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Performance and Emission Characteristics of MPFI Engine by Using Gasoline - Ethanol Blends

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Abstract: Ethanol is rarely used as an automobile fuel; blends with standard gasoline are much more common. Use of higher (above 50%) ethanol gasoline blends required modification in both calibration and engine hardware. In this paper experiments are conducted on MPFI engine to study the performance and emission of the ethanol gasoline blended fuel. The ethanol is blended with 10%, 20%, and 30% by volume with gasoline. The various engine performance characteristics like BTE, BSFC and BSEC are recorded from the acquired data and emission parameters like UBHC, CO, $C0_2$, and NO_X are measured using five gas BOSCH analyzer. The results are revealed that on adding the 20% ethanol to gasoline there is increase in the brake thermal efficiency and fuel consumption is slightly less as that of gasoline. It is also found that there is considerable amount of decrease in emission on using ethanol with gasoline blend. Experimental results indicated that when ethanol-gasoline blend is used, the engine CO and HC emission decreases notably as a result of the leaning effect caused by the ethanol addition and CO_2 emission increases because of the improved combustion.

Keywords: MPFI engine, Ethanol gasoline blends, Performance, Emission characteristics

I. INTRODUCTION

Fossil fuels reserves in the world are limited and expected to be exhausted in next 65 years. The rapid depletion of the world's crude oil reserves and environmental considerations has focused on the clean, renewable, and sustainable and non-petroleum fuels. The energy crisis, environmental pollution by fossil fuels necessitates to development of alternative fuel for internal combustion engine. Some of the investigations have been made using ethanol as a fuel in SI engines. In some of countries, use of ethanol blends with gasoline is mandatory. Number of published work available on Carburetor type SI engine using gasoline-ethanol blends of fuel [1]. In the present investigation, performance analysis were carried out on MPFI SI engine. Using gasoline, gasoline-ethanol blends (gasohol) as fuel. Ethanol, which is one of the renewable energy sources and is obtained from biomass, has been tested intensively in the internal combustion engines. Ethanol is an important, viable alternative to unleaded gasoline fuel Ethanol is used as an automotive fuel; it can be used alone in specially designed engines, or blended with gasoline and used without any engine modifications. Most importantly, the millions of automobiles on the road today can use this improved fuel [5]. Fuel ethanol what has been called gasohol - the most common blends contain 10% ethanol mixed with 90% gasoline (E10). Because the ethanol is a high-octane fuel (2.5 - 3 points above the octane of the blending gasoline) with high oxygen content (35% oxygen by weight), it allows the engine

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to more completely combust the fuel, resulting in fewer emissions. Since ethanol is produced from plants that harness the power of the sun, ethanol is also considered a renewable fuel. Therefore, ethanol has many advantages as an automotive fuel. [6] Ethanol is a water-free alcohol and there for can withstand cooler temperatures. Table 1 enlists the various properties of ethanol blends when compared to Gasoline fuel.

TABLE 1
PROPERTIES OF GASOLINE FUEL BLENDED WITH VARIOUS PERCENTAGES OF ETHANOL (AVERAGE VALUES) [8]

Sample code	Ethanol (%)	Gasoline (%)	Flash Point (^{0}c)	Auto ignition temperature (^{0}C)	Vapour pressure at (Kpa at 37.8^{0}C)	Energy density (MJ/L)	Octane number	Specific gravity
E00	00	100	-65	246	36	34.2	91	0.7474
E10	10	90	-40	260	38.9	33.182	93	0.7508
E20	20	80	-20	279	39	32	94	0.7605
E30	30	70	-15	281	38	31.5	95	0.7782
E40	40	60	-13.5	294	35.6	30	97	0.7792
E50	50	50	-5.0	320	34	29	99	0.7805
E60	60	40	-1.0	345	31	28	100	0.7812
E70	70	30	0.0	350	28	27	103	0.7823
E80	80	20	5.0	362	24	26.5	104	0.7834
E90	90	10	8.5	360	18	23.6	106	0.7840
E100	100	00	12.5	365	9	23.5	129	0.7890

