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EXPERIMENTAL INVESTIGATION ON PERFORMANCE OF A FOUR STROKE PETROL ENGINE WITH ETHANOL PETROL BLENDS

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Abstract - *This study has been undertaken to investigate the performance parameters of four stroke petrol engine with ethanol and petrol blends for determining the optimum value of ethanol which can be blended with petrol without undergoing any modification in the engine design and also it is intended to estimate some of the parameters which can boost up the overall performance of the engine. For this a four stroke single cylinder engine is considered with electric loading and conducted test for different proportions of ethanol-petrol blends.*

Key Words: I.C Engine, Ethanol, Blending, Performance

1. Introduction

The biggest challenge in front of the human being is to limit and decrease the green house effect caused by various activities of human being. A major contributor to the green house effect is the automobile sector. In spite of ongoing activities to improve efficiency, the sector is still generating significant increase in CO_2 emissions. As the automobile sector is expected to rise substantially, especially in developing countries this problem is addressing more. Furthermore, the supply of petroleum fuels will sooner or later become a limiting factor, an important step in efforts to solve the problem is to replace fossil fuels source energy with bio energy.

In the automobile, However blending bio fuels with petroleum based fuels for use by the present conventional vehicle fleets has the advantages that even using quite low blending concentrations will result in substantial total volume of gasoline being substituted by bio fuels, and that the present infrastructure for distributing fuels can be used. Today, the transport sector is a major contributor to net emissions of greenhouse gases, of which carbon dioxide is particularly important. In Some country this sector accounts for roughly 20 % of total energy consumption, and almost 50 % of the total net emissions of carbon dioxide. The carbon dioxide emissions originate mainly from the use of fossil fuels, mostly gasoline and diesel oil in road transportation systems, However, since the total transportation work load is steadily increasing such measures will not be sufficient if we really want to reduce the emissions of carbon dioxide.

In order to reduce absolute amounts of these emissions we have to go further and an additional measure that will be required is to replace fossil vehicle fuels with renewable ones, this means bio-based fuels. Probably the best candidate bio fuels to replace gasoline in the short term are alcohols. Alcohols can be blended with gasoline or used as neat fuel in both optimized spark ignition engines and compression ignition engines. In the medium term ethanol produced from grain will probably be the most important alternative fuel for replacing gasoline, and in the long term ethanol produced from cellulose might take over from grain ethanol. Today, ethanol accounts for a substantial part of the alternative fuel market, especially in developing countries.

Hence an attempt will be made in the present study for a four stroke petrol engine, blending ethanol with proper proportions to improve the performance of the engine.

2. Ethanol Benefits and Considerations

Ethanol is a renewable, domestically produced transportation fuel. Whether used in low-level blends, such as E10 (10% ethanol, 90% gasoline), or in E85 (flex fuel)—a gasoline-ethanol blend containing 51% to 83% ethanol, depending on geography and season—ethanol helps reduce emissions. Like any alternative fuel, there are some considerations to account for when contemplating the use of ethanol

3. Methodology

Experimentation was carried out to study the performance of a single cylinder four stroke petrol engine with ethanol and petrol blends. For this study petrol is blended with ethanol with different proposition like 5 %, 10 % and 15 %.

The engine is four stroke single cylinder, air cooled, and petrol driven commercially used for Generator set or agricultural pump set. It is coupled to an Electrical dynamometer and mounted on a strong base, and is complete with air, fuel, temperature, load and speed measurement system.

4. Engine Description

The test setup comprises of the following:

Engine coupled to Electrical Dynamometer
Measurement and control panel
Load bank (Heater bank)
Temperature Sensors.

- **Engine**

Four strokes, single cylinder, spark ignited, vertical, air cooled, Petrol driven.

Make : VILLIERS
Compression ratio : 4.67:1
Cylinder bore : 70 mm
Stroke length : 66.7 mm
Displacement : 256 CC

- **Electrical Dynamometer**

Alternator Rating : 2 KVA
Speed : 2800-3000 rpm
Voltage : 230 V AC,

Foot mounted, continuous rating.

