Performance and Emission Characteristics of a Two Stroke Petrol Engine When Fuelled by Jatropha/Petrol Blends

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Abstract

This paper investigates performance and emissioncharacteristics of a two stroke petrol engine.A single cylinder two stroke petrol engine was used for the experiments at various speeds. An a EUROGAS model 8020 gas analyser and a smoke meter were used for the measurements of exhaust gas emissions. Engine performance (brake power, indicated power, brake mean effective pressure, mechanical efficiency, brake specific fuel consumption, volumetric efficiency, brake thermal efficiency and air–fuel ratio, and emissions (carbon monoxide, carbon dioxide, hydrocarbons, nitrogen monoxide and oxygen), were measured to evaluate and compute the behaviour of the two stroke petrol engine running on blends of petrol and lubricant oil without and with jatropha biodiesel and ethanol.

The results showed that the best value among the blends of the brake power, indicated power, brake mean effective pressure, mechanical efficiency, hydrocarbons emissions and nitrogen monoxide in the blend (98%petrol and 2% lubricant oil), the best value of brake specific fuel consumption, brake thermal efficiency, air–fuel ratio in the blend (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol), the best value of carbon monoxide, carbon dioxide and oxygen emission in the blend (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol).

Keywords

Petrol engine, Jatropha, Biodiesel, Ethanol, Performance, Emission

I. Introduction

MaximinoManzanera[1] investigated the influences of ethanol and methanol addition to unleaded gasoline on non-road SI engine performance and emission characteristics. He carried out tests on a single cylinder carbureted four-stroke spark ignition non- road engine (type Bernard Moteures 19A). He found that the ethanol/gasoline blend increase the brake power and brake torque, and decreases the brake specific fuel consumption. Methanol/gasoline blend resulted brake power and brake torque less than gasoline and exhibited badly brake specific fuel consumption more than gasoline. The emissions of methanol/gasoline blend have badly impactmore than of ethanol/gasoline blend.

An experimental investigation was conducted by F.K. Forsonet al. [2] to explore the performance and emissions of jatropha oil/diesel blend in a direct-injection single-cylinder diesel engine,the results showed that, the performance of pure jatropha, pure diesel and blends of jatropha and diesel oil nearly the same. On the other hand, jatropha oil/diesel blend have positive share in reductionof the exhaust gas temperatures.

The performance and emission characteristics of a single cylinder four stroke diesel engine which is fuelled with different blends of jatropha oil and diesel (10-50%)was studied by T. Alango et al. [3], at the speed 1500 RPM under many loads,obtained that the value of the brake thermal efficiency of diesel is the best at all loads, the great value of the brake thermal efficiency and minimum specific fuel consumption were found for blends up to 20% Jatropha oil. In the side of emission, a less value of CO_2 wasfound in the blend B20.

Ch. Narasimhaet al.[4] investigatedthe performance and emission characteristics ofa four stroke single cylinder diesel engine fuelled with diesel/Rice Bran Oil blends with Ethanol and Ethyl Hexyl Nitrate (Ethanol was added as 10% by volume to the diesel-biodiesel blends) and they mentioned that, brake thermal efficiency increased with all blends when compared to the conventional diesel fuel, the brake specific fuel consumption is decreased with the blends when compared to diesel, CO, CO_2 and HC emissions are decreased significantly with the blends when compared with diesel. The analysis showed that, the best blend is RBE35 (35% Rice Bran Oil, 10% ethanol and 65% diesel)in the side of performance compared to other blends (RB25, RB35, RB45, RBE25, RBE45) and diesel.

A study utilizedthe Jatropha straight vegetable oil (JSVO)with different fuel injection pressure angles in indirect injection (IDI) diesel engine by P. Suresh Kumar et al.[5], exhibited thatThe advanced combustion timing results increases NO_X emission due to the mono and poly unsaturated fatty acidsof Jatropha biodiesel,brake thermal efficiency improves as the fuel injection pressure is increased for the oil JSVO at full load, the brake thermal efficiency decreases, for diesel, associated withincrease of the fuel injection pressure at full load,increasing in the CO emissions continuously for diesel associated with the increase of the advance angle of fuel injection up to 250 BTDC, the CO_2 emission of JSVO increases gradually as the advance angle of fuel injection is increased up to 230 BTDC but the CO_2 emission start decreasing beyond 230 BTDC, It is also observed that the HC emission JSVO decreases as the fuel injection pressure increases and it shows that the effect of increasing the HC emission at high advance angle pre dominates the effect of decrease of HC emission at high injection pressure.