II. MULTIPORT FUEL INJECTION

Multiport fuel injection injects fuel into the intake ports just upstream of each cylinder's intake valve, rather than at a central point within an intake manifold. MPFI (or just MPI) systems can be sequential, in which injection is timed to coincide with each cylinder's intake stroke; batched, in which fuel is injected to the cylinders in groups, without precise synchronization to any particular cylinder's intake stroke; or simultaneous, in which fuel is injected at the same time to all the cylinders. The intake is only slightly wet, and typical fuel pressure runs between 40-60 psi. Many modern EFI systems utilize sequential MPFI; however, in newer gasoline engines, direct injection systems are beginning to replace sequential ones.

III. EXPERIMENTAL SETUP AND TESTING

Whole set of experiments are conducted at the designed Vehicle speed of 60KMPH and engine speed of 2500 RPM. Figure 1 and 2 shows MPFI engine setup and Figure 3 shows schematic diagram of experimental setup. Table 2 provides the engine details. The engine was started and allowed to warm up for a period of 10-20 minutes. Before starting the engine, checked for system, like cooling system, lubrication system, injection system etc. The experiments are conducted at no-load, 25 %, 50 % and 75 % of full load. Data such as fuel flow, air flow, etc are recorded at this condition. The engine runs with the gasoline and its blends with ethanol varying from 10 to 30% by volume with Gasoline. However the blends above E30 did not show consistence results when compared with that of Gasoline. Hence, the research is confined to the blends up till E30. The data recording is done after the experiment was carried out for three times to obtain a repeatability of values for each blend. The BOSCH five gas analyzer is used for measuring the exhaust emissions and the Figure 4 shows the same.

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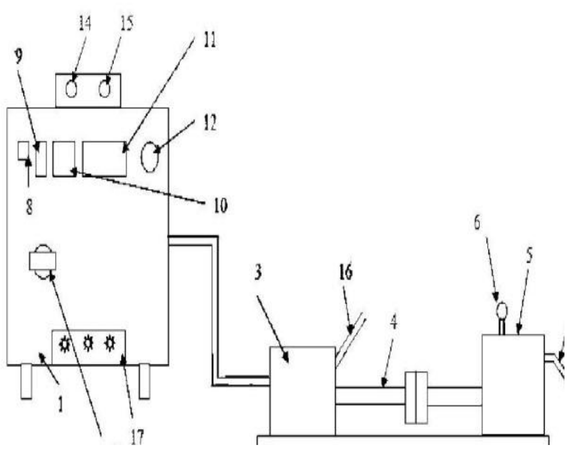
Figure 1: Shows MPFI engine setup

Figure 2: Photograph of the Experimental Setup



1. Engine test rig
2. Engine bed
3. Engine
4. Shaft
5. Dynamometer
6. Loading arrangement
7. Water supply
8. Ignition switch
9. Load indicator
10. Dynamometer speed indicator
11. Temperature indicator
12. Ignition switch
13. Accelerometer
14. Speedometer
15. Fuel Indicator
16. Exhaust pipe
17. Cylinder cut off switch

Figure 3: Schematic diagram of experimental setup

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Figure 4: BOSCH five gas analyzer

TABLE 2

TEST ENGINE SPECIFICATIONS

Item	Specification
Model:	Maruti 800cc,MPFI engine
Manufacturer :	Maruti Udyog Ltd.
Type	Petrol, 3cyl, Inline
Cooling	Water cooled.
Displacement :	796cc.
Compression ratio	7.9:1
Maximum Power	39.5bhp@5000rpm
Firing order	1-3-2

IV. RESULTS AND DISCUSSION

Engine test are performed at different blends with the volumetric ratios of 0% to 30% with an increment of 10% ethanol. Engine was operated with each blend at constant speed with varying load. The mixture was prepared just before the experiments to prevent the reaction of ethanol with water vapor. The desired speed is maintained by the Electronic Control Unit (ECU). The required engine load was obtained through the hydraulic dynamometer control. The variables that are continuously measured include force on hydraulic dynamometer (kg), fuel consumption (kg/min) and air-fuel ratio. For comparison purposes the tests were also conducted with Gasoline under the same conditions. From the results of these tests it is noticed that the optimum blend for Gasohol (blends of Gasoline and Ethanol) is 20 % by volume.