- **Measurement and Control Panel**

Air Measurement :
Manometer : U tube, water filled, 30 cm
Air Tank: Made from MS, 300 x 300 x 300 cm
Orifice: Circular, 20 mm diameter

Fuel Measurement:

Main Fuel tank - with bottom shutoff ball valve, Petrol tubes, valves, Burette, 3 ways Manifold

Load Measurement:

Voltmeter: Digital, 0-750 V AC
Ammeter: Digital, 0-20A AC
Load Bank: Resistance, 10- Nos, 200 watts each.
Switches : 10 Nos.
Temperature Measurement:
Indicator : Digital, 0-999 °C
Thermocouple: Fe- K (J type)

- **Observations**

Cylinder bore D : 70 mm
Stroke length L : 66.7 mm
Water density ρ_w : 1000 kg/m^3
Calorific value of petrol Cv : 44,000 KJ/kg
Acceleration due to gravity g: 9.81 m/sec^2
Petrol density ρ_f : 0.72 Kg/lit
Air Density ρ_a : 1.2 Kg/ m^3

Table -1: Physical and Chemical Properties of Petrol and Ethanol

	Character	Ethanol	Petrol
1	Molecular weight	46.07	100 -105 Avg
2	Composition by mass	W (C) = 52 % W (H) = 13 % W (O) = 35 %	W (C) = 85 % W (H) = 15 %
3	Specific gravity	0.794	0.7 – 0.78
4	Density kg/m^3	790	700 – 780
5	Boiling Temperature in °C	78	27 – 255
6	Freezing Point in °C	-114	-57
7	Ignition Temperature in °C	423	390 – 420
8	Theoretical air fuel ratio (kg/kg) of air	9.0	14.7
9	Octane number	100	80 – 99
10	Cetane number	8	0 – 10
11	Low heating value at 20°C in MJ/L	21.09	32.17
12	Mixed gas calorific value MJ/kg°K	3.87	3.73 – 38.3

5. Calorific Value of Fuels

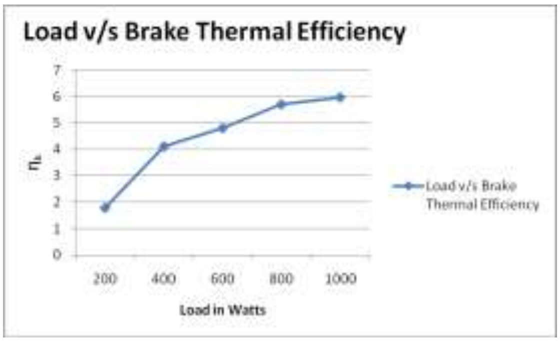
Blend	Density	MJ/Kg°K
Petrol	720	44.00
E5	738.59	44.25
E10	741.30	43.5
E15	744.00	42.75

6. Experimental Results and Discussions

The following results were obtained when conducted experiment with the above said proposition of fuels, in first set of conduction, petrol without blending of ethanol is used, later petrol with 5 % ethanol, Petrol with 10 % ethanol and petrol with 15 % ethanol is used, noted the readings and calculated performance parameters and plotted the graph.

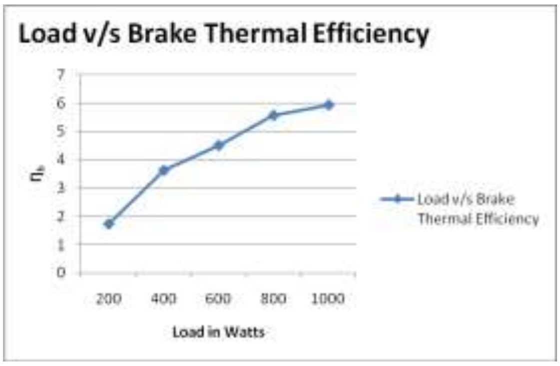
Each Graph Explains the Performance of the Engine

For Petrol



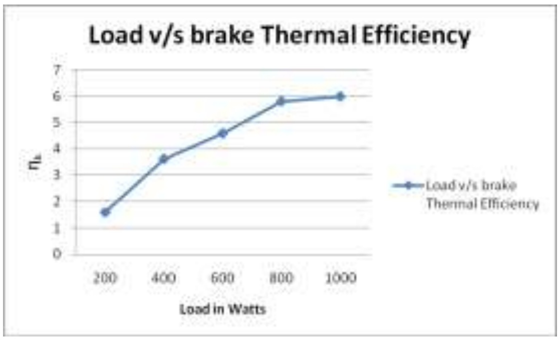
Graph 1: Load v/s Brake Thermal Efficiency

