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Performance Analysis of Gasoline Engine with Different Ethanol Blends

Venktesh Kumar[1], Shashi Kumar Jain[2], Ankit Goyal[2]

[1]Gopal Narayan Singh University, Jamuhar, Sasaram, India

[2]Department of Mechanical Engineering, Technocrats Institute of Technology & Science, Bhopal, India

Email address:
venkteshkumar2@gmail.com (Venktesh Kumar)

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Abstract: The rapidly growing consumption of petroleum-based fuels causes the government to expend a significant source of foreign currency on oil imports, which impacts the trade deficit in the government's current account. The purpose of the feasibility is to see how unleaded fuel blends impact the performance of an unmodified engine operating on numerous blends. This testing was performed using a four-stroke, single-cylinder, water-cooled multi-fuel engine (Computer controlled variable compression ratio multi-fuel injection, kirloskar type engine) with a carburetor fuel injection system. Multiple parameters such as brake thermal efficiency, brake power, engine torque, brake mean effective pressure, and brake specific fuel consumption were assessed throughout the benchmarks. Regular unleaded blends with multiple fuel proportions have been used in these investigations. Six ethanol blend fuels were tested and their physical and chemical characteristics were analyzed, with 90 octane numbers achieved using unleaded fuel at E0, E5, E10, E20, and E40, along with variations in compression ratio. Research experiments were carried out at various different pressure ratios of 10.5:1 and 12:1, with engine speed calibrated to 1500 rpm. The findings demonstrate that blending unleaded fuel with a fraction of ethanol enhances the efficiency of the engine, such as brake power, torque, and brake thermal efficiencies and fuel consumption, thereby reducing brake specific fuel consumption. While compared to other proportions, the E20 (Ethanol 20%) ratio delivered the best brake power versus speed.

Keywords: Blending, Brake Power, Efficiency, Fuel Consumption, Ethanol, Gasoline, Engine

1. Introduction

Due to the sheer world's urban sprawl and progression into hegemony, there is a steep increase in oil demand, which causes an oil shock whenever there is a mismatch between market forces [1]. As a consequence, many regions are looking for alternative fuels to replace existing fuels that are clean, renewable, and ecologically friendly. Because it has antiknock qualities that allow higher compression ratios and, as a consequence, higher engine output power, along with some other variable characteristics that are vital to its ecological sustainability in pyrolysis as a standard motor fuel, ethanol is one of them that is deemed as a suitable replacement alternative to it [2]. In prior eras, ethanol has been employed as a substitute fuel. In this observation, I have focused on ethanol, which is one of the earliest major compounds. These really are ethanol, propanol. An additive dubbed an octane rating is applied to gasoline to enhance the research octane number, which diminishes the likelihood of engines knocking [3]. In prior studies, a majority of scholars have attributed their work, predominantly the correlation assessment, which really should be input through Fig, demonstrating that there had been an expansion in engine thermal performance [4]. Our experimental test fuel will be ethanol (laboratory grade), which will be mixed with regular petrol and perform on unaltered gasoline engines at compression ratios of 10.5:1 and 12:1 by taking into account numerous factors functioning cylinder pressures, combustion characteristics, and compression ratio, which are only associated with the technical specifications, alternative energy sources can be developed [5].

2. Experimental Setup

1. Single cylinder Four stroke water cooled multi fuel

variable compression engine

2. Eddy Current dynamometer (attached with machine) for loading
3. Gas analyzer instrument model AVS 444 HE Digi gas Analyzer

Table 1. *Enginedetails.*

Company	Kirloskar
Model	TV1
No. of Cylinder	Single
Bore	87.5mm
Stoke	110mm
Displacement	661CC
Connecting Rod Length	234mm
Normal Compression Ratio	17.5:1
Variable Compression Ratio	6:1to18:1forPetrolandDiesel
Rated output	5HP@1500rpm
Type of Cooling	Water
Type of Starting	Battery Ignition
Type of lubricant	Forced
Petrolmodeoutput6:1to9:1	5KW@1500-1800rpm
Diesel mode output14:1 to 18:1	5KW at 1500 rpm
Fuel	Dual Fuel

4. Performance test carried out by using various ethanol blends ratio mixed with unleaded petrol with conventional carburetor.

