International Engineering Research Journal

Performance and Emission Analysis of Single Cylinder Diesel Engine by Using Jatropha Methyl Ester and Undi (Calophyllum Methyl Ester)

Amol Y. Kokare[1], Keshav M. Jadhav[2], Parshuram R. Chitragar[3].

Amol Y. Kokare, Student, Mechanical Engineering Department, VPKBIET,Baramati,
Keshav M. Jadhav, Assistant Professor, Mechanical Engineering Department, VKBIET, Baramati,
Parshuram R. Chitragar, Assistant Professor, Mechanical Engineering Department, VKBIET, Baramati.

Abstract

Now a day's, different nation facing the problem of shortage of energy. And different liquid fuels like kerosene, petrol, diesel is mostly used in industries, transport, agriculture, commercial and domestic sector. Running down of energy resources and environment awareness need to go towards renewable energy resources which is more reasonably priced and environmentally acceptable. Among many fuels, biodiesel considered are more desirable fuel. The world is facing a problem with the twin crises of fuel depletion and environmental degradation. Alternative fuel, conservation of energy and environment protection have become important in recent years.
The properties like flash point, fire point, cetane value, kinematic viscosity, specific gravity, calorific value were found at laboratory. To find the performance characteristic like brake thermal efficiency of single cylinder diesel engine by using diesel, blended Jatropha and blended Undi oil. Also emission of CO, HC, NOx ,smoke opacity is find out. Out of NOx is find 28% higher for Jatropha and 30% higher for Undi than Diesel.

Keywords: *Alternative Fuel, Undi, Jatropha, VCR Diesel Engine.*

1. Introduction

An invention of I.C. The engine has extremely increased energy demand. And this results deflection of petroleum reservoir across the world rapid rate as well as more combustion of fuel, the results rate of increase pollution and it's harmful to human and environment. So it needs to go towards substitute fuel like methane (CH_4), hydrogen (H_2) and vegetable oil. Again, it is found that biodiesel i.e. vegetable oil promise in these regards.

Since it can be produced from plants grounded in rural area and coastal area. How these are many varieties of vegetable oil evaluated in many parts of the world, but only a few vegetables like Karanja, Jatropla and Undioil can be considered is economical specially in India. But the use of direct end vegetable oil is restricted due to some of the Characteristic, density, viscosity, poor fuel atomization, carbon deposited, poor durability and poor thermal efficiency. This problem associated with direct vegetable oil is removed by using transesterification to produce biodiesel and is playing an important role to reduce viscosity of oil. [1]

Biodiesel is referred mono-alkyl ester of long fatty acid.A large number of experiments are carried on a single cylinder diesel engine by unit standard diesel and blend of Undi i.e. calophyllum inophyllum Linn oil 25,50,75,100 as well as the blends ofJatropha25,50,75,100.This study target to compare Jatropha and Undi oil in diesel engine characteristics is evaluated by using different blend.

2. Literature Review

Yamin et al. have studied biodiesel testing using four stroke, four cylinder diesel engine, which showed that the brake power and brake specific fuel consumption of biodiesel is slightly higher than that of normal diesel for both full and medium throat all over speed range.[1]

Singh et al. have tested a modified four stroke C.I. engine on pure biodiesel made from jatropha curcas oil for engine performance analysis, which may find large application in irrigation sector. By reducing viscosity of jatropha curcas oil, it will make close to that of conventional fuel so that it may find suitable use in C.I. engine for transportation and irrigation for the rural mass.[2]

Raju et al. have carried out an experimental investigation on a single cylinder variable compression ratio C.I. engine using pure Mahua oil as a fuel. Performance characteristics like brake thermal efficiency, exhaust gas temperature, fuel consumption and exhaust analysis were carried out to find the best suited compression ratio.[3]

B.K. Venkanna et al. A direct injection diesel engine typically used in agriculture sector was operated on neat diesel and H100. Injector opening pressure was changed to study the performance, emission and combustion characteristics. It was observed that increasing IOP with H100 from rated injector opening pressure increased the brake thermal efficiency and reduced CO,HC and smoke opacity emission. However, NOx emission was increased.[4]

3. Material and Method

The Jatropa curcase oil, Undi i.e. calophyllum inophyllum Linn oil is prepared by transesterification process and commercially available diesel.

3.1 Transesterification

Transesterification is a chemical process which converts triglycerides is a converted into mono alkyl ester of fatty acid and it is called as alcoholics. In this reaction fat or oil with alcohol convert biodiesel and glycerin. Catalyst is used in this reaction to faster the rate.

