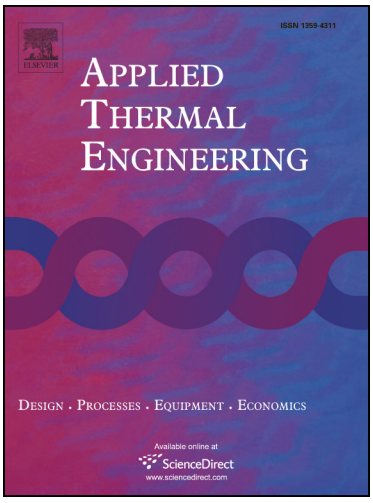

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Experimental Investigations to reduce Unburned Emissions in Reactivity Controlled Compression Ignition through Fuel Modifications

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Abstract

Reactivity Controlled Compression Ignition (RCCI) is a dual fuel LTC strategy wherein wider operating load range is achieved by utilizing low and high reactive fuels like gasoline and diesel, respectively. One of the major problems associated with RCCI is higher unburned emissions. The present work intends to reduce unburned emissions from RCCI combustion through fuel modifications. The investigated low and high reactive fuels include butanol- and ethanol-gasoline blends, gasoline-, butanol- and Karanja biodiesel-diesel blends. A production light duty diesel engine is modified to run in RCCI mode through suitable modifications. Based on PFI fuel sensitivity study, it is observed that 20% butanol and 80% gasoline blend (G80B20) results in lower HC, CO emissions and higher brake thermal efficiency. Similar results are obtained with 20% Karanja biodiesel and 80% diesel blend (D80K20) as the DI fuel. With G80B20 and D80K20 as PFI and DI fuels, respectively, the PFI to DI fuel ratio at each load conditions is optimized to further reduce unburned emissions in RCCI. Overall, it is concluded that by replacing gasoline and diesel with G80B20 and D80K20 as PFI and DI fuels, respectively, the HC and CO emissions are reduced by 50% along with 4.5% higher brake thermal efficiency.

Keywords: Low Temperature Combustion (LTC), Reactivity Controlled Compression Ignition (RCCI), Fuel modification, Alternative fuel, Unburned emissions.

Abbreviations: BMEP- Brake Mean Effective Pressure; bTDC- Before Top Dead Center; BTE- Brake Thermal Efficiency; CI-Compression Ignition ; CN- Cetane Number; CO- Carbon Monoxide; CR- Compression Ratio; CRDI- Common Rail Direct Injection; DI- Direct Injection; DTBP- Di- tert Butyl Peroxide; EGR- Exhaust Gas Recirculation; EHN- 2-Ethyl hexyl Nitrate; LHV- Lower Heating Value; LTC- Low Temperature Combustion; LTHR- Low Temperature Heat Release; NOx- Oxides of Nitrogen; PFI- Port Fuel Injection; PM- Particulate Matter; PRR- Pressure Rise Rate; RCCI- Reactivity Controlled Compression Ignition; RON- Research Octane Number; RPM- Revolution per Minute; SOI- Start of Injection; TDC- Top Dead Center; HC- Unburned Hydrocarbon

1 Introduction

The internal combustion engine and fuel design have evolved over the years so as to meet the worldwide stringent emission mandates **[1]**. For improved engine performance and lower exhaust gas emissions, various LTC strategies are introduced, wherein, both PM and NO_x emissions are significantly reduced owing to utilizing premixed, diluted fuel-air mixture **[2, 3]**. All the LTC strategies target to by-pass NO_x and soot formation zones by maintaining the temperature and fuel-air equivalence ratio below 2000 K and 2, respectively **[1]**. Reactivity controlled compression ignition (RCCI) is one such LTC strategies, wherein, two fuels of different