano search microscope and hardness measurements of the nozzle body seat were performed to investigate the textural and physical characteristics of the nozzle body seat. Optical measurements via optical microscopy and field emission scanning electron microscopy were performed to investigate the topographical information and microstructure of the nozzle body seat. The tests were conducted at constant injection pressure and injection duration, 180 MPa and 480 μs, respectively. The temperature of the nozzle body seat was raised to 350 ° C. The mechanism of wear and deformation on the nozzle body seat was considered. Temperature and test duration were intensively studied for their effects. In addition, the pre-heat treatment was considered in order to find a way to prevent the deformation of the nozzle body seat. Finally, the proposed mechanism related to wear and deformation was presented. It was found that temperature influences wear and deformation of the nozzle body seat significantly, especially at high temperatures. It causes the material of the nozzle to soften, thereby increasing wear and deformation. Test duration governs the plastic deformation of the body seat, particularly under long test durations due to the release of dislocations in the nozzle material, which decreases hardness. Moreover, tempering is an effective technique for preventing body seat deformation. The strong structure "cementite" advances precipitation as the tempering temperature rises. During the heated injection test, when the nozzle material is heated above the tempering temperature, however, the tempering process eliminates the isotropic dislocations, resulting in a low density of dislocations and structural changes and the deformation is promoted.

In chapter 4, this study focused on the deposit formation and the effects of the deposits on fuel injection together with the spray characteristics under the different additive, ambient gas, and times between

injections. The experiments were run on the testing machine, which was designed based on the commercially used common-rail system. The injection pressure was controlled at the maximum, which was 180 MPa, and the injection duration was controlled at 480 μs. The electric motor was employed to control the injection time at 700 and 1,400 rpm. The nozzle seat temperature was controlled at 350 ° C. The observations were designed to study the effects of additive, ambient gas, time between injections, and number of injections on the deposit inside the nozzle hole and the effects of the deposition on injection and spray characteristics including the mechanism of deposit formation. From this study, it was found that zinc is significant in the formation of nozzle hole deposits. Fuel injection is reduced as a result of the deposit that forms inside the nozzle hole. This demonstrates that nozzle hole deposit can form under non-combustion test conditions. In addition, the process of deposit formation evolves as test duration and time between injections increase. This reduces the maximum injection flow rate and the discharge coefficient. When a deposit forms inside the nozzle hole, the spray characteristics degrade, including a decrease in spray penetration, an increase in spray cone angle, and a decrease in spray volume.

In chapter 5, summarization of all the research works undertaken including the key findings were presented. Future research developments and recommendations were given as well.