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Effects of Pre-mixtures Condition on HCCI Engine and Environmental Factor Analysis by PRF

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Abstract: It was possible to obtain a Primary Reference Fuel (PRF) ranging from 0 to 100 mole%, by mixing iso-Octane with octane number 100 and normal heptanes with octane number 0. This study covers different intake temperature between 333K and 413K, different intake Pressure from .101MPa to .2MPa, different equivalent ratio and various RON. Here PRF0 is n-Heptane and PRF100 is iso-Octane, Rate of Heat Release (RHR) is reduced from PFR0 to PRF 100; it is interesting that there was less magnitude of low temperature reaction at iso-Octane. When intake Pressure varies between .101MPa and .2MPa, Pressure (.2MPa) has high LTR value compare to others intake Pressure; i.e. high intake Pressure has high HRR and low intake Pr has low value of HRR. While intake Temperature changes from 333K to 413K; low intake temperature has high LTR value compare to high intake temperature. With the increase of the PRF fuel octane number, NOx, HC and CO emissions increased, especially for HC emissions. IMEP, RI and PRRmax are varied with equivalence ratio. All of them are increased with rise of equivalence ratio. Here study is conducted very lean mixture, which is varying from .1 to .4; and base equivalence ratio is .2.

Key words: HCCI Engine, Combustion Duration, Low Temperature Reaction (LTR), High Temperature Reaction (HTR), Primary Reference Fuel (PRF), n-Heptane, iso-Octane, IMEP, and Emissions.

Nomenclature

HCCI: Homogeneous charge compression ignition
RI: Ringing intensity
PRR: pressure-rise rate
RHR: rate of heat release

1. INTRODUCTION

Using another energy source to drive a vehicle does not seem competitive within the next decade; a more feasible short-term solution is to develop a fossil-fuel-based engine that is highly efficient One of the most prominent techniques to enhance engine efficiency while reducing NOx emissions is to operate an engine with HCCI technology. The principle of HCCI can be viewed as a hybrid between spark ignition (SI) and compression ignition (CI) engines. Like the concept of SI engines, premixed mixtures are first charged into a cylinder. Like the concept of CI engine, the mixture is ignited by auto ignition due to compression. Based on the auto ignition by compression, the combustion of an HCCI engine is mainly controlled by the chemical and thermodynamic properties of the mixtures and is first initiated by several hot auto-igniting spots at the core regions where temperature is higher than the other regions. Homogeneous Charge Compression Ignition is an alternative engine operating mode. In the range of conditions where it operates, it can provide better efficiency with lower NOx and particulate matter emissions than conventional SI or CI engines. However, the absence of a positive method to control

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ignition timing narrows the operating range, between engine knock and partial burning/misfire. This limits the use of an HCCI engine in vehicle applications unless costly technologies are used to control some key parameters such as compression ratio, intake pressure / temperature or mixture composition to provide ignition timing control over a sufficient range.

2. Calculation Method

In this study all of the calculation was done by CHEMKIN2 and SENKIN program. It was originally developed at the Lawrence Livermore National Laboratory and later it was reduced by V. Golovichev (http://tfd.chalmers.se/~valeri/MECH.html). Here we considered 99 species and 462 reactions.

Table: Engine Specifications

Process	Only 1 Compression & Expansion
Bore	112 mm
Stroke	115 mm
Displacement	1132 cc
Intake Valve Close	ABDC 48˚
Exhaust Valve Open	ABDC 312˚
Compression Ratio	21.6
Connecting Rod	205 mm

3. Results and Discussion

Figure1 shows pressures histories on different intake temperatures. Intake temperature varies from 333K to 413K. The maximum pressure was 9.76MPa while intake temperature 355K and the maximum pressure was 8.933MPa at intake temperature 413K. When intake temperature increase maximum pressures are reduces.

Figure 2 provides about cylinder temperature and crank angle at various intake temperatures. Maximum temperatures are 1670 to 1896K from intake temperature 333K to 413K.

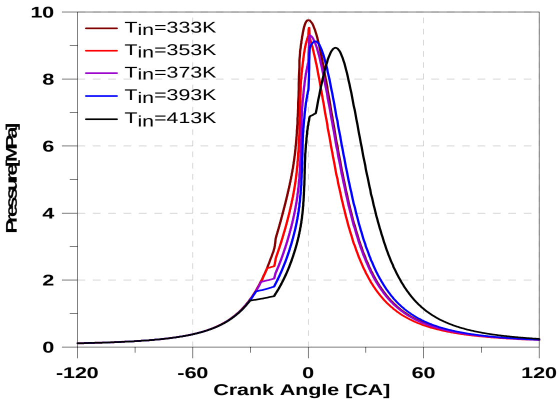

Figure 1: Cylinder Pressure history at different intake temperature

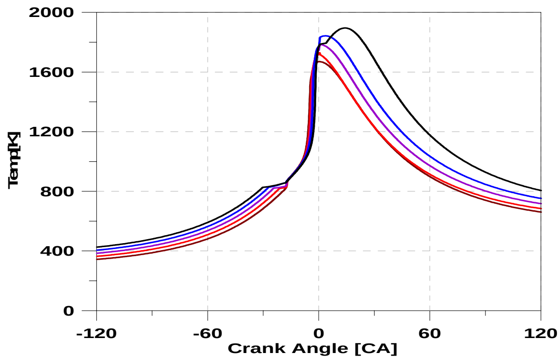

Figure 2: Cylinder Temperature history at different intake temperature

4. CONCLUSIONS

1. This study is able to detect combustion under very lean conditions with an equivalence ratio as low as 0.2 which is necessary for idling conditions in an HCCI engine.
2. The LTR starting time and HTR starting time are advanced with the increase of initial temperature.

Reference

Mari Nagae, “Effect of Intake Gas Pressure and Temperature on Combustion Process in HCCI Engine Numerical Analysis Using PRF Fuels/Air Mixture”, SAE paper 2008-08-0079