ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

Performance Characteristics Analysis of Jatropha-Diesel Blends in VCR Engine

Deepak Nibe[1], Nitin Tambe[2], Rakhmaji Gavahane[3], Omesh Raktate[4]

Assistant Professor, Mechanical Engineering Department, Amrutvahini College of Engineering, Sangamner , University of Pune, India[1, 2, 3, 4]

Abstract: The scarce and rapidly depleting conventional petroleum resources have promoted research for alternative fuels for internal combustion engines. Among various possible options, fuels derived from vegetable oils/animal fats present promising ‘‘greener’’ substitutes for fossil fuels. Vegetable oils, due to their agricultural origin, are able to reduce net CO_2 emissions to the atmosphere along with import substitution of petroleum products. However, several operational and durability problems of using straight vegetable oils in diesel engines have been reported in the literature, which are because of their higher viscosity and low volatility compared to mineral diesel fuel. In the present study, experiments were conducted using mineral diesel and jatropha-diesel blends to study the emissions and performance characteristics of diesel engine. A single cylinder, four stroke, constant speed, water cooled, variable compression ratio engine was used for the experiments. The acquired data were analyzed for various parameters such as brake thermal efficiency (BTE), brake power (BP), brake specific fuel consumption (BSFC), brake mean effective pressure (BMEP) and emissions such as CO_2, CO and HC emissions. While operating the engine on jatropha-diesel blends, performance and emission parameters were found to be very close to mineral diesel for lower blend concentrations.

Keywords: Jatropha, VCR Engine, Emissions, BTE, BSFC.

I. INTRODUCTION

The growing concern on environmental pollution caused by the extensive use of conventional fossil fuels, diminishing petroleum reserves and agriculture based economy of our country are the driving forces to promote biodiesel as an alternative fuel. Fuels derived from renewable biological resources for use in diesel engines are known as biodiesel. Biodiesel is environmentally friendly liquid fuel similar to petrol – diesel in combustion properties. Biodiesel derived from vegetable oil is being used in USA and Europe to reduce air pollution and dependence on fossil fuel.

1.1 JATROPHA, A PROMISING ALTERNATIVE FUEL

Since India is net importer of vegetable oils, edible oils cannot be used for production of biodiesel. India has the potential to be a leading world producer of biodiesel, as biodiesel can be harvested and sourced from non-edible oils like jatropha, curcas, pongamia, neem, mahua, castor, linseed etc. Some of these oils produced even now are not being properly utilized. Out of these plants, India is focusing on jatropha curcas, which can grow in arid and wastelands. Oil content in the jatropha seed is around 30-40%. India has about 80-100 million hectares of wasteland which can be used for jatropha plantation.

Implementation of biodiesel in India will lead to many advantages like green cover to wasteland, support to agriculture and rural economy and reduction in dependence on imported crude oil and reduction in air pollution. The main disadvantages of vegetable oils, as diesel fuels are associated with the highly increased viscosity, 10-20 times greater than the normal diesel fuel. Thus, although short-term tests using neat vegetable oils showed promising results, problems appeared after the engine had been operated for longer periods. To solve the problem of the very high viscosity of neat vegetable oils, the following method was adopted, i.e. blending in small blend ratios with normal diesel fuel.

The advantages of bio-diesel as diesel fuel are the minimal sulphur and aromatic content and higher flash point, lubricity, cetane number, biodegradability and non-toxicity. On the other hand their disadvantages include higher viscosity and pour point and the lower calorific value and volatility. Furthermore their oxidation stability is lower, they are hydroscopic and as solvents may cause corrosion of components attacking some plastic materials used for seals, hoses, paints and coatings. For all the above reasons it is generally accepted that blends of standard diesel fuel with biodiesels can be used in existing diesel engines without any modification. The properties of pure diesel and jatropha are given in Table 2.1

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)
Amrutvahini College of Engineering, Sangamner
Vol. 3, Special Issue 1, March 2016

1.2 VCR ENGINE, A CONVINCING TOOL

Choosing an appropriate VCR technology is a decisive step to determine the cost of VCR implementation in future vehicles. The different available VCR technologies have to be compared by focusing on all the positive and negative impacts on engine components and their operations. The benefits of VCR engine also includes increased power density, reduced number of cylinders, sophisticated injection technologies, and complex after treatment. Indeed to be marketable, the VCR technology has to present indispensable features such as robustness, durability, easy integration into all vehicles and low noise and vibration levels.

The VCR engine provides excellent fuel flexibility, since the compression ratio can be varied and adjusted to suit the properties of the fuel, and therefore the engine will always run at the compression ratio best suited to the fuel being used. Compression ratio is an important parameter in any engine, which decides performance of the engine. With increase in compression ratio in diesel engine, its break power increases. This also leads to increase in mechanical efficiency. Further relative decrease in clearance volume leads to increase in volumetric efficiency. At the same time, it leads to increase in specific fuel consumption (SFC). This will affect the overall performance of the engine. It becomes necessary to conduct the trial on engine to find out the overall performance of the engine at various compression ratios.

In the near future, fuel consuming vehicles will not only be penalized by markets, but also by government. Reducing fuel consumption reduces the national oil bill and promotes economic growth and associated tax revenues. Fig.1.1 shows VCR engine test setup developed by Apex Innovations Pvt. Ltd, Sangli. In this setup the operation mode of the engine can be changed from diesel to petrol or from petrol to diesel with some necessary changes. In both modes the compression ratio can be varied without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. In this trial, we can compare the performance of the engine at various compression ratios by various parameters like brake thermal efficiency, indicated thermal efficiency, mechanical efficiency, specific fuel consumption, volumetric efficiency, brake mean effective pressure, indicated mean effective pressure etc. With computerized test setup and trial, it also becomes possible to compare heat balance sheet at various compression ratios. Lab view based engine performance analysis software package "Engine soft" is provided for on line performance evaluation.

