Abstract

Homogenous Charge Compression Ignition (HCCI) is a promising technology that offers high fuel economy and low oxides of nitrogen and particulate emission for automotive and stationary engines. This study presents results of experimental investigations and development of HCCI combustion engine fuelled with gasoline and primary alcohols (ethanol, methanol and butanol). For the study of HCCI combustion concept, several engine modifications and suitable instrumentation was carried out in an existing CI engine. Port fuel injection strategy was used to prepare homogeneous mixture of fuel and air in the HCCI mode. Start of injection timing and injection duration of the fuel injector was controlled using injector driver circuit developed for this study. Auto-ignition of fuel-air mixture in the cylinder was achieved by electrical intake air pre-heating. Instrumentation of the engine for measuring the exhaust emissions, particulate emissions, in-cylinder pressure and temperature at various points was done. LabVIEW based software was developed for in-cylinder pressure data acquisition and analysis of different combustion parameters.

Main objective of this research was to investigate the performance, combustion, and emission characteristics of HCCI engine using different gasoline like fuels under controlled rate of combustion. Effect of engine operating parameters on different combustion parameters such as combustion phasing, combustion duration, thermal efficiency, combustion noise and emissions were investigated in this study. Impact of engine operating conditions on particulate emissions in HCCI combustion using gasoline and alcohols have been investigated. Cycle-to-cycle variations of different combustion and performance parameters were also evaluated. Further investigations of cyclic variability are conducted to find the effect of various engine operating conditions on random and deterministic cyclic variability. Results show that HCCI engine has deterministic behavior in combustion timing as fuel-air mixture becomes richer. Behavior of combustion parameters during fueling transient and engine startup was also investigated in this research. The emission results show that in the HCCI combustion mode, NO_x and PM emissions drastically reduce simultaneously in comparison to conventional diesel engines. Results also indicate that particulate emission in terms of particle number cannot be neglected in HCCI engines. Closed loop control of combustion phasing is successfully demonstrated using dual fuel.