For E5



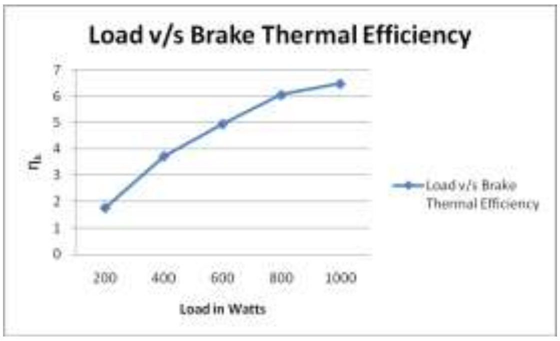
Graph 2: Load v/s Brake Thermal Efficiency

For E10



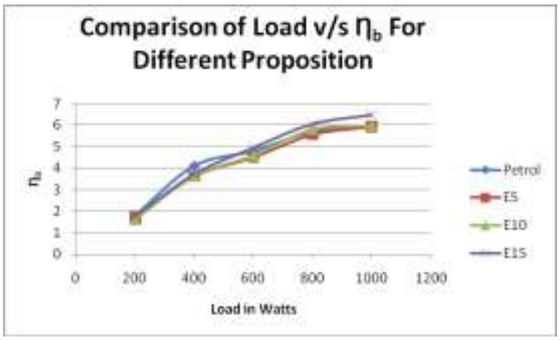
Graph 3: Load v/s Brake Thermal Efficiency

For E15



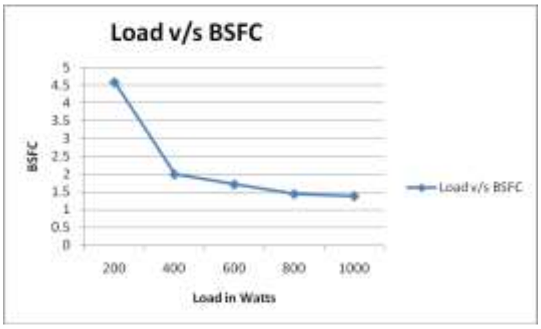
Graph 4: Load v/s Brake Thermal Efficiency

Comparison



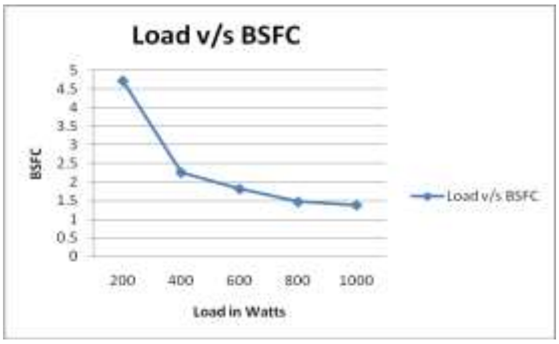
Graph 5: Comparison of Load v/s Brake Thermal Efficiency