The seeds of Undi i.e. calophyllum inophyllum Linnand seeds of Jatropha were collected, cleaned and dried. The seeds are ground to convent fine powder by heavy duty electric motor. Then seeds powder mixed with a mixture of methanol and ethanol. The transesterificatiom with continuous stirring was carried at 400 RPM oscillation. Heat is given by hot plate to keeping 60^{0}C for about 60 minutes.The solid cake and mother liquor were separated by vacuum filtration A rotary evaporator was used to separated solvent. The oil fraction separator is about 800C and it is preserved in airtight container for further used and analysis purpose.

Transesterification of Undi and Jatropa was blended with diesel oil in varying proportion like 25, 50,75,100% it also reduces viscosity.Their blends as very stable under normal condition biodiesel oil preparation. [5]

3.2 Material Properties

Fuel properties of diesel and blended of Jatropa curcase L. Oil and Undi i.e. calophyllum inophyllum Linn oil are listed below. It has found out at laboratory of IBDC baramati. [5]

Table. 1*Material Properties*

Sr. No.	Test Description	Ref. STD. ASTM 6751-	Reference		Diesel	Jatropha methyl ester				Calophyllum methyl ester			
			Unit	Limit	B00	B25	B50	B75	B100	B25	B50	B75	B100
1	Density	D 1448-1972	kg/m3	850-900	830	835	846	858	871	832	845	856	868
2	Viscosity	D 445-73	Cst	3.0-6.1	2.9	3.6	4.1	4.6	5.9	3.2	3.8	4.56	5.7
3	Cetane Number	D 613	-	41-55	51	51.3	51.4	52.4	52.91	51.2	51.4	52.3	53
4	Calorific value	D 6751	MJ/kg	34-45	42.5	41.3	41.18	40.1	38.55	41.4	41.16	40	39.17
5	Ash Content	D 482	-	0.1 max	0.10	NA	NA	NA	0.51	NA	NA	NA	0.51
6	Flash point	D 93	-	120-170	65	76	108	130	147	74	105	124	138
7	Fire point	D 93	-	130-185	69	82	114	137	152	78	111	129	145
8	Acid Value	EN 14101	mgKOH	0-0.1	NA	NA	NA	NA	0.75	NA	NA	NA	0.75
9	Moisture	D 2709	% vol.	0.05 max	NA	NA	NA	NA	NA	NA	NA	NA	NA

3.3 Experimental Setup and Test Procedure:

A single cylinder, four stroke diesel engines, bore diameter 80 mm, rated power developed 3.7 kW at 1500 RPM, compression ratio 5 to 20, stroke length 110 mm, cylinder diameter of 87.5mm, connecting rod length 150 mm, compression ratio 12:18, water cooled. Indus five gas analyzer was used for measurement of carbon monoxide, CO, Hydrocarbon HC, NOx emission. The engine was operated on baseline diesel first, then on a blend of Jatropa curcase L. Oil and Undi i.e. calophyllum inophyllum Linn oil. The different fuel blend and diesel are subjected to performance and emission test on an engine with a different load range and compression ratio. Then performance data are analyzed from the graphs regarding brake thermal efficiency, brake specific fuel consumption, emission etc. [6]

4. Result and Discussion

A number of engine test is carried out by using standard diesel and different blends of Jatropa curcase L. oil and Undi i.e. calophyllum inophyllum linn oil like BJ25, BJ50, BJ75, BJ100, BU25, BU50, BU75 and BU100. Performance and emission data is carried out by different blend of biodiesel by Jatropa curcase L. Oil and Undi i.e. calophyllum inophyllum Linn oil and is compared with baseline data of standard diesel which shown below. [7]

4.1 Brake Thermal Efficiency

Brake thermal efficiency (BTE) is the most important parameter which denotes how much percentage of energy present in fuel and which can be converted into useful work. The comparative analysis of BTE of various blended of Jatropa curcase L. Oil and Undi i.e. calophyllum inophyllum Linn oil with diesel (BJ25, BJ50, BJ75, BJ100, BU25, BU50, BU75 and BU100) standard baseline diesel is shown in the fig. 1. BTE of Jatropa curcase L. Oil and Undi i.e. calophyllum inophyllum Linn oil are lower than diesel for whole load range. The decreasing trends of efficiency as increase concentration of blends due to lower calorific value of biodiesel. It may also cause by its poor atomization because of high viscosity.[7]

4.2 Brake Specific Fuel Consumption

The break specific fuel consumption is not considerable parameter due to different blends are having calorific value and densities are different.

