Combination of Intake Throttling and Exhaust Gas Recirculation to Improve Low Load Combustion Efficiency of a Dual Fuel Engine

Nikhil D Khedkar, Asish K Sarangi

Indian Institute of Technology Bombay, Mumbai, India

Abstract

Reactivity controlled compression ignition (RCCI) strategies in compression ignition engines have shown great potential to utilize low reactive fuels along with the diesel pilot fuel to reduce oxides of nitrogen (NO_x) and soot emissions simultaneously. However, poor low load combustion efficiency remains a challenge with this strategy. In this work, a production light duty diesel engine was operated in the RCCI mode with methane as the low reactive fuel. The engine was operated at a speed of 1500 rev/min and a load of 3 bar gross indicated mean effective pressure. The effects of cold exhaust gas recirculation (EGR) and intake air throttling strategies on engine performance and emissions were investigated and compared. The results suggested that achieving combustion phasing close to top dead centre plays a key role in the improvement of the combustion efficiency with both these strategies. However, the improvement in the combustion efficiency with the intake air throttling strategy was significantly higher compared to the cold EGR strategy owing to an increase in the fuel-air equivalence ratio. Very low NO_x (<0.4 g/kWh$_{indiacated}$) and soot (<0.01 g/kWh$_{indicated}$) emissions were achieved with ~40 % cold EGR; however, NO_x emissions increased with intake throttling owing to an increase in the peak combustion temperature. A combination of reduced premix ratio (50 %) and high cold EGR levels (~50 %) resulted in ~90 % combustion efficiency while maintaining very low NO_x and soot emissions. This work highlights the importance of understanding the effects of the individual control strategies such as start of injection timing, EGR, premix ratio and intake throttling which then can be combined to improve the performance of the RCCI strategy at low load.