For Petrol



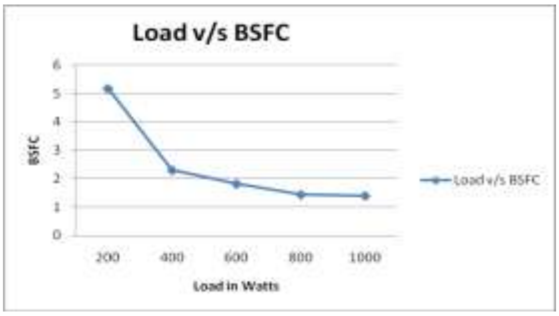
Graph 6: Load v/s BSFC

For E5



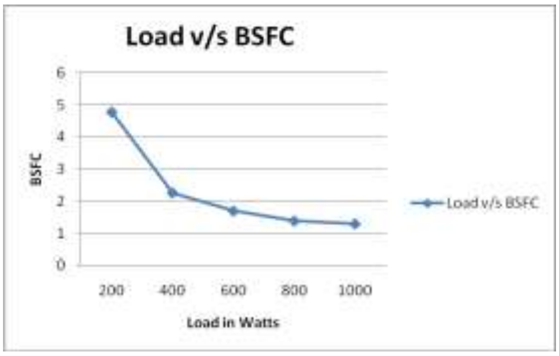
Graph 7: Load v/s BSFC

For E10



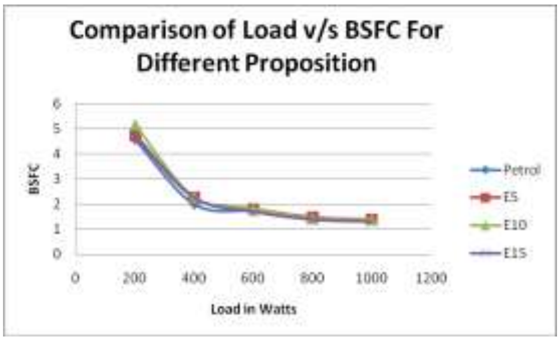
Graph 8: Load v/s BSFC

For E15



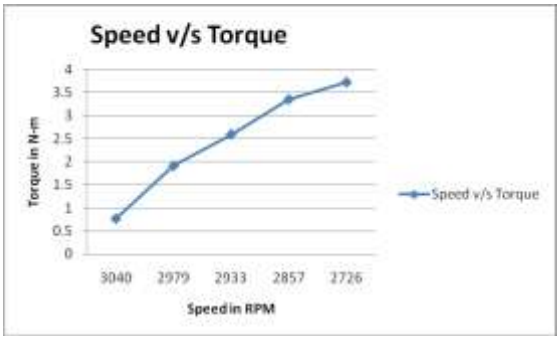
Graph 9: Load v/s BSFC

Comparison



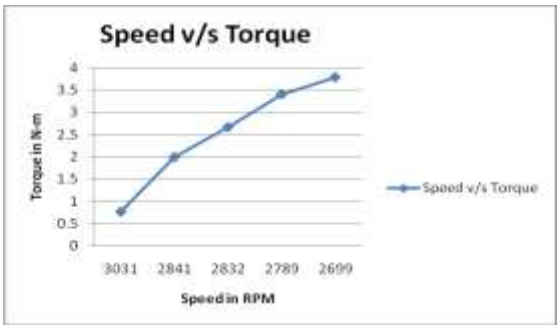
Graph 10: Comparison of Load v/s BSFC

For Petrol