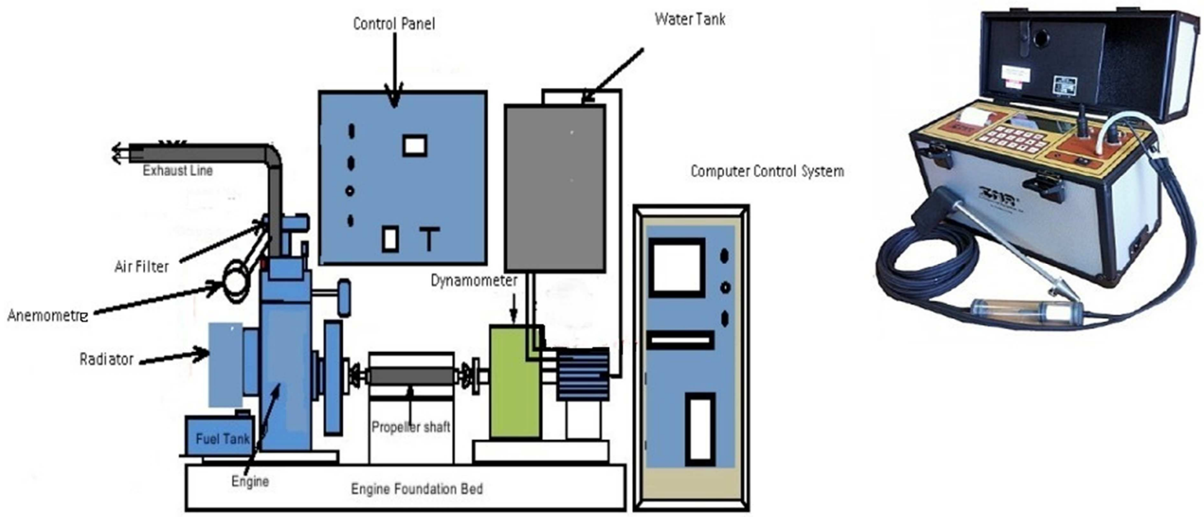

Figure 1. *Engine Set Up along with AVS 444 HE Digi gas Analyzer.*

3. Experimental Procedure

Initially the engine is operated on by using conventional unleaded petrol with carburetor at multiple compression ratio at 10:1, 10.5:1, 11:1, 11.5:1 and 12:1 the procedure is laid down below:-

1. The experimental machine operated on without blending for the obtaining steady state condition at fixed speed at 1500 rpm for measurement of fuel consumption [6].
2. After obtaining constant speed we have now applied the load without blending and note down all the reading such as fuel consumption, emission parameters of exhaust such as carbon di-oxide, Nitrous Oxides etc [7].
3. After all the observation without blending, then experiment have laid down on five blends and prepared blends of pure ethanol at ration of E0, E5, E10, & E20, and operate on machine by using this ratio of blends.
4. The power developed along with emission standard by the engine by using ethanol is measured.

Basic Measurement of Engine:-In the experimental investigation, we concentrated mainly on the following engine parameters: brake power, brake specific fuel consumption, brake thermal efficiency, and brake specific fuel consumption. At the same time, we measured several exhaust parameters: carbon dioxide, carbon monoxide, nitrous oxide, exhaust emission, hydrocarbons, smoke and allied pollutant etc.