1.3 OBJECTIVE

1. To determine the suitable jatropha-diesel blend that gives maximum performance and reduced emissions for the engine.
2. To compare experimentally the performance and emission characteristics by testing the engine with jatropha-diesel blend and pure diesel fuel at various compression ratios, at constant speed under different loads without any knock.

II. LITERATURE SURVEY

Several studies have been conducted on the usage of jatropha-diesel blends as fuel in the C.I. engines.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

2.1 INFERENCES FROM LITERATURE

Forson F.K. et. al [1] conducted tests on a single cylinder direct-injection engine operating on diesel fuel, jatropha oil and blends of diesel and jatropha oil in proportions of 97.4%, 2.6%, 80%, 20% and 50% / 50% by volume. The tests showed that jatropha oil could be conveniently used as a diesel substitute in a diesel engine. The tests further showed increases in brake thermal efficiency, brake power and reduction of specific fuel consumption for jatropha oil and its blends with diesel generally but the most significant conclusion from the study is that 97.4% / 2.6% jatropha fuel blend produced maximum values of the brake power and brake thermal efficiency as well as minimum values of the specific fuel consumption.

Venkateswara Rao T. et. al [2] carried out experimental investigations to examine properties, performance and emissions of different blends (B10, B20, B40) of pongamia methyl esters (PME), jatropha methyl esters (JME) and neem methyl esters (NME) in comparison to diesel. Results indicated that B20 have closer performance to diesel and B100 had lower brake thermal efficiency mainly due to its viscosity compared to diesel. However its diesel blends showed reasonable efficiencies, lower smoke, and CO and HC emissions.

Raheman H. et. al [3] undertook a study at IIT Kharakpur, India on behavior of diesel engine when operated with biodiesel and its blend (B60, B80, B100) at varying loads (L), compression ratio (CR) and ignition timing (IT). Their experimental results indicated that the brake specific fuel consumption (BSFC) and exhaust gas temperature (EGT) increased where as brake thermal efficiency (BTE) decreased with increase in the proportion of biodiesel in the blend at all compression ratios (18:1-20:1) and injection timings (35^0 – 45^0 before TDC).

Baitiang Teerapong et. al [4] studied the effect of neat biodiesel (B100) and pure jatropha oil on engine performance, black smoke density, fuel consumption and durability of engines. From the performance test, when comparing BDF and jatropha oil with diesel, the engine performances were slightly different with a small increase of fuel consumption. It is noticeable that black smoke measured from the engines using both biodiesel and jatropha oil can be hugely reduced. It was found that the highest amount of jatropha oil that could be used was a blend between jatropha oil and diesel fuel of 60:40 by volume for practical running time before failure.

Agarwal Deepak et. al [5] conducted experiments using various blends of Jatropha oil with mineral diesel to study the effect of reduced blend viscosity on emissions and performance of diesel engine. A single cylinder, four stroke, constant speed, water cooled, direct injection diesel engine typically used in agricultural sector was used for the experiments. The acquired data were analyzed for various parameters such as thermal efficiency, brake specific fuel consumption (BSFC) smoke, CO_2, CO and HC emissions.

While operating the engine on jatropha oil blends, performance and emission parameters were found to be very close to mineral diesel for lower blend concentrations. However, for higher blend concentrations, performance and emissions were observed to be marginally inferior.

Agarwal observed significant improvement in engine performance and emission characteristics for the biodiesel fuelled engine compared to diesel fuelled engine. Improved thermal efficiency of the engine, reduced brake specific fuel consumption and a considerable reduction in the exhaust smoke opacity was observed.

2.2 AVAILABILITY AND USABILITY OF JATROPHA AS A FUEL FOR C.I ENGINE

2.2.1 Availability of Jatropha

India has rich and abundant resources of both edible and non-edible oil seeds. The production of methyl/ethyl esters from non-edible oils is much more expensive than that of diesel fuels. This is due to the relatively high costs of vegetable oils (about four times the cost of diesel in India).Therefore there is a need to search and explore alternate feed stocks for the production of biodiesels. Non-edible oils from sources such as honge, Jatropha and neem are easily available in many parts of India and are cheap compared to edible oil. Jatropha curcas is a large shrub or tree commonly found throughout most of the tropical and sub-tropical regions of the world. The jatropha curcas plant is a drought-resistant, perennial plant living up to 50 years and has the capability to grow on marginal soils.

It requires very little irrigation and grows in all types of soils. The production of jatropha seeds is about 0.8 kg/m^2 per year. The oil content of jatropha seed ranges from 30–40% by weight and the kernel itself ranges from 45% to 60%. Fresh jatropha is a slow drying, odorless and colorless oil, and turns yellow after aging.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

2.3 PROPERTIES OF JATROPHA

Standard methods i.e. ASTM and I.P methods were used to determine the properties of the jatropha oil. The chemical and physical properties of the jatropha oil relative to the diesel fuel are provided in Table.2.1.