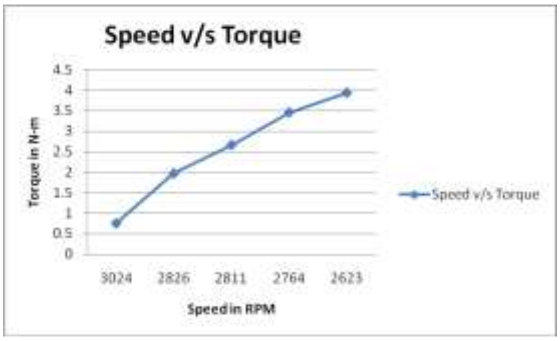
Graph 11: Speed v/s Torque

For E5



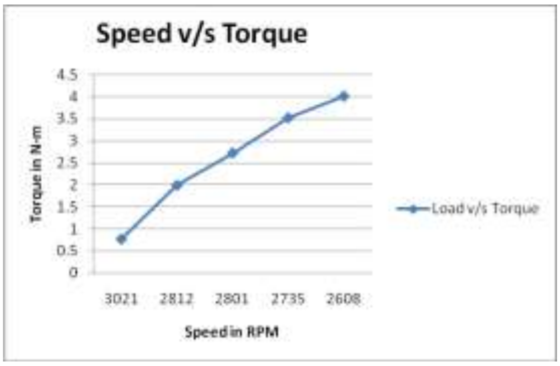
Graph 12: Speed v/s Torque

For E10



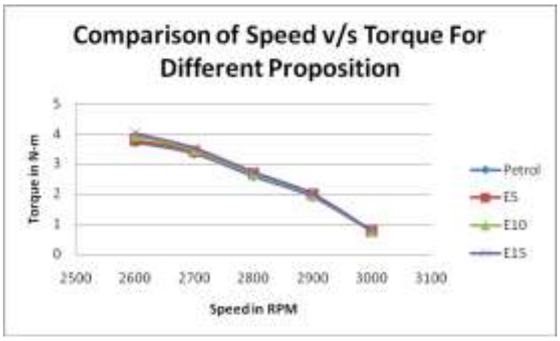
Graph 13: Speed v/s Torque

For E15



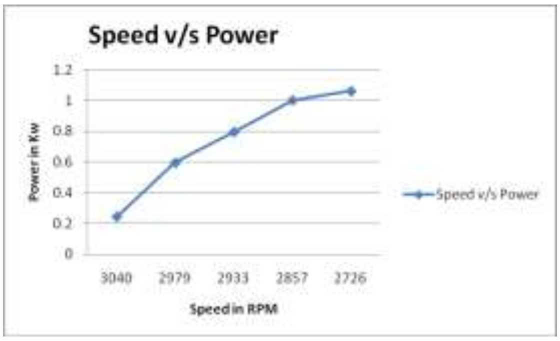
Graph 14: Speed v/s Torque

Comparison



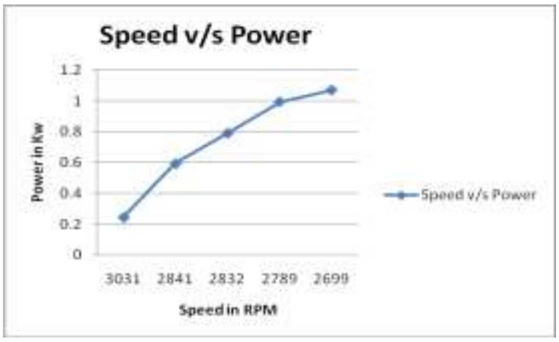
Graph 15: Comparison of Speed v/s Torque

