ABSTRACT

An experimental investigation was carried out on a single-cylinder four-stroke spark-ignition engine fuelled with methanol (M100) and ethanol (E100) to study energy efficiency improvement and emissions reduction using oxygen-enriched air and increased compression ratio. Additional oxygen from the external supply from the cylinder along with the main source of oxygen inducted from the atmosphere called "oxygen-enriched air" was injected into the engine's intake manifold. The compression ratio of the engine was increased from 9.8:1 (base) to 10.6:1. The performance, emission, and combustion characteristics were analysed with M100 and E100 fuels compared with base gasoline.

The results indicate that brake thermal efficiency of the engine at MBT spark timing increased along with emissions (CO, HC, NO) reduction with M100 and E100 compared to base gasoline. The performance improvement and emissions reduction with M100 are higher than that of E100. The brake thermal efficiency was higher by 4.5% with M100 than E100. The emissions of CO and HC were lower by 4.7% and 23% respectively with M100 and NO emission was higher by more than four times with M100 compared to E100. Further experimental studies were carried out to enhance thermal efficiency and emissions reduction with oxygen-enriched air (30-40% by mass). The emissions of CO and HC decreased drastically along with improved thermal efficiency with the oxygen-enriched air. The brake thermal efficiency increased to 19% with M100 which was 12.8% with base gasoline. The CO and HC emissions decreased by more than 75% compared to base gasoline. However, NO emission increased drastically by more than three times with M100 compared to gasoline. In the last phase, the experimental tests were conducted on the engine with an increased compression ratio and oxygen-enriched air. The brake thermal efficiency increased by 9.4% which was the highest with M100. The CO and HC emissions were the lowest being 0.63 g/kWh and 0.017 g/kWh respectively with M100. The main reasons for

the improved efficiency and emissions reduction include high reactant temperature and pressure at the high compression ratio, increased oxygen concentration, high heat release rate, and better combustion. The performance improvement and emission reductions are higher with M100 than that of gasoline and E100. The main reasons for better performance with M100 include high flame velocity, absence of carbon-to-carbon bond, high oxygen concentration, and fewer intermediate species such as formaldehyde during combustion compared to E100. The performance of the engine with E100 is better than base gasoline.

A notable conclusion emerged from this research study is that a spark ignition engine fuelled with methanol (M100) with oxygen-enriched air (35% to 38% oxygen concentration increased from base 23% in the atmospheric air) and increased compression ratio could provide the best performance improvement and emissions reductions compared to ethanol (E100) and gasoline.