Table 2.1 Properties of mineral diesel fuel and jatropha oil

Property	Mineral diesel	Jatropha oil
Density (kg/m^3)	866.9	917.5
API gravity	31.7	22.7
Cloud point (°C)	3±1	9±1
Pour point (°C)	15	-3
Flash point (°C)	86	99
Fire point (°C)	103 ±3	274 ±3
Conradson carbon residue (%,w/w)	0.1 ±0.0	0.8 ±0.1
Ash content (%, w/w)	0.01 ±0.0	0.03 ± 0.0
Calorific value (MJ/kg)	45.90	42.048
Carbon (%, w/w)	80.33	76.11
Hydrogen (%, w/w)	12.36	10.52
Nitrogen (%, w/w)	1.76	0
Oxygen (%, w/w)	1.19	11.06

III. PREPARATION OF BLENDS

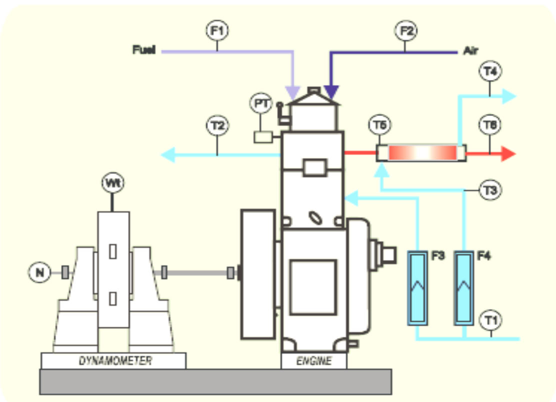
For the present work different blends of diesel and jatropha are used. The different blends are J0, J5, J10 and J15. The number following J indicates percentage of volumetric amount of jatropha in diesel. These blends are prepared for two liters of each category. By using standard formula various properties can be calculated for each blend. These calculated properties along with properties of diesel and jatropha are given in Table 3.1.

Table 3.1. Properties of diesel and jatropha blends

Fuel property	Diesel	Jatropha	J5	J10	J15
Density (kg/m^3)	866.9	917.5	869.4	871.4	873.4
Calorific value (MJ/kg)	45.90	42.048	45.070	44.807	44.544
Flash point (^{0}C)	86	99	88	88.5	89
Kinematic viscosity (cSt)	5.7	36.9	6.12	6.9	7.2
Pour point (^{0}C)	15	-3	15	13	13

3.1 EXPERIMENTAL SETUP

This section includes schematic diagram of the engine setup on which the experimentation has been done.



Schematic arrangement

Fig.3.1 Schematic arrangement of experimental setup

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
IARJSET
International Advanced Research Journal in Science, Engineering and Technology
2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)
Amrutvahini College of Engineering, Sangamner
Vol. 3, Special Issue 1, March 2016

Product: Research engine test setup, 1 cylinder, 4 strokes, multifuel (computerized)

3.2 EXPERIMENTAL PROCEDURE

The present study was carried out to investigate the performance and emission characteristics of diesel and jatropha blends, in a stationary single cylinder, four stroke, multifuel VCR engine (computerized) running on diesel mode. The operation mode of the engine can be changed from diesel to petrol or from petrol to diesel with some necessary changes.

In both modes the compression ratio can be varied without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement.

The compression ratio is adjustable even when the engine is running. The flywheel is calibrated in degrees to allow accurate measurement of ignition timings using stroboscopic light method. a screw adjustment is provided so that the ignition timing whose setting indicated by a calibrated pointer, can be adjusted while the engine is running. The eddy current dynamometer is used as a loading device whose power absorption unit consist of a well balanced star wheel rotor mounted on precision bearings, rotates in the stator.

The reaction torque is sensed by using various weighing mechanism such as spring balance or load cell with digital indicator etc. The main shaft of the dynamometer is having arrangement for fitting flange coupling at both ends. The control of extension unit is mounted on a separate panel. Fuel flow measurement and fuel consumption unit consists of fine beam infra red sensors, conditioning card, & a calibrated pipette of 50 cc. The digital signals are directly interfaced to computer interface card.

The exhaust gas calorimeter system is also interfaced with computer measuring water carried away by exhaust gases. Thermocouples are provided to measure all the temperatures required for heat balance sheet. Computerized water flow measurement set-up is also provided. Computerized air flow measuring set-up consist of an air tank and orifice meter is also provided. A computer suitable to carry out analysis using the software ‘Engine soft’ is provided.

The major pollutants in the exhaust of a diesel engine are CO, CO_2 and HC. Exhaust gas analyzer was used for the measurement of CO and HC emissions. The engine was operated on diesel first and then on blends of jatropha.

The different fuel blends and mineral diesel were subjected to performance and emission tests on the engine. The performance data were then analyzed from the graphs regarding thermal efficiency, brake power; brake-specific fuel consumption and brake mean effective pressure.

The mineral diesel fuel was first tested at compression ratio 15 and at variable loads. Keeping the compression ratio 15 constant and varying the load in the range of 3 kg, 6 kg, 9 kg and 12 kg all the performance parameters were automatically recorded by the computer which is interfaced with the engine.

Lab view based engine performance analysis software package “Engine soft” is provided for on line performance evaluation. The compression ratio was then changed to 16, 17, 18 and the performance parameters were recorded for each load considered. The same procedure was repeated for the various blends considered for the tests. (J5, J10, J15) and the performance parameters were recorded.

IV. RESULTS AND DISCUSSION

The tests were performed for each test blends J0, J5, J10, J15 at four different loads (3 kg, 6 kg, 9 kg, 12 kg) and at constant speed. Four different compression ratios (15, 16, 17, 18) were considered for the tests. The following results were obtained from the tests.