For Petrol



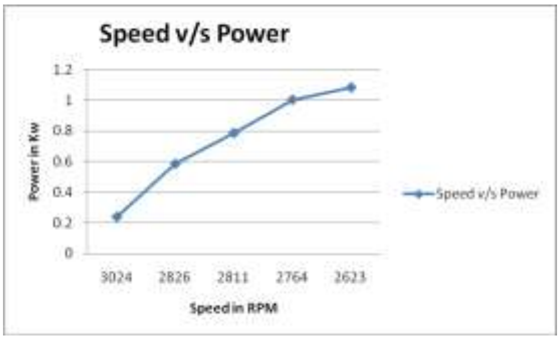
Graph 16: Speed v/s Power

For E5



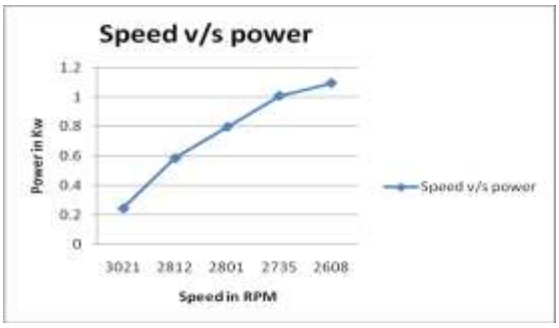
Graph 17: Speed v/s Power

For E10



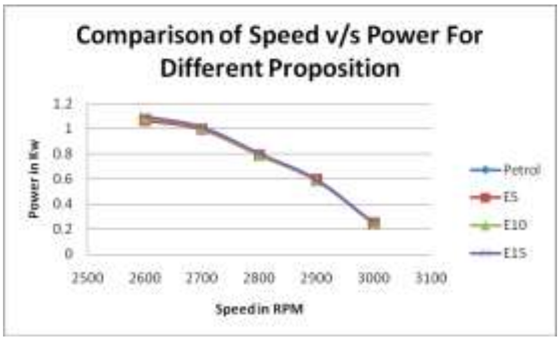
Graph 18: Speed v/s Power

For E15



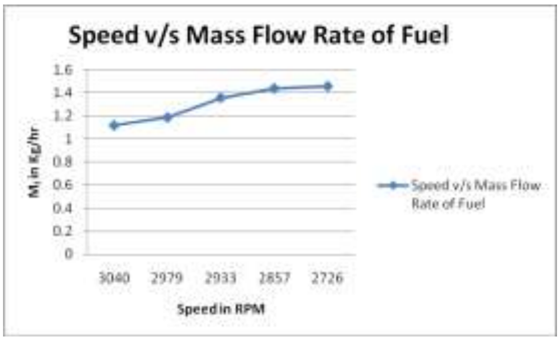
Graph 19: Speed v/s Power

Comparison



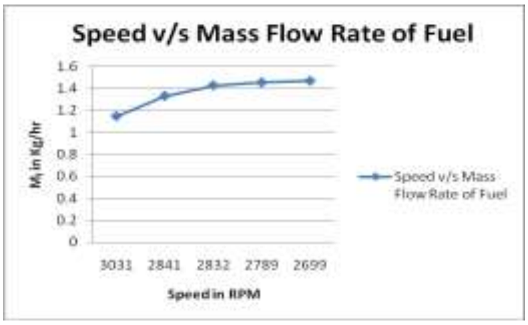
Graph 20: Comparison of Speed v/s Power

For Petrol



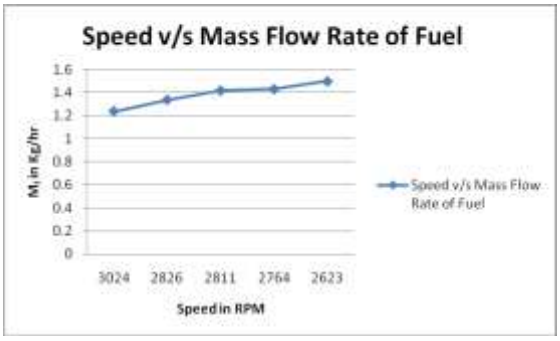
Graph 21: Speed v/s Mass Flow Rate of Fuel

For E5



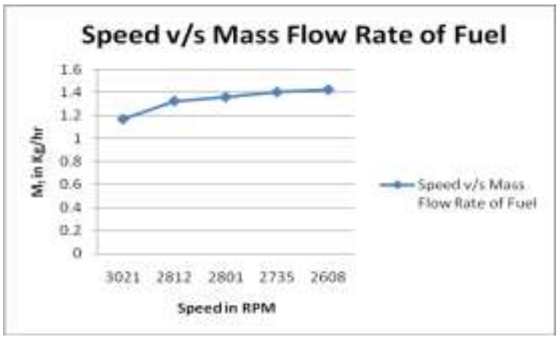
Graph 22: Speed v/s Mass Flow Rate of Fuel

For E10



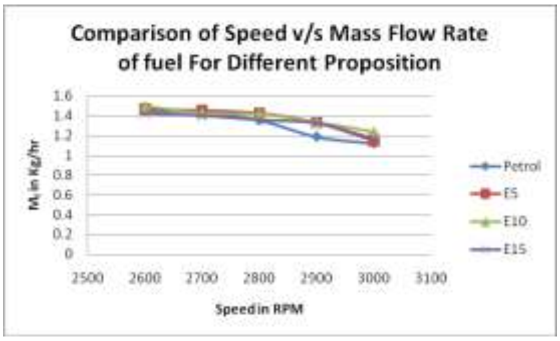
Graph 23: Speed v/s Mass Flow Rate of Fuel

For E15



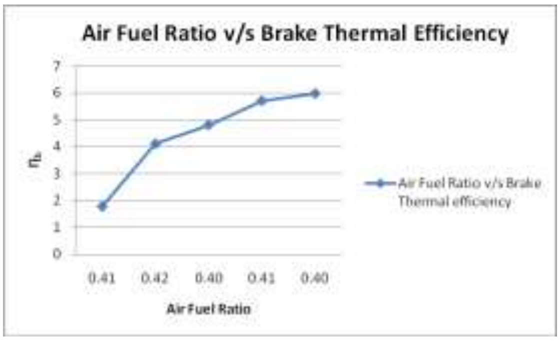
Graph 24: Speed v/s Mass Flow Rate of Fuel

Comparison



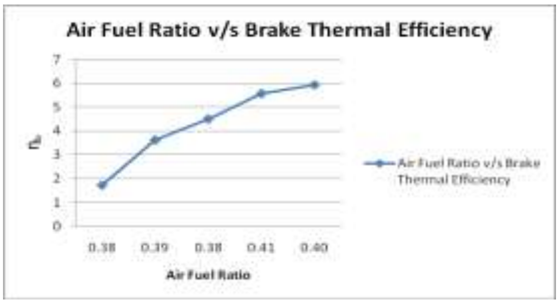
Graph 25: Comparison of Speed v/s Mass Flow Rate of Fuel