A.M. Liaquat et al [6],investigated the performance and emission characteristics of various blends of Jatropha biodiesel with diesel on a single cylinder four stroke diesel engine. The results showed that the blends of (10% Jatropha biodiesel and 90% diesel) and (20% Jatropha biodiesel and 80% diesel)have superior emission characteristics than other blends and closer to diesel value.

The experimental workcarried out on the engine performance parameters and emissions characteristics for direct injection diesel engine using coconut biodiesel blends without any engine modificationsfor the fuels DF (100% diesel fuel), CB5 (5% coconut biodiesel and95% DF), and CB15 (15% CB and 85% DF) respectively byA.M. Liaquatet al. [7],Engine performance test has been carried out at 100% load, keeping throttle 100% wide open with variable speeds of 1500 to 2400 RPM at an interval of 100 RPM. Whereas, engine emission tests have been carried out at 2200 rpm at 100% and 80% throttle position. The results exhibited thatall fuels gives decrease in torque and brake power, while increase in specific fuel consumption has been observed for biodiesel blended fuels over the entire speed range compared to net diesel fuel. On the other hand thebiodieselblenddecreasesHC, CO and, increasesCO_2 and NO_x compared to diesel fuel. Besides that there isa reduction in sound level for both biodiesel blended less than the diesel fuel. From the experimentsobtained that CB5 and CB15 can be used in diesel engines without any modifications.

VijittraChalatlon et al. [8], studiedthe effects of use pure oil of jatropha biodiesel and as a blend with petroleum diesel fuel on diesel engines. A direct injection (DI) diesel engine was tested using diesel, Jatropha oil, and blends of Jatropha oil and diesel in different proportions. A wide range of engine loads and Jatropha oil/diesel ratios of 5/95% (J5), 10/90% (J10), 20/80% (J20), 50/50% (J50), and 80/20% (J80) by volume were considered. The experiments showed thatno significant change in brake thermal efficiency and brake specific fuel consumption was experienced up to J20 ratios. However, higher blends suffered from deterioration in efficiency and fuel consumption about 10 to 25%. At low load operations, CO_2 emission with blends was lower than that of diesel, but observed thatincrease of the CO_2 emission became at high load with the increase of the percentage of Jatropha oil in the blends. In the side of the CO emission with blends,it is much higher than the diesel associated with theincrease of the percentage of Jatropha oil in the blend.

NitinShrivastava et al. [9], examined the Performance and emissions of a four cylinder direct injection diesel engine with different loading conditionsfuelled with diesel fueland a Jatropha Biodiesel called Jatropha oil methyl ester (JOME) blends B20 (20%JOME and 80% diesel) and B50 (50%JOME and 50% diesel). JOME was prepared using Jatropha oil, methyl alcohol and potassium hydroxide as catalyst. The results showed that decrease in $NO_x$for the pure JOME and its blend B20 and B50, B20 and diesel fuel nearly havethe same brake thermal efficiency.

This paper investigates the engine performance and emissions characteristics of a two stroke petrol engine when fuelled by the blends (97% petrol and 3% lubricant oil), (98% petrol and 2% lubricant oil), (94% petrol, 2% jatropha biodiesel,2% lubricant oil and 2% ethanol) and(92% petrol, 4% jatropha biodiesel,2% lubricant oil and 2% ethanol) at different speeds (1750, 1850, 1950, 2050 and 2080RPM).

II. EXPERIMENTAL SETUP

This section explains the experiments and the specifications of the devices and materials used in experiments which are gasoline, jatropha biodiesel, two stroke petrol engine and dynamometer.

A)Specifications ofGasoline and Jatropha Biodiesel:

The octane number to gasoline was determined by ASTM D2699 method, for gasoline (92.2). The flash point was determined by ASTM D. 93 method, for jatropha biodiesel (154.8°c). The cloud point was determined by ASTM D.2500, for jatropha biodiesel (12°c). The Density was determined by ASTM D.4052, for jatropha biodiesel (0.8841 g/cm^3).The kinematic viscosity at 40°c was determined by ASTM D.445 method, for jatropha biodiesel (4.729 mm^2/s).