4.1 Effect of Various Blends on Engine Performance

Fig.4.1 to fig.4.4 shows that the brake thermal efficiency increases with increasing concentration of biodiesel in the blends. However the brake thermal efficiency of J5 is higher than pure diesel and all other blends. This may be due to increased amount of oxygen in J5, which might have resulted in improved combustion.

Figure also shows that the brake thermal efficiency improved with the increasing compression ratio. Increase in the compression ratio increases the temperature, reduces the ignition delay.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

The biodiesel blends have lower volatility compared to diesel, so at higher temperature their combustion characteristics improve. The J5 was found to be the best compared to diesel and all other blends at all compression ratio.

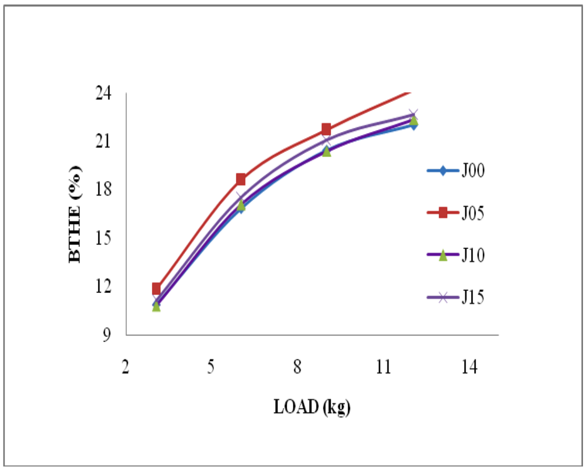


Fig. 4.1 Brake thermal efficiency against load at compression ratio 15

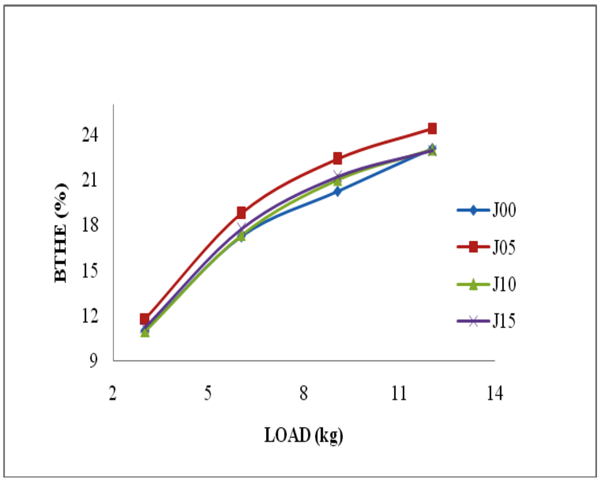


Fig. 4.2 Brake thermal efficiency against load at compression ratio 16

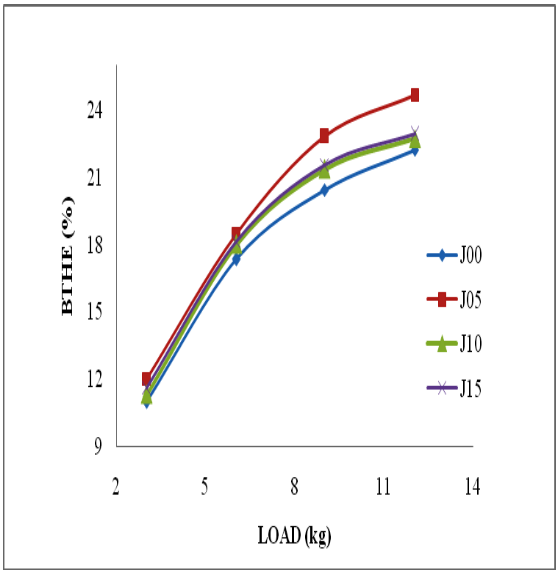


Fig. 4.3 Brake thermal efficiency against load at compression ratio 17

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

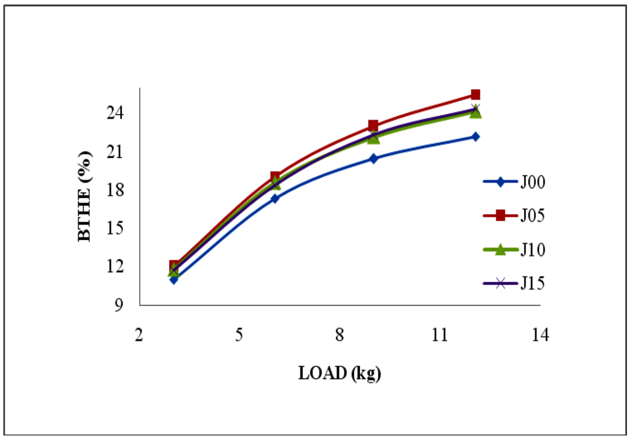


Fig. 4.4 Brake thermal efficiency against load at compression ratio 18

Fig. 4.1 to fig. 4.4 shows that the brake thermal efficiency improved with the increase in the load. This is due to increased temperatures inside the cylinder as load increase**s,** more fuel burning and less amount of heat loss. The J05 was found to be the best compared to diesel and all other blends at all loads.

Fig.4.5 to fig. 4.8 shows that for lower concentrations of biodiesels in the blends (J5, J10, J15) the brake power is very close to that of mineral diesel. The J5 blend was found to be the best compared to mineral diesel and all other blends. This may be due to extra amount of oxygen in J5, which might have resulted in improved combustion.