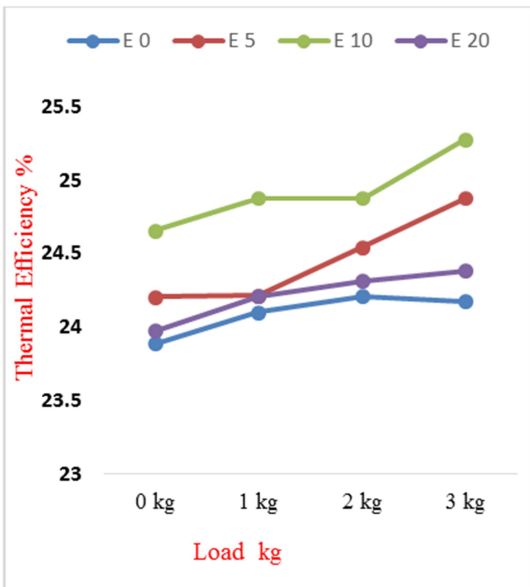

Figure 2. *Load kg V/sThermal Efficiency (%).*

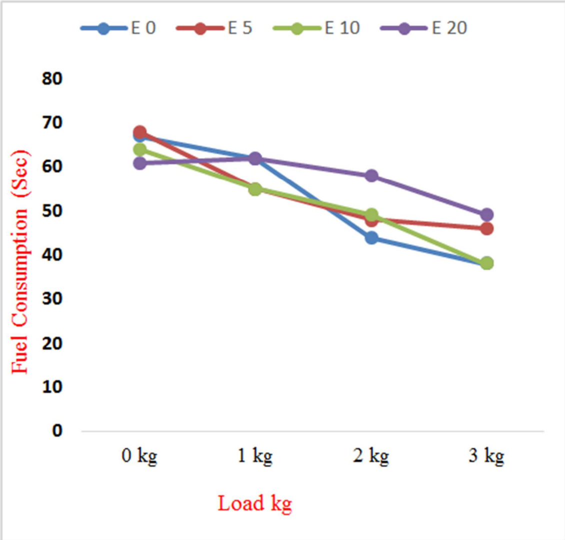

Figure 3. *Load kgV/s Fuel consumption (Sec).*

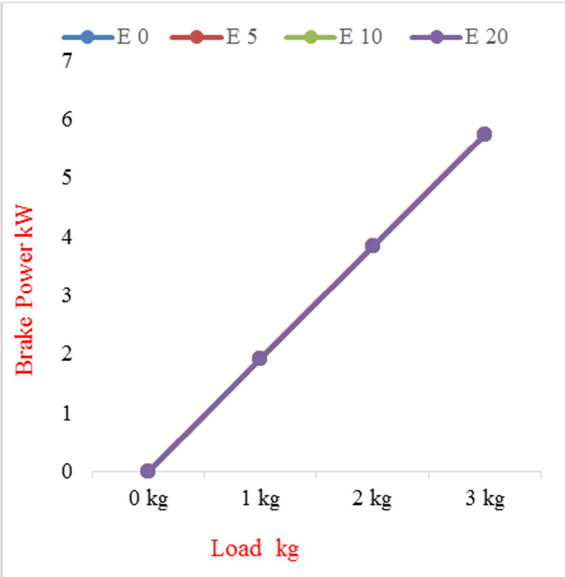

Figure 4. *Load kg V/s Brake power (K.W).*

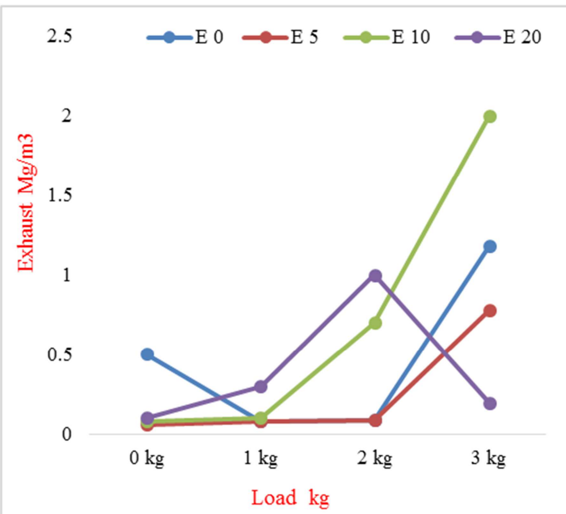

Figure 5. *Load kgV/s Exhaust (Mg/m^3).*

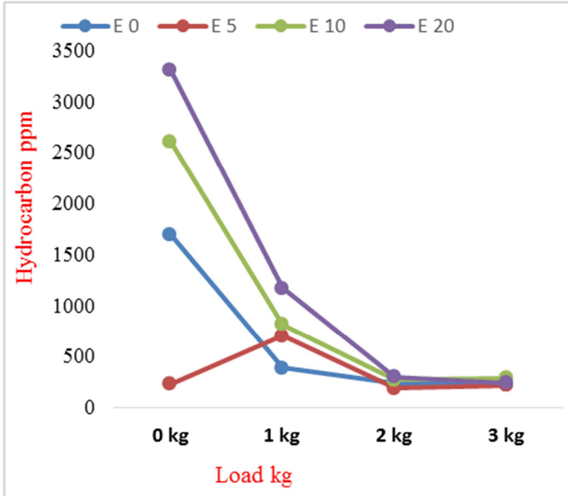

Figure 6. *Load in Kilogram V/s HC (ppm).*

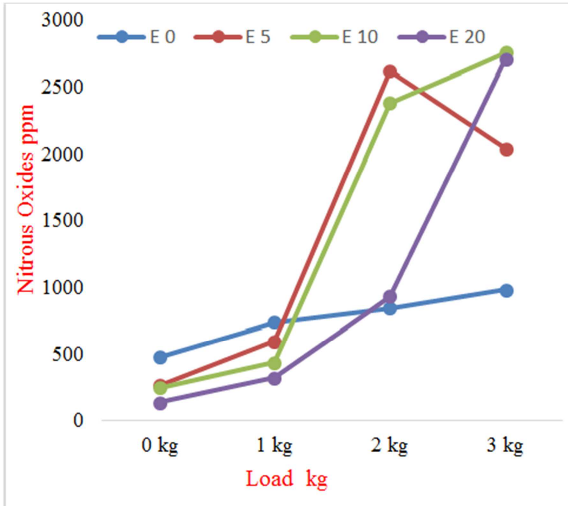

Figure 7. *Load in Kilogram V/s NOx (ppm).*

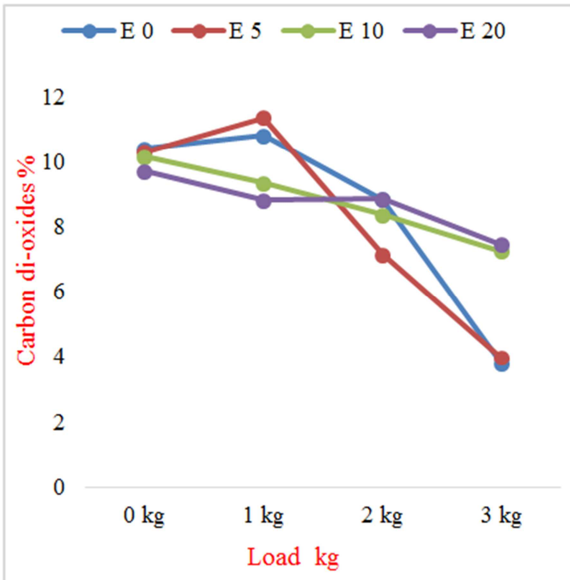

Figure 8. *Load kg V/s Carbon di- oxides (%).*

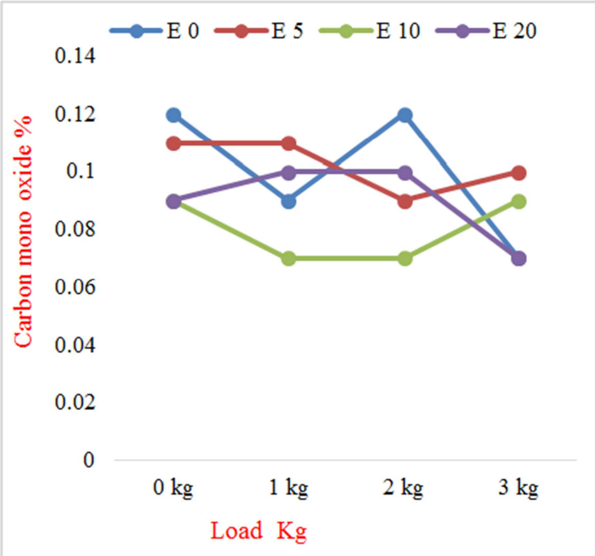

Figure 9. *Load kg V/s Carbon mono oxide %.*

According to the research that exists, enhancing the alcohol content of petroleum products strives to slightly improve the performance of the engine while simultaneously minimizing combustion variables, and that is only precisely the case to a concoction of 20 percent [8]. Beyond that juncture, the engine needs adaptation and seems to have trouble running under a stack of negligible kg, and it shuts off because it stops functioning [9]. The performance parameters of the fuel injection engine augmentation recorded, correspondingly, particularly brake-specific fuel consumption, were indeed altered by tweaking this same compression while operating the engine at incredible speeds [10]. The deployment of such an ethanol-gasoline combination culminated in slightly above-average brake thermal efficiency [11]. It was concluded that the optimum brake thermal efficiency for E20 was 24.5%, E10 was 24.2%, and E5 was 23.60% [12]. The attributes of petroleum (average number) in correlation to the proportion of ethanol were indeed mentioned beneath, and so all combinations are verified and approved by the laboratories mentioned in the table which accompanies. Most data is collected from specified requirements, so all combinations are validated using ASTM standards [13, 14].