B)Engine Specifications:

Single cylinder two stroke petrol engines mounted on separate moving frame is provided with test bed. It is variable speed, air cooled engine. The engine is provided with electrical ignition system, the specification of the engine as in table I and Fig. 1 below:

Table ISpecifications of the engine

Technical Details	Specifications
Maximum Power	4.63kw at 5000 RPM
Maximum Torque	9N-m @3500 RPM
Displacement	145 cc
Bore (d)	57 mm
Stroke (L)	57 mm
Make	Bajaj Auto

Fig.1Single cylinder two stroke petrol engines

C) Dynamometer:

A DC generator (capacity 8 kw), as in figure (2) below, which can be also used as Motor acts as dynamometer to measure power of the engine. It can be run as a motor to conduct Motoring test and start the engines. The control Panel for Generator is fitted on load bank. It is a swing field generator supported on bearings at both ends and a load cell measure the load acting on the generator due to torque generated.

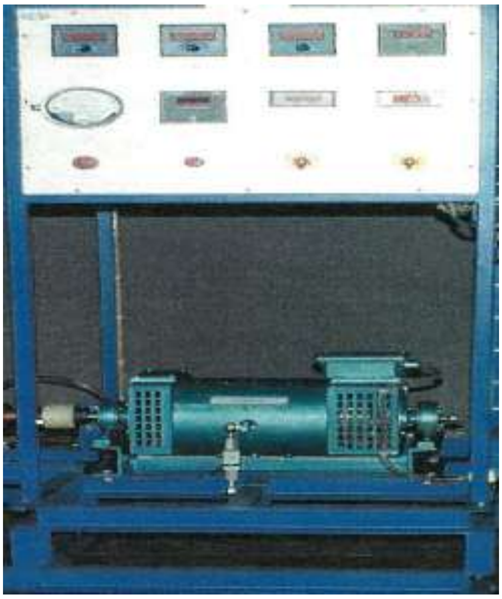


Fig.2Electrical dynamometer

D) Experiments:

The experiments of engine performance and emissions are carried out at different speeds: 1750, 1850, 1950, 2050 and 2080 RPM. Engine performance consists of brake power, indicated power, brake mean effective pressure, mechanical efficiency, brake specific fuel consumption, volumetric efficiency, brake thermal efficiency and air/fuel ratio. The emissions consist of carbon monoxide, carbon dioxide, hydrocarbons, nitrogen monoxide and oxygen.

III.Results and Discussions

The results of the engine performance and emissions where discussed as below:

A)Brake power:

The brake power (B.P) can be found from equation (1) as below:

$$B.P=\frac{(2\pi NT)}{60*1000}(KW) \qquad (1)$$

Where:

T ≡ Torque (N.m)

N ≡ Speed (RPM)

The value of the brake power (B.P) as in figure (3), which it produce by the engine, for 0% load and for the almost speeds, increase for the blend (98%petroland 2% lubricant oil) more than the blend (97%petroland 3% lubricant oil) due to the decrease in the percentage of petrol fuel in the blend, and it decrease respectively more than the blend(97%petroland 3% lubricant oil), for the blends(94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (92% petrol, 4% jatropha biodiesel, 2% lubricant oil,2% ethanol) due to adding the jatropha biodiesel and ethanol, and due to decrease in the percentage of petrol fuel in the blend.

At the speed 1950, the blends (98%petroland 2% lubricant oil) and (97%petroland 3% lubricant oil) have the same value, also the blends (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) have the same value in this speed.

At the speed 1850, the blends (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and
(92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) have the same value.

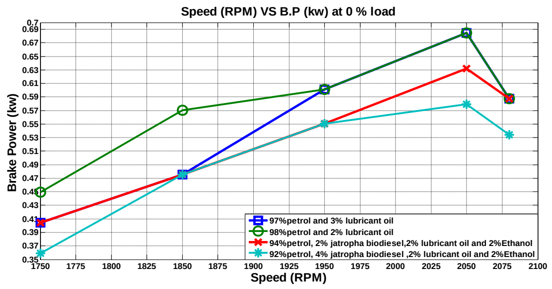


Fig.3Speed (RPM) VS brake power (kw)

B)Indicated power (I.P):

The indicated power can be found from equation (3), as below :

Friction power(F.P)

$$=\frac{(\text{voltage (v)}*\text{ Current (I)})(\text{Motor efficiency})}{1000}(KW)(2)$$

I.P= B.P. + F.P. KW *(3)*

The great value of the indicated power (I.P), as in figure (4) below, for 0% load and for the almost speeds, founded in the blend (98%petroland 2% lubricant oil), which it more than the blend (97%petrol and 3% lubricant oil) due to the decrease in the percentage of lubricant oil in the blend, and more than the blends (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) respectively, due to adding the jatropha biodiesel and ethanol.