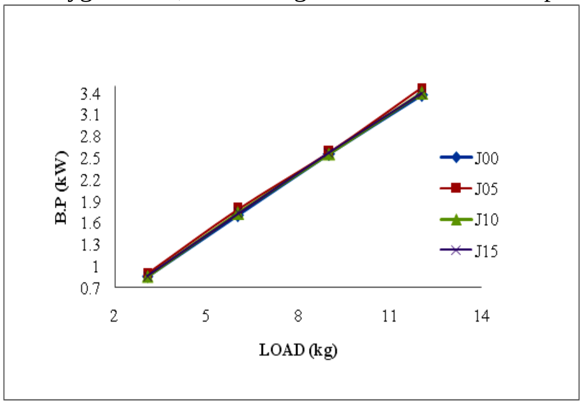


Fig. 4.5 Brake power against load at compression ratio 15

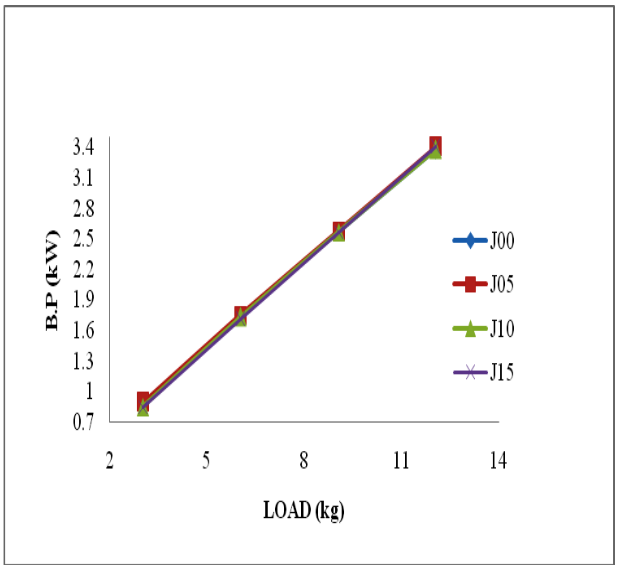


Fig. 4.6 Brake power against load at compression ratio 16

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

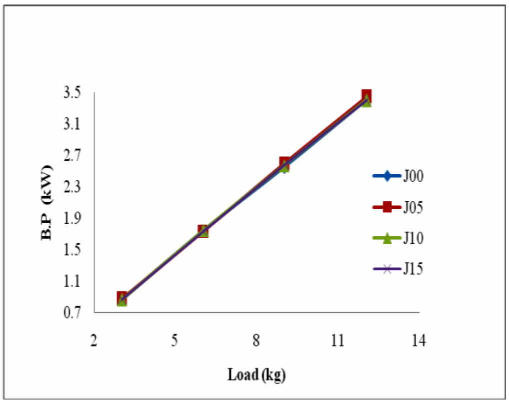


Fig. 4.7 Brake power against load at compression ratio 17

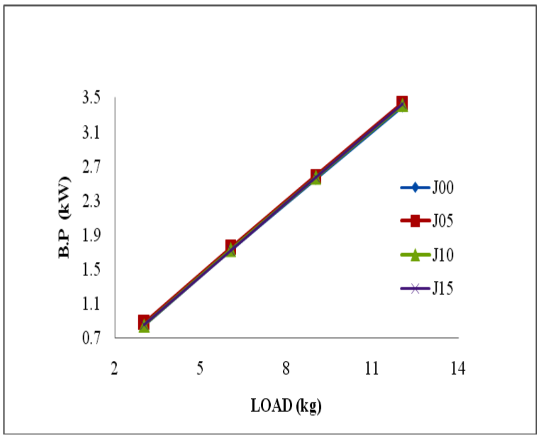


Fig. 4.8 Brake power against load at compression ratio 18

Fig.4.5 to fig.4.8 shows that the brake power improved with the increasing compression ratio. Increase in the compression ratio increases the temperature in the cylinder, reduces the ignition delay. The biodiesel blends have lower volatility compared to diesel, so at higher temperature their combustion characteristics improve. The J5 was found to be the best compared to diesel and all other blends at all compression ratio.The brake power improved with the increase in the load. This is due to increased temperatures inside the cylinder as load increases , more fuel burning and less amount of heat loss. The J5 was found to be the best compared to diesel and all other blends at all loads as seen from the figure. Fig.4.9 to fig.4.12 shows that for lower blends (J5, J10, J15) the brake specific fuel consumption is lower than mineral diesel. The oxygen present in the biodiesel might have helped in improved combustion of the blend. The J05 blend was found to be the best compared to diesel and all other blends. This may be due to extra amount of oxygen in J05 blend, which might have resulted in improved combustion.