A. Brake Specific Fuel Consumption

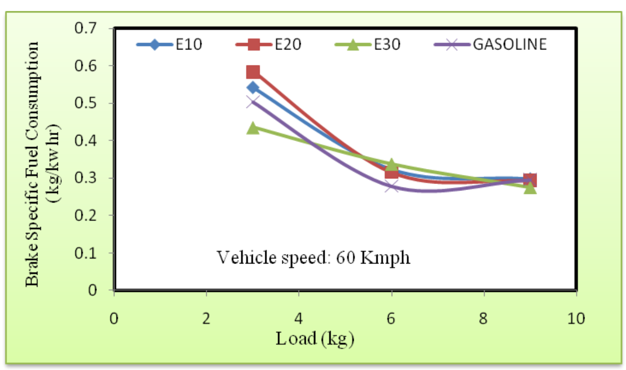

Figure 4: Variation of BSFC with Load for various gasohol blends

The variation of BSFC with load of gasoline and its blends is shown in Figure 4. All the blends show decreasing trend of BSFC with respect to load. The main reason for this is that the percentage increase in fuel required to operate the engine is less than the percent increase in brake power due to relatively less portion of the heat losses at higher loads. The figure shows that the BSFC for gasohol blends is marginally same as that of Gasoline fuel, at all loading conditions.

B .Brake Thermal Efficiency

The variation of BTE with load for gasoline and its blends is shown in Figure 5. For all fuels, the BTE is improved with increase in load. This is due to reduction in heat loss and increase in power with increase in load. It is observed that the E20 fuel gave the higher efficiency than the Gasoline fuel for all load condition and the efficiency for E10 and E30 fuels are slightly lower than the gasoline. For E20 blend the maximum brake thermal efficiency is obtained as 32 % at 75% of full load.

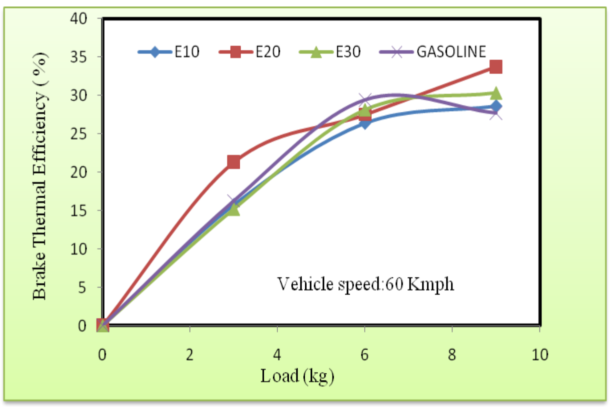

Figure 5: Variation of BTE with Load for various gasohol blends

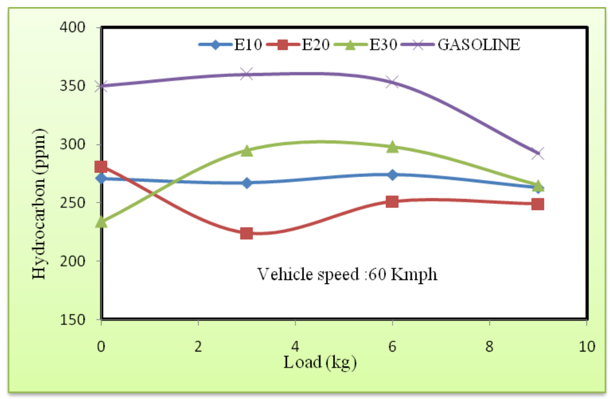

Figure 6: Variation of HC with Load for various gasohol blends

C. *Exhaust Emissions*

Figure 6 shows the variation of UBHC (Unburnt Hydrocarbons) with load. It is observed that the UBHC emissions for the Gasohol are lower than the Gasoline fuel. The UBHC emission for E30 at 75% of full load condition is nearly 20 % lesser than Gasoline. The presence of oxygen in the fuel was thought to promote complete combustion that leads to lowering the HC emissions. These reductions indicate more complete combustion of the fuel.