At the speeds 1950, 2050 and 2080, the blends (97%petrol and 3% lubricant oil) and (98%petrol and 2% lubricant oil), have the same value.

At the speed 1850, the blends (97%petrol and 3% lubricant oil), (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) , have the same value.

At the speed 2080, the blends (97%petrol and 3% lubricant oil), (98%petrol and 2% lubricant oil) and (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol), have the same value.

At the speeds1850 and 1950, the blends (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol), have the same value.

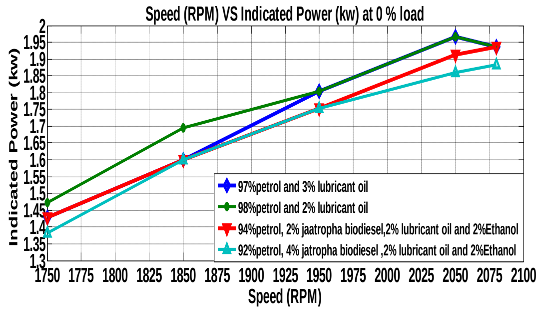


Fig.4Speed (RPM) VS indicated power (kw)

C) Brake Mean Effective Pressure (B.M.E.P):

The brake mean effective pressure can befound from equation (4) below:

$$B.M.E.P=\frac{\text{Brake Power}}{100*L*A*(N/60)}(\text{bar})\ (4)$$

Where:

L ≡ Stroke lrngth (m)

A ≡ Area of the engine bore (m^2)

The great value of the brake mean effective pressure (B.M.E.P), as in figure (5) below, for almost speeds, comes gradually as in the blend (98%petrol and 2% lubricant oil) at the first, secondly the blend (97%petrol and 3% lubricant oil), thirdly the blend (94%petrol, 2% jatropha biodiesel,2% lubricant oil and 2% ethanol) and finally the blend (92%petl, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol), due to the decrease in the percentage of lubricant oil in the blend or due to adding the jatropha biodiesel and ethanol.

At the speeds 1950 and 2050, the blends (98%petrol and 2% lubricant oil) and (97%petrol and 3% lubricant oil), have the same value.

At the speeds 1750, 1850 and 2080, the blends (97%petrol and 3% lubricant oil) and (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) have the same value.

At the speeds 1850 and 1950, the blends (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol), have the same value.

At the speeds 1850 and 1950, the blends (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (97%petrol and 3% lubricant oil), have the same value.

At the speed 2080, the blends (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol), (98%petrol and 2% lubricant oil) and blends (97%petrol and 3% lubricant oil), have the same value.

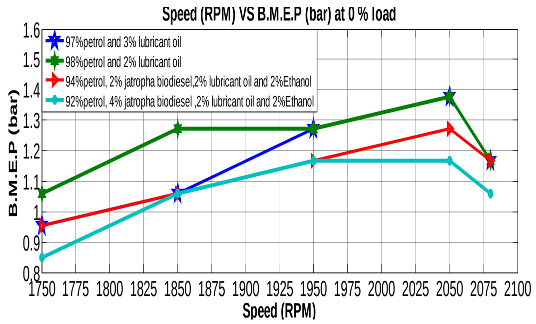


Fig.5 Speed (RPM) VS brake mean effective pressure (bar)

D)Mechanical Efficiency:

The mechanical efficiency can be found from equation (5) below:

$$\eta_{mech} = \frac{\text{Brake Power}}{\text{Indicated Power}}\ 100\%(5)$$

The value of the mechanical efficiency,as in figure (6), for 0% load and for the almost speeds, increase for the blend (98%petrol and 2% lubricant oil) more than the blend (97%petrol and 3% lubricant oil) due to the decrease in the percentage of lubricant oil in the blend, and it decrease respectively more than the blend(97%petrol and 3% lubricant oil), for the blends (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (92% petrol, 4% jatropha biodiesel, 2% lubricant oil, and 2% ethanol) due to adding the jatropha biodiesel and ethanol.