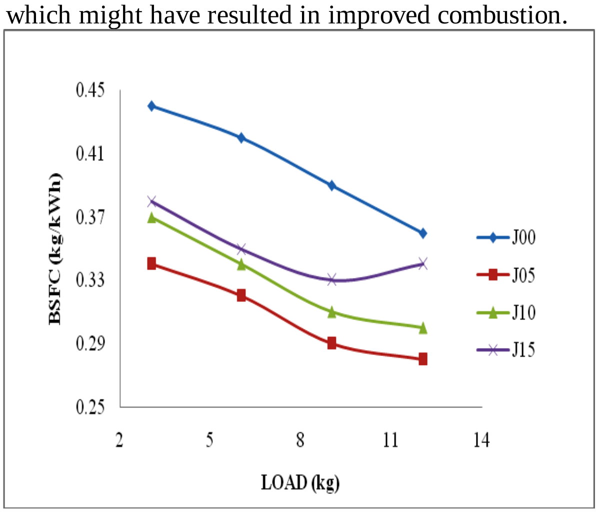


Fig. 4.9 Brake specific fuel consumption against load at compression ratio 15

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

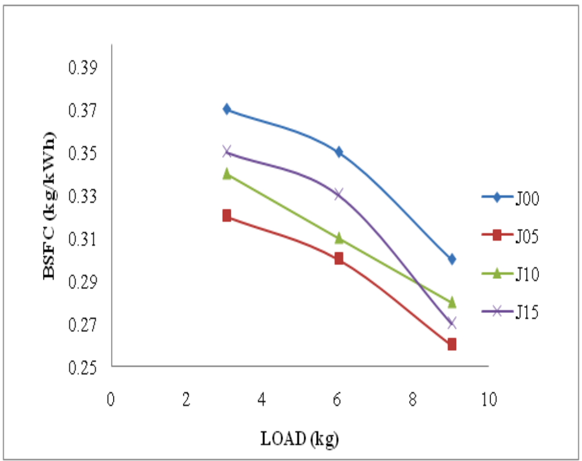


Fig. 4.10 Brake specific fuel consumption against load at compression ratio 16

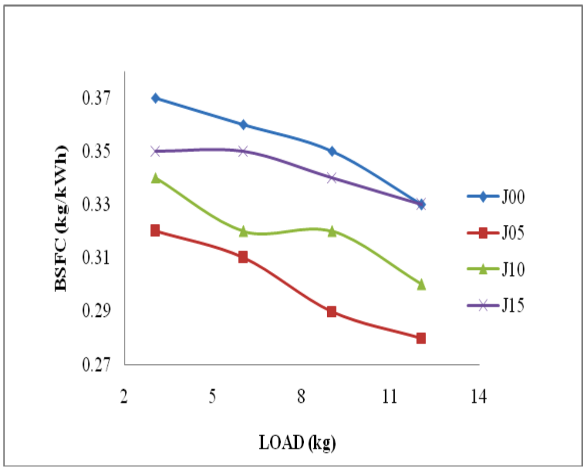


Fig. 4.11 Brake specific fuel consumption against load at compression ratio 17

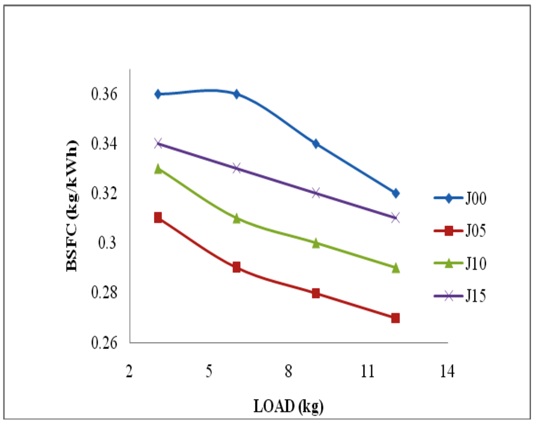


Fig. 4.12 Brake specific fuel consumption against load at compression ratio 18

Fig.4.9 to fig.4.12 shows that the brake specific fuel consumption decreases with increasing compression ratio. The results shows that increasing the compression ratio have more benefits than with pure diesel. Due to their low volatility and high viscosity biodiesels might be performing relatively better at higher compression ratio. The J5 blend was found to be the best compared to diesel and all other blends at all compression ratio. Fig.4.9 to fig.4.12 shows that the brake specific fuel consumption was observed to decrease with increase in load for all blends and pure diesel at any combination of compression ratio. The reason for this is that percent increase in fuel required to operate the engine is less than the percent increase in brake power due to less portion of the heat losses at higher loads. The J5 blend was found to be the best compared to diesel and all other blends at all loads.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
IARJSET
International Advanced Research Journal in Science, Engineering and Technology
2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)
Amrutvahini College of Engineering, Sangamner
Vol. 3, Special Issue 1, March 2016

