SUMMARY OF Ph.D. DISSERTATION

School	Student Identification Number	SURNAME, First name
Integrated Design Engineering		LIM, Ock Taeck

Title

The Effects of Inhomogeneities on HCCI Engine Combustion

Abstract

Homogenous Charge Compression Ignition (HCCI) combustion is the process in which a homogeneous pre-mixture is auto-ignited through compression. The unique property of HCCI engine allows the combustion of very lean or dilute mixtures, resulting in low combustion temperatures that dramatically reduce engine-out NOx emissions. Also, unlike conventional diesel combustion, the charge is well mixed, so PM emissions can be very low, while still providing high diesel like efficiencies. In spite of those advantages, HCCI engine has a high pressure-rise rate (PRR) during combustion, making it critical to the high-load operating limit of this engine by knocking. In order to solve this, there is suggested mixture inhomogeneity method and thermal stratified method. The purposes of this research are to get fundamental knowledge about the effects of thermal stratification and fuel strength stratification on HCCI combustion using rapid compression machine (RCM).

The chapter 1 summarizes characteristics and problems of HCCI engine and shows objectives.

The chapter 2 describes RCM on which experimental work was conducted, the analyzing methods of its data and the numerical calculation with elementary reactions.

The chapter 3 describes the HCCI combustion characteristic of single fuel with *iso*-Octane, *n*-Heptane and *n*-Butane that have been shown to be a reasonable surrogate for commercial fuel and exhibits different ignition characteristics. The effects of equivalence ratio and initial temperature on HCCI combustion under homogeneous mixture condition, the experiments were conducted on RCM fueled with single fuel. From the results, the equivalence ratio and initial temperature increase, the low temperature oxidation reaction (LTR) start timing and the high temperature oxidation reaction (HTR) start timing are advanced. However, the temperatures at the beginning of LTR and HTR were constant, regardless of fuels.

The chapter 4 describes the thermal stratification effect on HCCI combustion. The temperature stratification was made by buoyancy effect in combustion chamber of RCM. The major intents were the PRR and the combustion reaction time with its temperatures under stratified charge conditions and homogeneous charge conditions. We also measured the chemiluminescence images and analyzed the time to start of luminescence intensity. In results, under stratified condition, the PRR were higher than that of homogeneous condition. Under stratified condition, the luminosity duration was longer than the case of homogeneous condition. Further, under stratified condition, the brightest luminosity intensity is delayed than the homogeneous condition.

The chapter 5 describes the mixture stratification effects on HCCI combustion. The fuel was directly injected with micro syringe on the cylinder bottom; the fuel is evaporated by cylinder temperature and than the stratified charge is made by gravity. In results, under mixture stratification condition, there was a little higher rate of pressure rise than mixture homogeneous condition. Because the higher fuel concentration is located on bottom side of cylinder, the temperature difference before HTR was a little, almost HCCI combustion is occurred simultaneously.

The chapter 6 describes the HCCI combustion of mixture fuels under thermal stratified condition and mixture stratification. Under same equivalence ratio, as the mixing ratio increases, LTR start timing and HTR start timing became longer. Moreover, the PRR became lower.

The chapter 7 summarizes acquired knowledge and discusses the way for avoiding knocking on HCCI combustion, concludes the study finally.