3.2 Unburned Hydrocarbon HC Emission

Unburned HC emission is one of the important parameter to determine the behavior of the engine. The biodiesel blend gives relatively Low HC as compared to the diesel. This is because better combustion of biodiesel inside the combustion chamber due to availability of excess content of oxygen in biodiesel as compare to diesel as shown in fig. 2. Also observed that HC emission of the various blends is low at partial load and increased at high load. This is due to the availability of less oxygen for the reaction when more fuel is injected into the engine at higher load.[7]

4.3 Carbon-monoxide, CO Emission

Carbon monoxide emission occurs due to the incomplete combustion of fuel. Biodiesel blends give less CO due to complete combustion. When the percentage of blends of Jatropa curcase L. Oil and Undi i.e. calophyllum inophyllum Linn oil increases, emission of CO decreases as shown in fig. 3. Co emission is toxic. The more amount of oxygen present in biodiesel results in complete combustion of fuel and it will supply necessary oxygen convert CO to CO2.[7]

4.4 Emission of NOx

NOx is one of the important emission factors because it creates problems such as cough, asthma, etc. NOxemission is more for biodiesel as compare with diesel because of more oxygen is present and it will faster the rate of reaction and hence the temperature of combustion is reached high. NOx emission is high at high output conditions in both of Jatropa curcase L. Oil, Undi i.e. calophyllum inophyllum Linn oil and diesel is shown in fig. 4. [8]

