The thermal and auto-ignition performance of a homogeneous charge compression ignition engine fuelled with diethyl ether and ethanol blends

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ABSTRACT

This study aims to numerically investigate the thermal and auto-ignition performance of a Homogeneous Charge Compression Ignition (HCCI) engine fuelled with diethyl ether and ethanol blends at different inlet air temperatures and lambda values. In this study, DEE and DEE/ethanol blends with different volume percentages, such as 85% DEE/15% ethanol (D85E15) and 70% DEE/30% ethanol (D70E30) was used as test fuels. A four-stroke single-cylinder HCCI engine was designed to use reduced fuel chemistry to create a zero-dimensional single-zone model. The single-zone combustion model was developed with the first law of thermodynamics as a differential form. The inlet air temperature ranged from 360 K to 420 K at 15 K intervals, and the lambda ranged from 1.5 to 2.5 at 0.25 intervals to evaluate the combustion control in the HCCI engine. A numerical study was carried out at an engine speed of 1200 rpm. The numerical validation model results were well agreed with reported experimental results, and the significant trends of the combustion phases were varied with a minimum error of 5%. The numerical results show that the in-cylinder pressure and heat release rate are decreased for all test fuels with the increasing lambda. The combustion phase was found to be advanced, and the combustion duration was expanded with increasing inlet air temperature. Increasing the ethanol proportion in the test fuel delayed the start of combustion. For D85E15 and D70E30 at lambda of 2 and inlet air temperature of 420 K, the indicated mean effective pressure was increased by about 12.6% and 6.10 bar. Furthermore, with DEE and D85E15 at a lambda of 2, the indicated thermal efficiency was increased by approximately 11.4% and 49.17%. It is concluded that the combustion and performances characteristics for the HCCI engine are significantly affected by DEE and ethanol fuel blends.

KEYWORDS

Auto-ignition; Diethyl-ether; Ethanol; HCCI; Inlet air temperature; Thermal performance

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