論文 / 著書情報
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題目(和文)	多段超高圧燃料噴射と噴孔オフセットノズルを用いた予混合圧縮自己着火燃焼の制御に関する研究
Title(English)	Study on Premixed Charge Compression Ignition Combustion Control using Multi Pulse Ultrahigh Pressure Injection and Offset Orifice Nozzle
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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 ）

Compression ignition engines provide higher thermal efficiency compared to other internal combustion engines. However, large amounts of soot and NO_x are produced during combustion. Soot and NO_x emissions can be simultaneously reduced by applying Premixed Charge Compression Ignition (PCCI) combustion. The main purpose of this study is to investigate the effect of ultrahigh injection pressure and multi pulse injection on PCCI combustion and to verify the new PCCI combustion concept.

In chapter 1, the recent research on PCCI had been reviewed. PCCI combustion provided high indicated thermal efficiency (ITE) with low Soot and NO_x emission. However, the conventional PCCI combustion is limited by operating range due to rapid combustion. This problem can be overcome by shortening mixture formation timing by using ultrahigh injection pressure. To control maximize the benefit of ultrahigh injection shorten spray penetration is required. The spray penetration can be reduced by multi pulse injection. In this chapter the new combustion concept that uses the combination of ultrahigh injection pressure and multi pulse injection to control PCCI combustion had been proposed. The research objective and outline of the thesis were also introduced in this chapter.

In chapter 2, the effect of injection pressure had been investigated. The combustion characteristics were observed under single pulse injection condition with various injection pressure, injection amount and oxygen concentration. The 5 mg injection amount had been selected to represent the one pulse of multi pulse injection. The injection pressure had a strong effect to reduce ignition delay. However, the effect of injection pressure shows in the different ways depends on injection amount. In case of 5 mg injected amount increasing the injection pressure made the duration become longer due to lean equivalence ratio. Once the injection amount increased to 10 and 15 mg, the combustion duration increased with increasing the injection pressure. This due to the combustion phase change from PCCI combustion to diffusive combustion. Increasing injection pressure promote mixture formation by increased turbulence energy at nozzle orifice outlet, thus less soot emission. However, this also increases CO and THC from fuel impinging.

In chapter 3, until this chapter the proposed combustion concept had been clarified. The experiment was conducted with a single cylinder engine. The engine was operated under constant load condition with various injection pressures and pulse number. The experiment found that PCCI combustion can be controlled by applying ultrahigh pressure and multi pulse injection allowing fuel to be injected near TDC. On the other hand, the combination of ultrahigh pressure and multi pulse injection is an effective method to increase ITE and simultaneously reduce soot and NO_x emission. Unfortunately, too high injection pressure casts ITE decreased and CO, THC increased for fuel impinge.

In chapter 4, As the results show in the previous chapter, too high injection pressure made ITE reduction from spray impinging. To maximize the benefits of increasing injection pressure, shorter spray penetration is required. Generally,

spray penetration can be shortened by reduce orifice diameter. However, this led to a reduction of the fuel flow rate and loss of ITE. The offset orifice nozzle is offers short spray penetration and without prolonging actual injection duration. The offset orifice nozzle was designed by shift orifice aliment from into the sac center to the edge of sac follow swirl direction to create unsymmetrical fuel velocity at the nozzle orifice outlet. This made fuel spray bend following the offset direction. In this chapter the new design of nozzle had been examining under single pulse injection condition. The experiment was carried out on single cylinder engine both without and with optical access. The offset orifice nozzle provides similar ignition delay and combustion duration compared to standard design nozzle. On the other hand, offset orifice nozzle also provides higher ITE under all operating conditions. This due to more combustion occurs inside the combustion chamber that can see from the larger OH* chemiluminescence area and intensity. The higher flame temperature of offset orifice nozzle also benefices for the oxidation process of CO and THC

In chapter 5, the new combustion concept using ultrahigh injection pressure, multi pulse injection and offset orifice nozzle had been verified. As the results of the previous chapter, the 3 main injection pulses had been selected. The experiments were also conducted on single cylinder engine both without and with optical access. The offset orifice nozzle provided advance rate of heat release rate, higher gross ITE under all operating conditions. The advance rate of heat release of offset orifice nozzle was observed under multi pulse injection. This is due to the benefits from shorter liftoff length and higher equivalence ratio inside spray area. On the other hand, orifice nozzle also provided lower CO and THC emission as in the single pulse injection condition. The offset orifice nozzle also shows significantly larger OH* chemiluminescence area and intensity throughout the combustion as under single pulse condition. The flame temperature of offset orifice nozzle also shows in the same way as under single pulse condition. However, at the injection pressure 350 MPa the flame temperature of offset orifice nozzle shows significantly higher flame temperature at the beginning of combustion process due to short lift off length. The gross ITE over 47.5% can be achieved with low CO and THC emission can be achieved.

Chapter 6 is summarization of all the research works undertaken including the key findings was presented. Future research developments and recommendations were also given.