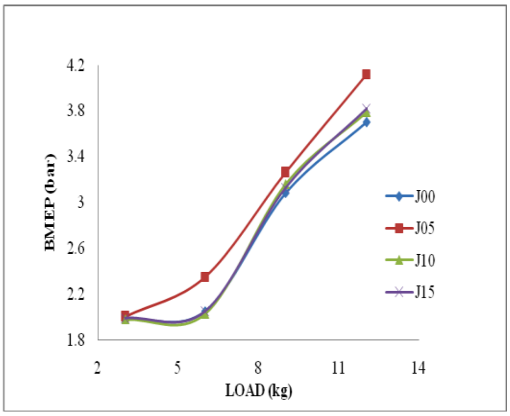


Fig. 4.13 Brake mean effective pressure against load at compression ratio 15

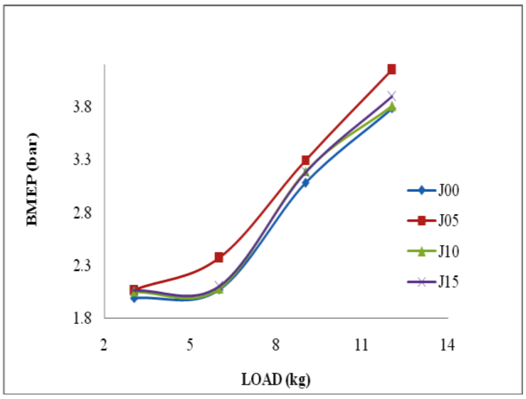


Fig. 4.14 Brake mean effective pressure against load at compression ratio 16

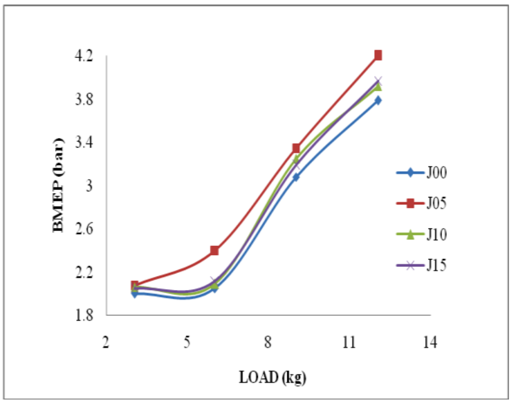


Fig. 4.15 Brake mean effective pressure against load at compression ratio 17

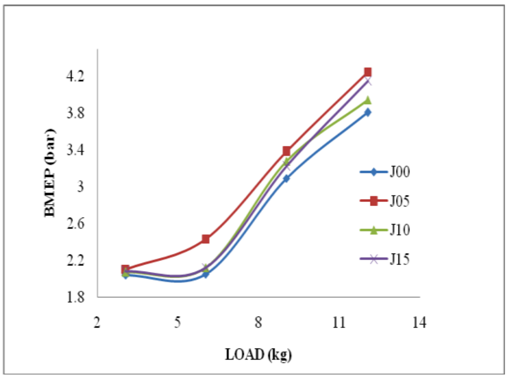


Fig. 4.16 Brake mean effective pressure against load at compression ratio 18

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
2nd International Conference on Advances in Mechanical Engineering (ICAME-2016)
Amrutvahini College of Engineering, Sangamner
Vol. 3, Special Issue 1, March 2016

Fig.4.13 to fig.4.16 shows that the brake mean effective pressure is a function of blend, load and compression ratio. The brake mean effective pressure increases with the increase of concentration of biodiesel in the blend. The best values are achieved for J5 blend. The brake mean effective pressure also increases with increasing values of load and compression ratio. The best values are achieved for J5 blend at all loads and compression ratio.

4.2 Effect of Various Fuels on Engine Exhaust Emissions

The effect of neat mineral diesel and various blends such as J5, J10, J15 on engine exhaust emission is shown in fig.4.17 to fig.4.19.

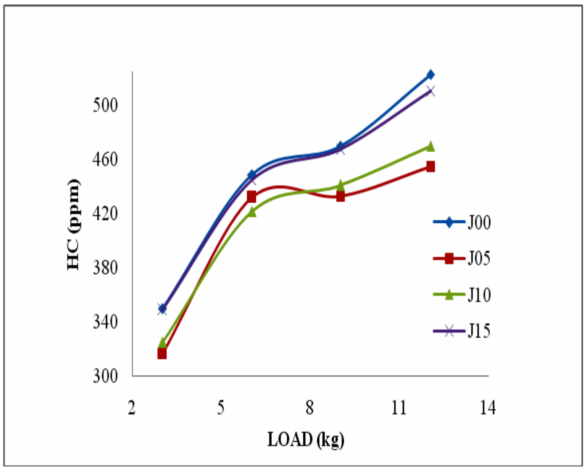


Fig.4.17 Effect of various fuels on HC emissions against load at compression ratio 18

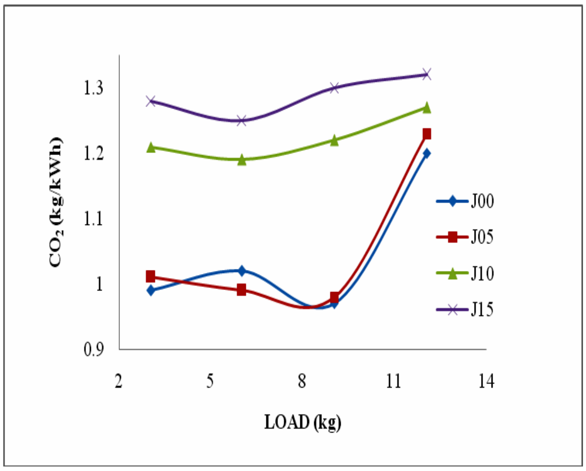


Fig.4.18 Effect of various fuels on CO_2 emission against load at compression ratio 18

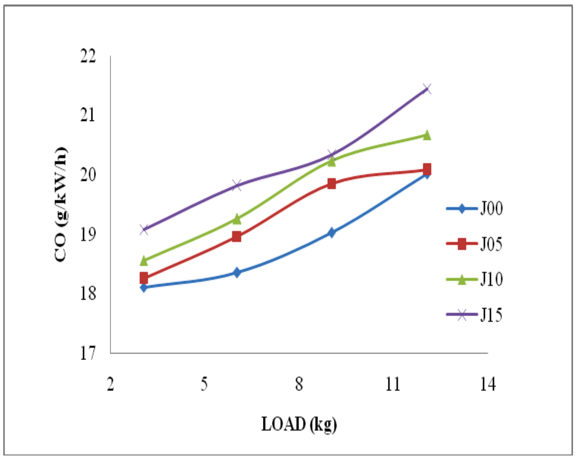


Fig.4.19 Effect of various fuels on CO emissions against load compression ratio 18

Fig.4.17 to fig.4.19 shows that HC emissions of all biodiesel blends were found to be very close to diesel at compression-18 and at various loads. The emissions were also observed to increase with the load. CO_2 emissions of all biodiesel blends were observed to be higher than diesel fuel at compression ratio 18. The emissions were also observed to increase with the load. CO emissions of all biodiesel blends were observed to be higher than diesel fuel at compression ratio 18. The emissions were also observed to increase with the load.

