

Combustion and Emission Behaviour of Ethanol Fuelled HCCI Engine: An Experimental Investigation

By

Rakesh Kumar Maurya

Petroleum fuel supply concerns and increasingly stringent exhaust emission regulations require new propulsion systems that provide high performance, excellent fuel economy, as well as reduced exhaust gas emissions. Homogeneous charge compression ignition (HCCI) is new combustion concept that may develop as an alternative to diesel engines with high efficiency, low NO_x and particulate emissions. HCCI is a hybrid of well-known Spark ignition (SI) and Compression Ignition (CI) engine concepts. As in SI engine, a homogeneous fuel air mixture is prepared in the intake system. During the compression stroke, the temperature of the premixed charge increases and reaches the point of auto-ignition; i.e. the mixture burns without the help of any ignition system, just as CI engine. In the HCCI combustion, the control of combustion timing and rate of combustion is complicated hence the HCCI combustion has not reached a level of development and cost that makes its market introduction possible.

This research presents and discusses the results of an experimental investigation and development of an ethanol-fuelled experimental HCCI engine. For the study of HCCI combustion concept, several modification and suitable instrumentation is done in the existing two cylinder diesel engine. The setup for HCCI combustion is developed in one of the two cylinders of the engine and other cylinder operates like normal diesel engine. In this investigation, port fuel injection method is used for the homogeneous mixture preparation for HCCI mode. To control the HCCI combustion phasing, intake air pre-heating and exhaust gas recirculation (EGR) are used. The HCCI combustion is successfully achieved. Experiments are performed for combustion and emission behavior of HCCI combustion. It is found that HCCI combustion starts at intake air temperature of 145 °C. Combustion behavior investigation is carried out on two temperatures 150 °C and 170 °C respectively. Emission test are done at 170 °C for air-fuel ratio of 45 ($\lambda = 5$) with EGR 0% and 30% respectively. The emission results shows the in the HCCI combustion mode NO_x and PM emissions are drastically reduced simultaneously as compared to diesel engine.

Keywords: Homogeneous Charge Compression Ignition, HCCI, Auto-ignition, Premixed Charge Compression Ignition, Combustion, Internal Combustion Engines.