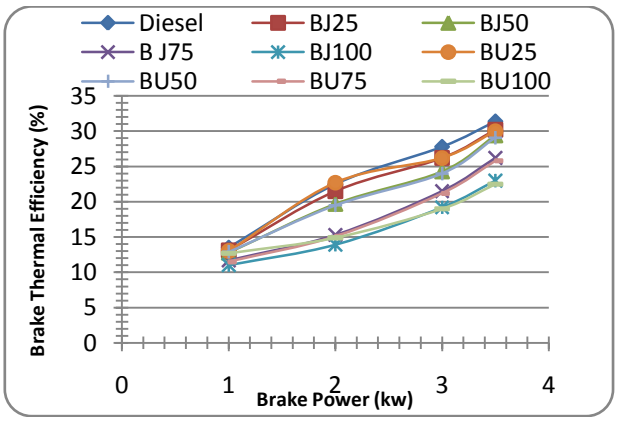

Fig. 1*Variations of BTE with brake power*

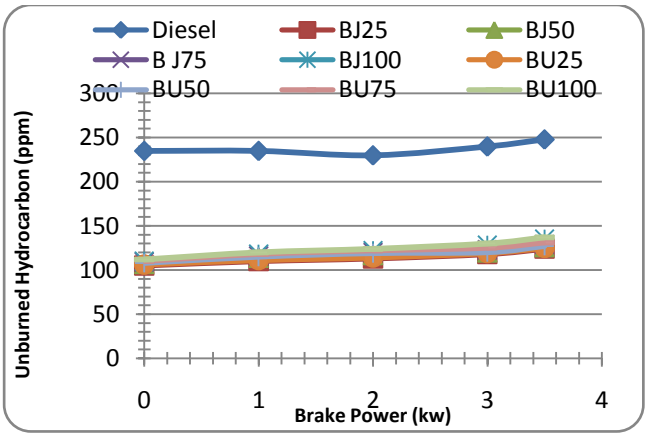

Fig. 2.*Variation of Unburned Hydrocarbon with brake power*

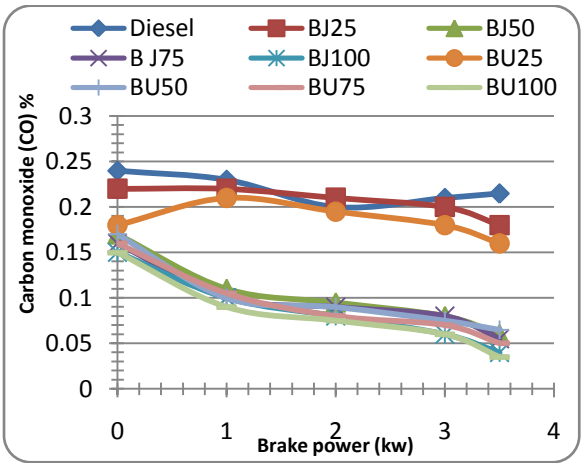

Fig. 3 *Variability of Carbon monoxide with brake power*

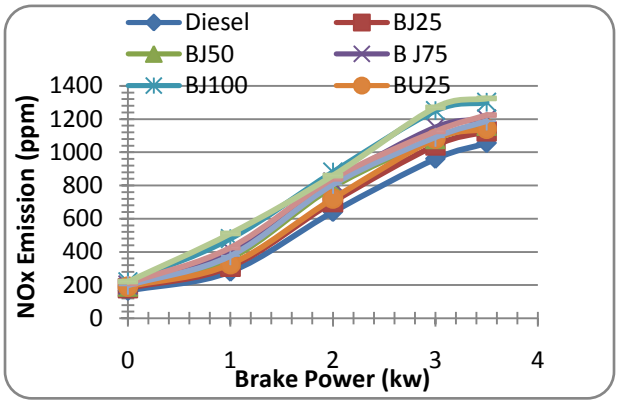

Fig. 4 *Variation of Oxide of Nitrogen (NOx) with brake power.*

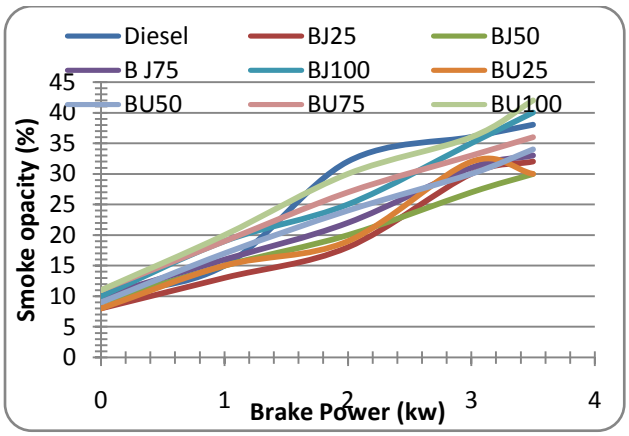

Fig. 5 *Variation of Smoke opacity with brake power*

3.6 Emission of Opacity

Emission opacity means smoke is produced due to incomplete combustion of fuel. In case of Jatropa curcase L. Oil and Undi i.e. calophyllum inophyllum Linn oil smoke produced less as compared to diesel due to complete combustion because more oxygen is present. Now, as thepercentage of blends increase from B15 to B100 for both of Jatropa curcase L. Oil and Undi i.e. calophyllum inophyllum Linn oil, smoke density are reduced. Variation of smoke emission with brake power is shown in fig. 5.

4. Conclusion

The performance of the engine and emission characteristic of Jatropa curcase L. Oil and Undi i.e. calophyllum inophyllum Linn oil are analyzing with standard baseline diesel. It is found that, brake thermal efficiency is 22% lower forBJ50 and 24% lower for KU50 of Jatropa curcase L.Oiland Undi i.e. calophyllum inophyllum Linn oil as compared with diesel. Co, HC, and smoke emission are also lower for biodiesel as compare with diesel. An emission of NOx is 28% higher for Jatropa curcase L. Oil and 30% for Undi i.e. calophyllum inophyllum Linn oil than standard baseline diesel.

Reference

[1] A. YAmin, A.Jehad, Nina Sakhnin. Ahmed Sakhrieh (2009), “Performance of C.I. engine using biodiesel as a fuel”, Amman-Jorden, GCREEDER.

[2] Indraj Singh and Vikas Rastogi (2009), “Performance analysis of modified four-stroke engine using biodiesel fuel for irrigation purpose”, International Journal of applied environmental sciences, ISSN 0973-6077, Volume 4, No. 2.

[3] V. Ramachandra Raju, GVNSR Ratnakar rao and M. Murlidhar Rao (2008), “Optimizing the compression ratio for diesel fuelled C.I. Engine”, ARPN Journal of engineering and applied sciences, Volume 3, No. 2.

[4] B.K. Venkanna et.al., “Influence of injector opening pressure on the performance, emission and combustion characteristics of DI diesel engine running on calophyllum inophyllum linn oil (hone oil)”,Int. Jou. Of Ren. Ene., 6(1), 2011.

[5] Harrington KJ. Chemical and physical properties of vegetable oil ester and their effect on diesel fuel performance. Biomass 1986; 1-17.

[6] Sahoo PK, Das LM (2009). Combustion analysis of jatropha, Karanja and plunge based biodiesel as a fuel in a diesel engine Fuel 88:994-999.

[7] Tamilvendham D. “Performance, emission and combustion characteristic of a methyl ester sunflower oil, eucalyptus oil in a single cylinder, air cooled and direct injection diesel engine”, International Journal of Engineering Science and Technology, Vol. 3 No.3 March 2011.

[8] W. Yuan, “Computational Modeling of NOx Emission from Biodiesel Combustion Based an Accurate Fuel Properties:, research paper for PhD students, Pennsylvania, Urbana, 2005.