For Petrol



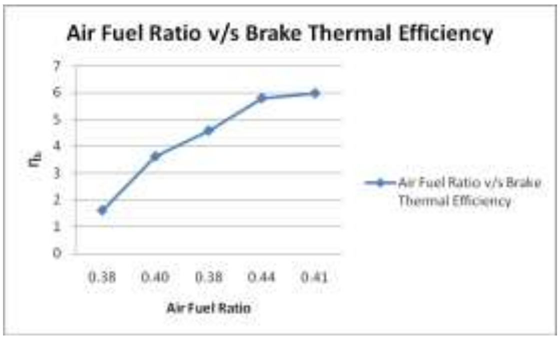
Graph 26: Air Fuel Ratio v/s Brake Thermal Efficiency

For E5



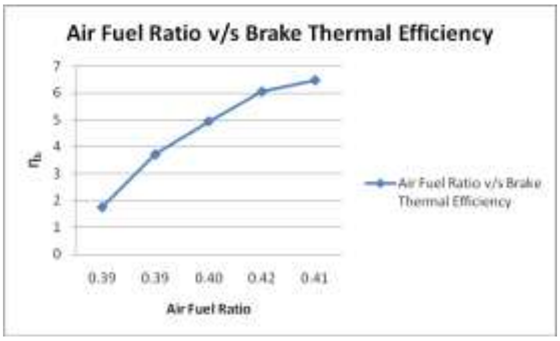
Graph 27: Air Fuel Ratio v/s Brake Thermal Efficiency

For E10



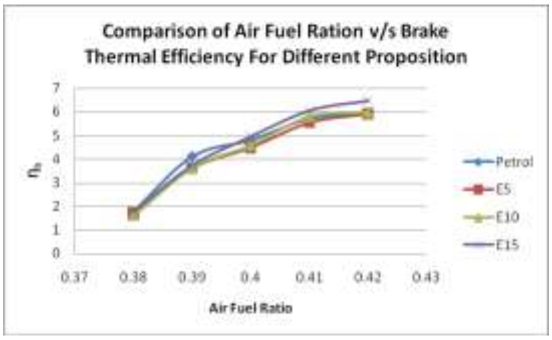
Graph 28: Air Fuel Ratio v/s Brake Thermal Efficiency

For E15



Graph 29: Air Fuel Ratio v/s Brake Thermal Efficiency

Comparison



Graph 30: Comparison of Air Fuel Ratio v/s Brake Thermal Efficiency

It is been observed from the study that the performance of the engine has enhanced with proper proposition of ethanol with petrol.

Graph 1 to graph 4 represents the change in brake thermal efficiency for different loads with different proposition and graph 5 shows that the brake thermal efficiency is slightly increased for ethanol blended petrol (i.e E15) which means the power developed at the shaft end is more when it is running with E15.

Graph 6 to graph 9 shows the change in brake specific fuel consumption for different loads with different proposition and graph 10 shows that BSFC is slightly less for E15 which means at higher loads the specific fuel consumption of the engine is less.

Graph 11 to graph 14 represents change in torque with different speed for different proposition and graph 15 shows that at low speeds the torque is slightly increased for E15 which means for low speeds the torque is increasing with proper proposition of ethanol (E15)

Graph 16 to graph 19 represents change in power for different speed for different proposition of the fuel. Graph 20 shows that the power output at the shaft is high for low speeds for E15 which means increased power output for low speeds with E15.

Graph 21 to 24 represents change in mass flow rate of fuel for different speed of the engine and graph 25 shows that mass flow rate of the fuel is less for low speeds of the engine for E15.

Graph 26 to 29 represents change in brake thermal efficiency for different air fuel ratio and graphs 30 shows that brake thermal efficiency of the engine has increased for higher air fuel ratio of the engine.

From the above study and also from the literature review it is clear that with proper proposition of ethanol with petrol the performance of the engine can be increased with appreciable values. And in this work it is intended to conduct a performance test for single cylinder four stroke petrol engines with different ethanol petrol blends. Not only with the different proposition of fuel also by making small changes in the engines.

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