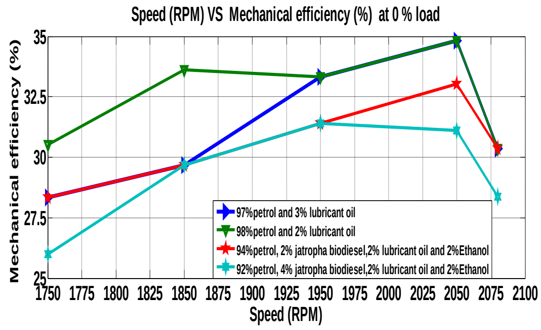
At the speeds 1950, 2050 and 2080, the blends (98%petrol and 2% lubricant oil) and (97%petrol and 3% lubricant oil) have the same value.

At the speeds 1750, 1850 and 2080, the blends (97%petrol and 3% lubricant oil) and (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) have the same value.

At the speeds 1850 and 1950, the blends94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and

(2% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) have the same value.

At the speed 1850, the blends (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (97%petrol and 3% lubricant oil) have the same value.



Figu.6Speed (RPM) VS mechanical efficiency (%)

E) Brake Specific Fuel Consumption:

The brake specific fuel consumption can be found from equation (6) below:

$$B.S.F.C = \frac{\text{T.F.C (kg/sec)}}{\text{Break power}}\ \text{kg/sec-kw}(6)$$

Where:

T.F.C ≡ Total fuel consumption (kg/sec)

The value of the brake specific fuel consumption, as in figure (7) for 0% load and for the almost speeds, increase for the blend (98%petrol and 2% lubricant oil) more than the blends (97%petrol and 3% lubricant oil), (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) respectively.

At the speeds 1750 and 1850, the blend (97 % petrol and 3% lubricant oil) have value more than the blend (98%petroland 2% lubricant oil) have the same value.

At the speed 1850 and 1950, the blends (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) have value less than the blend (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol).

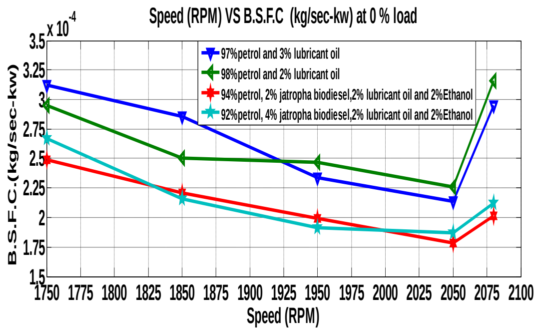


Fig.7Speed (RPM) VS Brake specificfuel consumption (B.S.F.C) (kg/sec-kw)

F) Volumetric efficiency:

It can be found from equation (7) below:

$\square_v = \frac{\text{Actual Air intake}}{\text{Theoretical Air intake}} * 100$ (7)

where:

Actual air intake =

$$C_d \times A \times \sqrt{\frac{(2\,gh \times 2.54)}{\rho}}\ \text{m}^3/\text{sec} \quad (8)$$

Theoretical Air intake= $\frac{L * A * N}{60}$ (m^3/sec) (9)

where:

C_d≡ Coefficient of discharge (0.65)

h ≡ pressure differential of air swept by the engine (inch of water)

g ≡ Specific gravity (m / s^2)

The value of the volumetric efficiency (%), as in figure (8),for 0% load, decrease for the blends (97%petrol and 3% lubricant oil) and (98%petrol and 2% lubricant oil), have the same values at all speeds, which are less than the blends (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol), those also have the same values at all speeds.

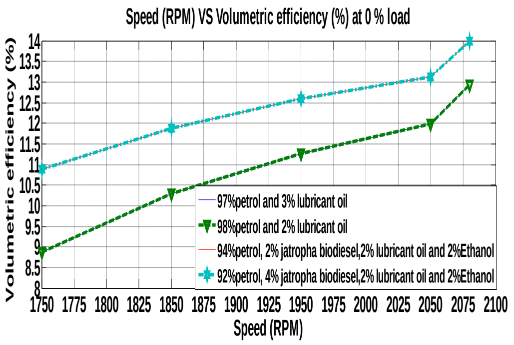


Fig.8 Speed (RPM) VS volumetric efficiency (%)

G) *BrakeThermal Efficiency($\square_v$):*

It can be found from equation (10) below:

$\square_v = \frac{\textit{Brake power}}{\text{Fuel Intake power}} * 100$ (10)

where:

fuel intake power= T.F.C in kg/s*calorific value of fuel (11)

From figure 9, The value of the brake thermal efficiency ($\eta_{B.T}$ %), for 0% load and for almost speeds, increase for the blend (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and2%ethanol) more than the blends (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol), (97% petrol and 3% lubricant oil) and (98%petrol and 2% lubricant oil) respectively.