V. CONCLUSION

The main objective of the present investigation was to evaluate the suitable jatropha-diesel blend in terms of engine performance and emissions. The performance and emissions tests were conducted with diesel, and blends of jatropha oil at different loads and at constant speed (1500 rpm). From the experimental results obtained, jatropha oil blends are found to be a promising alternative fuel for compression ignition engines.

- The performance parameters such as brake thermal efficiency, brake power, brake mean effective pressure for all jatropha blends was found to be higher as compared to diesel.
- The brake thermal efficiency increased by 14.67%, brake power increased by 1.19% and brake mean effective pressure increased by 11.54% as compared to diesel at the compression ratio 18 and at load 12 kg for the blend J5. For the blend J10 the percentage increase in brake thermal efficiency, brake power and brake mean effective pressure is 8.83, 1.17, 9.67 respectively as compared to diesel. For the blend J15 the percentage increase in brake thermal efficiency, brake power and brake mean effective pressure is 9.59, 0.88, 8.92 respectively as compared to diesel.
- The brake specific fuel consumption decreases upto 15.62% for various blends of jatropha.
- CO_2 emissions increase in the range of 2.05% to 3.93% in comparison with pure diesel.
- CO emissions increase in the range of 0.34% to 3.77% in comparison with pure diesel.
- As seen from the result tables J5 blend was found to be the suitable blend as compared to the blends J10 and J15.

REFERENCES

[1]. Forson F.K., Oduro E.K., Hammond-Donkon E., “Performance of jatropha oil blends in a diesel engine”. Technical note, Renewable Energy, Vol.29, 2004, 1135-1145.
[2]. Venkateswara Rao T., Prabhakar Rao G. and Reddy K. Hema Chandra, “Experiemntal Investigation of pongamia, jatropha and Neem Methy Esters as Biodiesel on C.I. Engine”. JJMIE, Vol.2, 2008, 117-122.
[3]. Raheman H., Ghadge S.V., “Performance of diesel engine with biodiesel at varying compression ratio and ignition timing”. Fuel, Vol.87, 2008, 2659-2666.
[4]. Teerapong Baitiag, K Suwannakitiat Kong, Duangmukpanao Tanakorn, Sukjamsri Chamaiporn, Subongkoj Topaiboul and Nuwong Chollacoop, “Effects of Biodiesel and Jatropha oil on performance, Black smoke and durability of single – cylinder Diesel Engine”. Journal of Metals, Materials and Minerals, Vol.18, 2008, 181-185.
[5]. Agarwal Deepak, Agarwal Avinash Kumar, “Performance and emissions characteristics of Jatropha oil in a direct injection compression ignition engine”. Applied Thermal Engineering, Vol.27, 2007, 2314-2323.
[6]. Rakopoulos C.D., Rakopoulos D.C., Hountalas D.T., Giakoumis E.G., Andritsakis E.C., “Performance and emissions of bus engine using blends of diesel fuel with bio-diesel of sunflower or cottonseed oils derived from Greek feedstock.” Fuel, Vol.87, 2008, 147-157.
[7]. Alpttekin Ertan, Canakci Mustafa, “ Determination of the density nd the ciscosities ofn biodiesel - disel fuel blends”, Renwable Energy, Vol 33, 2008, 2623 – 2630.
[8]. Nagaraju V. and Henein N., Quader A. and M. Wu, “Effect of Biodiesel (B-20) on Performance and Emissions in a Single Cylinder HSDI Diesel Engine”. SAE Technical Paper Series, 2008-01-1401.
[9]. Tormos Bernardo, Novella Ricardo, Garcia Antonio, Gargar Kevin, “Comprehensive study of biodiesel fuel for HSDI engines in conventional and low temperature combustion conditions”. Renwable Energy xxx (2009) 1-11
[10]. Reddy J. Narayana, Ramesh A., “Parametric studies for improving the performance ofa Jatropha oil-fuelled compression ignition engine”. Renewable Energy 31 (2006) 1994–2016.
[11]. Banapurmath N.R., Tewar P.G., Hosmath R.S.‚ “Performance and emission characteristics of a DI compression ignition engine operated on honge, jatropha and sesame oil methyl esters”. Renewable Energy 33 (2008) 1982–1988
[12]. Agarwal D., Kumar L., Agarwal A.K., “Performance Evaluation of a vegetable oil fuelled CI Engine”. Renewable Energy accepted 29th June 2007.
[13]. Laforgia D, Ardito V. Biodiesel fuelled 1D1 engines: performances, emissions and heat release investigation. Bioresour Technol 1995;51:53-9.
[14]. Monyem A, Gerpen JV, Canakci M. The effect of timing and oxidation on emissions. Trans ASAE 2001;44(l):35-42.
[15]. Pandey K.C. Investigations on use of soybean oil as a substitute fuel for diesel engines. Unpublished PhD thesis, IT Kharagpur; 2005.