Table 2. *Properties of gasoline fuel blended with various percentages of ethanol.*

S. NO.	Sample of Fuel Blends	Pour Point °C	Fire Point °C	Flash Point °C	Stoichio--- metric ratio (A/F)	Density Kg/m^3	Octane Number	Self ignition Temp.°C	Ethanol Content %	Viscosity In Centi Poise Cps	Boiling Point °C
1	E0	14	70	69	14.60	836	88	68	0.965	0.58	58
2	E5	13.5	68	67	14.20	832	94	64	4.6571	0.60	55
3	E10	13	66	65	14.05	828	90	62	10.865	0.68	55
4	E20	12.5	65	64	13.50	826	88	59	21.345	0.80	50
5	E40	12.30	53	52	12.80	822	80	55	39.925	1.051	50
6	E50	10.50	56	55	11.10	820	80	54	52.438	1.152	52
7	E100	14	69	68	9	842	97	63	99.952	2.304	76

An investigation was carried out on a quasi-dimensional model to know the implications of ethanol blending on the engine's thermodynamic cycle [15]. The results of the model were evaluated against those of experimental experiments that used the VCR engine. The Reid vapour pressure of the blended fuels first increased with the addition of ethanol subjected to a total value of 10% ethanol addition, and thereafter it dropped, resulting in a rise in evaporative emissions for ethanol gasoline mixed fuels [16-20]. When ethanol was added to gasoline, the blended fuel's octane number was enhanced and its compression ratio improved, which improved the engine's efficiency.

4. Result & Discussion

4.1. Performance Specifications

In an engine, the power produced in the chamber is referred to as the indicated power, although the effective power at the output shaft is recognized as the brake power. Because of parasitic loads and mechanical friction coefficient (oil pump, air conditioner compressor, etc.), cycling power is almost never predictable. The use of 10% ethanol increased engine output by 5%. When the alcohol concentration in the fuel blends was increased, engine brake power increased significantly across all engine speeds. This was attributed to the growth in suggested mean effective pressure for blends with higher ethanol content.

4.2. Thermal Its Efficacy

The effectiveness of an engine to dissipate heat from fuels to mechanical energy is quantified either by thermal efficiency, which would be the ratio of net work output to heat input. On the basis of the increased knock limit carried around by the higher octane rating of ethanol in correlation to gasoline, studies investigating the performance of a high compression ratio, enhanced spark ignition engine at completely open throttle scenarios came to the conclusion that higher engine thermal efficiency was accomplished.

4.3. Volumetric Impact

The term volumetric efficiency in the context of internal combustion engine design emphasizes how effectively the engine can convey the charge into and out of the alcohol, which can enhance charge density attributable to evaporative cooling in the intake manifold.

4.4. Brake Specific Fuel Consumption

A measure of an engine's fuel efficiency that burns fuel and develops shaft power is called brake specific fuel consumption (BSFC). It is sometimes adopted to analyze any engine's reliability in proportion to its shaft output. It is the fuel economy rate divided by the quantity of power generated. The fuel efficiency of numerous engines can indeed be cross-referenced with brake-specific fuel consumption. The primary features of a gasoline blend's brake-specific fuel consumption are its calorific value and density. In his experimental evaluation, he discovered that the brake-specific fuel consumption rates of E10 and E20 were comparatively higher than those of gasoline, respectively.

5. Conclusion

The conclusions of all these reports show that, concept of blending of ethanol with petrol for a SI engine has been implemented successfully to a variable compression dual fuel engine. After the experimental set up the engine was tested under E0, E5, E10, E20 & E40 with compression ratio 10.5:1 and 12:1 petrol with ethanol blended petrol. The test have been conducted under No load, 1Kg, 2Kg, 3Kg speed1500 rpm throughout the test and the engine produced a maximum power of 5.2 KW, at an engine speed of 1500 rpm AT 3Kg load. Testing this engine for higher speed has resulted in uncontrollable vibrations and due to old model of gas analyzer the variation of results may be occur in contrast to the use of pure ethanol for the blends, engine efficiency significantly increases as the percentage of ethanol in petrol increases. Four common ethanol-gasoline blends—E0, E5, E10, and E20—were used throughout the studies to explore the contribution of different ethanol-gasoline mix ratios on brake engine power, brake thermal efficiency, and engine emissions. The experiment used various blends of ethanol-gasoline fuel, and performance analyses were carried out at constant speed and variable conditions at a speed of 1500 rpm to load at 0 kg, 1 kg, 2 kg, and 3 kg. The addition of ethanol improved brake thermal efficiency slightly, but only up to a certain limit, which is 20% in gasoline.

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