The variation of CO and CO_2 with load is presented in Figure 7and 8. The CO is a toxic by-product of all hydrocarbons combustion that is also reduced by increasing the oxygen content of the fuel. More complete oxidation of fuel results in more complete combustion to CO_2 rather than leading to the formation of CO. It is observed that the CO emissions for Gasohol blends are lower than the Gasoline fuel. It is also observed that the CO emissions are still lower for E20 fuel at all load condition. The CO emission for E20 was 22% lower than the Gasoline fuel.

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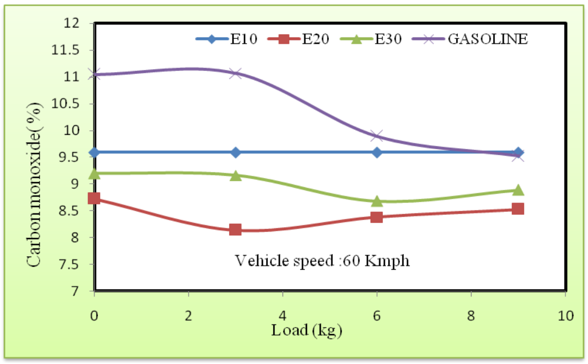

Figure 7: Variation of CO with Load for various gasohol blends

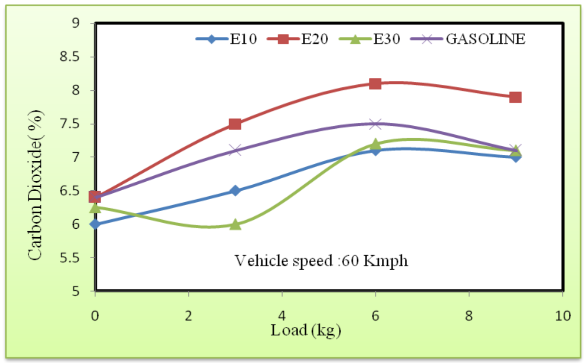

Figure 8: Variation of CO_2 with Load for various gasohol blends

D. *Nitrous Oxides*

The effect of gasoline alcohol blends on NOx emissions are shown in Figure 9. Major factor contributing to NOx emissions include high flame temperature and presence of oxygen during combustion. Due to much lower flame temperature the ethanol contributes its NOx emissions are usually lower than that of gasoline [3,5]. It apparent that any HC oxidation process that takes place during combustion of alcohol blends provides leaning of mixtures that lead lower NOx emissions.

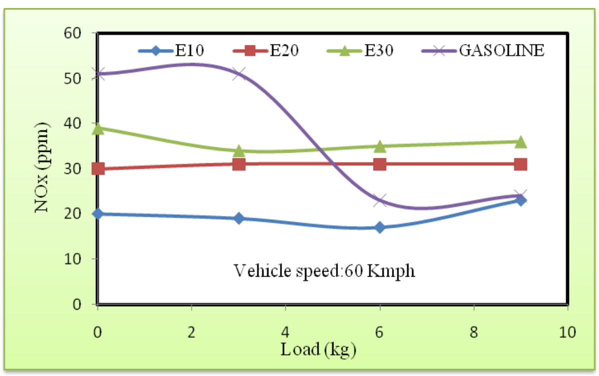

Figure 9: Variation of NO_x with load for various gasohol blends

V. CONCLUSION

The MPFI engine performed satisfactorily on Gasohol, so that the ethanol can be used as an alternative fuel in existing MPFI gasoline engine without any hardware modification. It could be concluded that the blends of ethanol with gasoline fuel up to 20 % by volume could replace the gasoline for running the existing MPFI engine without any hardware modifications also Gasohol reduces the environmental impacts of transportation, reduce the dependence on crude oil imports and offer business possibilities to agricultural enterprises for periods of excess agricultural production. Hence the Gasohol was found to be a potential alternative fuel to petrol. Since its physical properties are close to those of petrol fuel and since it is a renewable source of energy it can be right solution to India's oil crisis.

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