At the speeds 1850 and 1950, the blend (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) have value more than the blend (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol).

At the speeds 1750 and 1850, the blend (98% petrol and 2% lubricant oil) have value more than the blend (97%petrol and 3% lubricant oil).

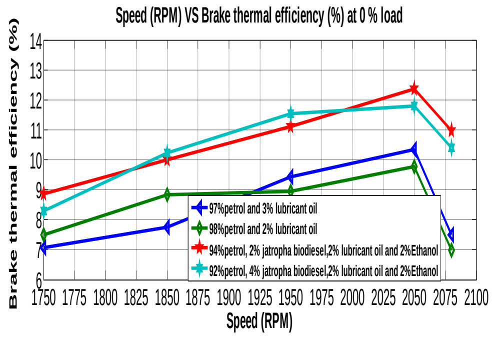


Fig.9 Speed (RPM) VS brake thermal efficiency (%)

H) *Air/Fuel Ratio*:

It can be found from equation (12) below:

Air Fuel ratio = $\frac{\text{Air intake in kg/sec}}{\text{T.F.C. kg / sec}}$ (12)

Where:

Air intake = Air in m^3/s *density of air kg/m^3

The value of the air–fuel ratio, as in figure (10) below, for 0% load and for almost speeds, increase for the blend (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) more than the blends (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol), (97%petrol and 3% lubricant oil) and (98%petrol and 2% lubricant oil) respectively.

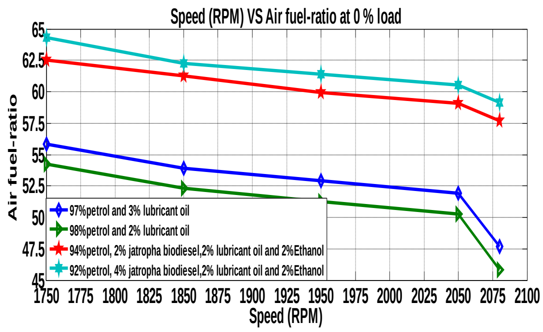


Fig.10. Speed (RPM) VS air–fuel ratio

I): *Carbon Monoxide:*

The value of the carbon monoxide (CO) (% volume), as in figure (11) below, for 0% load and for the all speeds, increase for the blend (97% petrol and 3% lubricant oil) more than the blends (98%petrol and 2% lubricant oil), (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) respectively.

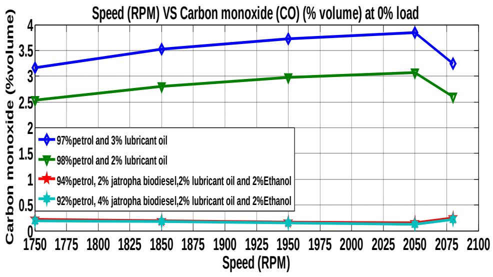


Fig.11 Speed (RPM) VS carbon monoxide (CO) (% volume)

J) Carbon Dioxide:

The value of the carbon dioxide (CO_2) (% volume), as in figure (12) below, for 0% load and for the almost speeds, increase for the blend (98% petrol and 2% lubricant oil) more than the blends (97% petrol and 3% lubricant oil), (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) respectively.

At the speed 2050, the blend (97%petrol and 3% lubricant oil) have value less than all blends.

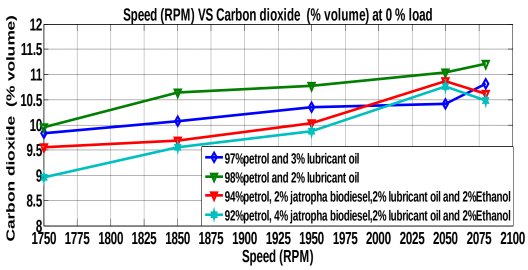


Fig.12. Speed (RPM) VS carbon dioxide (CO2) (% volume)

K) Hydro Carbons Emissions:

The value of the hydrocarbons emissions (Hc), as in figure (13) below, for 0% load and for the almost speeds, increase for the blend (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) more than the blends (97%petrol and 3% lubricant oil), (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (98%petrol and 2% lubricant oil), respectively.

At the speed 2050, the blends ((92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) have value less than all blends.

The blend (97%petrol and 3% lubricant oil), have value less than the blend (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol)in the speed 1750 and have value less than all blend in the speed 2080.

