Experimental investigations on utilization of ethanol-gasoline blends in a spark-ignition vehicle using chassis dynamometer

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Abstract

Ethanol in gasoline acts as an octane booster and its use in spark ignition engine vehicles enhances energy efficiency and reduces exhaust emissions. However, as the calorific value of ethanol-gasoline blends is lower than base gasoline, the vehicles suffer in terms of power drop, higher fuel consumption and lower flame velocity under conventional mode of operation. Hence, this experimental investigation is aimed at optimization of design and operating conditions of the engine for improvement in vehicle performance and reduction in emissions.

Physicochemical properties of various ethanol-gasoline blends (E10, E20, E30, E40 and E50) were tested as per IS 2796 test methods. It was found that the mid-level ethanol-gasoline blends such as E30 provides significant advantages in terms of higher octane number, desirable Reid vapor pressure, H/C ratio and O/C ratio compared to gasoline and lower blends. Experimental tests were conducted on a single cylinder spark ignition engine powered two-wheeled vehicle with 30% ethanol-gasoline blend using chassis dynamometer.

In a conventional (unmodified) spark ignition vehicle, the CO and HC emissions decreased by 66% and 75% respectively with E30 compared to base gasoline under wide-open throttle (WOT) conditions. However, the vehicle power dropped upto 10% with increase in fuel consumption of 5% with E30 fuel compared to gasoline. Further, E30 fuel resulted in higher combustion duration, lower in-cylinder pressure and heat release rate. Hence, compression ratio of the engine was increased from 9.4 to 11.5:1 to enhance fuel economy and further

reduction in emissions. The vehicle power increased by an average of 4.5% with decrease in the specific fuel consumption by an average of 8.9%. CO and HC emissions decreased up to 52% and 43% while NOx emission increased up to 32% with the combination of higher compression ratio and optimal spark advance. Study on unregulated emissions revealed that carbonyl emissions such as formaldehyde and acetaldehyde increase linearly with ethanol-gasoline blends in both steady-speed and IDC tests. Acetaldehyde emission was three times higher than formaldehyde emission. The engine with E50 fuel emitted the highest acetaldehyde emission of 209 ppm and formaldehyde emission of 70 ppm during IDC test.

The notable finding emerged from the research work is that the performance and fuel economy of E30 fuelled vehicle can significantly be improved with increased compression ratio (11.5:1) and optimised spark timing (4°CA advancement from the base timing). The increase in vehicle power up to 8.0% and reduction in SFC up to 13% were achieved under these conditions compared to base gasoline.