The blend (94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol), have values less than the blend (98% petrol and 3% lubricant oil), in the speeds 1950 and 2050.

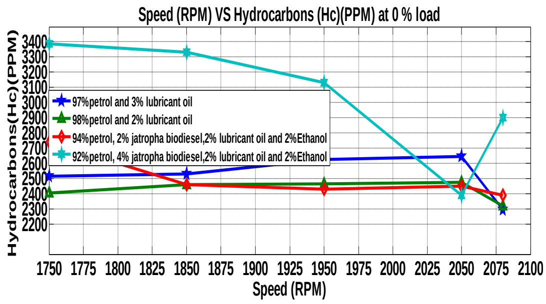


Fig.13 Speed (RPM) VS hydrocarbons (Hc) (ppm)

L) Nitrogen Monoxide:

The great value of nitrogen monoxide (NO) (ppm), as in figure (14) below, for almost speeds and for 0% load, comes gradually as in the blend (94%petroll, 2% jatropha biodiesel ,2% lubricant oil and 2% ethanol) at the first, secondly the blend (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol), thirdly the blend (97% petrol and 3% lubricant oil) and finally the blend(98%petrol and 2% lubricant oil).

At the speed 2050, the blends (97%petrol and 3% lubricant oil) and (92%petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol), have the same value.

At the speed 2080, the blends (97%petrol and 3% lubricant oil) and (98%petrol and 2% lubricant oil) have value more than the blend (92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol).

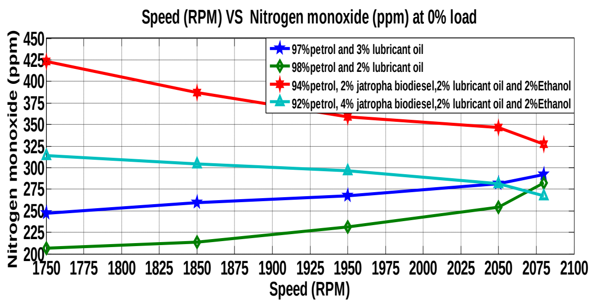


Fig.14 Speed (RPM) VS Nitrogen monoxide (NO) (ppm)

M) Oxygen Emission:

The great value of the oxygen emission(O_2) (% volume), as in figure (15) below, for almost speeds and for 0% load, comes gradually as in the blend(92%petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) at the first, secondly the blend (94%petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol) , thirdly the blend(97%petrol and 3% lubricant oil) and finally the blend(98%petrol and 2% lubricant oil), due to adding jatropha biodiesel at the first and second blends, where is the oxygen emission increase with the increase of it , or due to the increase in the percentage of lubricant oil in the third and fourth blends, where is the oxygen emission increase with the increase of it.

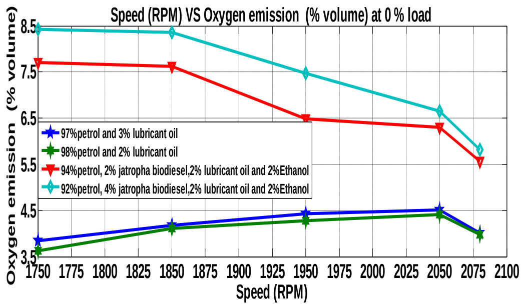


Fig.15Speed (RPM) VS oxygen emission O2 (%volume)

V. Conclusions

The best value of thebrake power,indicated power,brake mean effective pressure andmechanical efficiency, isfound in the blend (98%petrol and 2% lubricant oil) at the speed 2050 RPM, where the best value of thehydrocarbons and nitrogen monoxide emissionsisfound at same blend butat the speed 1750 RPM.

The best value of thebrake specific fuel consumption andbrake thermal efficiency,are found in the blend(94% petrol, 2% jatropha biodiesel, 2% lubricant oil and 2% ethanol)at the speed 2050 RPM, where the best value ofthe air/fuel ratiois found at the same blend but at the speed 1750 RPM.

The best value of thecarbon monoxide,carbon dioxide andoxygen emissionis found in the blend(92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol)at the speed 1750 RPM.

The best value of the volumetric efficiencyis found in the blends(92% petrol, 4% jatropha biodiesel, 2% lubricant oil and 2% ethanol) and (94% petrol, 2% jatropha, 2% lubricant oil and 2% ethanol))at the speed 1750RPM.

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