International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Influence of Madhuca Longifolia Biodiesel Blends on Diesel Engine Characteristics

G. Jamuna Rani, Y. V. Hanumantha Rao, B. Balakrishna

Abstract*: *In daily life the demand for fuel is increasing and there is a need to find alternate fuels to overcome the environmental pollution problems. In this present study, experimentation was done on a diesel engine, at a speed of 1500 rpm by varying load from 0% to 100% using diesel and Madhca Longifolia biodiesel blends and the results were analysed to know the engine behaviour. Madhuca Longifolia biodiesel was prepared by using the acid catalyst method followed by transesterification process and then the tested biodiesel blended fuel samples MLB25, MLB0, MLB75, MLB100 were prepared by adding Madhuca Longifolia biodiesel in the rate of 25, 50, 75, 100 for diesel on volume basis. From the aquired results It was perceived that the performance of the engine was improved with MLB25 fuel sample compared to all other biodiesel blend fuel samples. And for all biodiesel blend fuel samples, the exhaust emissions like unburned hydrocarbons (ubhc), carbon oxide (CO), Smoke were reduced compared to the diesel and nitrogen oxide emissions (NOx) were increased slightly compared to diesel fuel. From the observed results, the MLB25 fuel sample suggested as alternate fuel in diesel engines in place of conventionsl diesel.

Keywords: Bio-diesel blends, CI engine, Madhuca longifolia, Efficiency, emissions

I. INTRODUCTION

Now a day the population of the world is increasing and the availability of fossil fuels has been reduced by increased consumption. Due to this there is a necessicity, to find alternate fuel resources. One of the available alternate sources is biofuels and they are renewable (Masimalai S.K. , 2010), inflammable, less toxic and causes less emissions (Sims R.E., 2010). As there is increase in use of un conventional sources which decrease the availability of fuels, the biodiesels are introduced for reduction of emissions and reduction of climatic change. Biofuels extracted from plants could be edible oils (groundnut, sunflower, sesame oil etc) and non edible oils (Karanja, Pongamia, Jatropa, Rubber seed oils etc). The effect of WB5 & WB20 Waste cooking oil biodiesel blends on CI engine was investigated (Wail M. Adaileh et al, 2012) and notified that the emissions were reduced. The performance of DI engine was investigated using Caster seed oil (NL Panwar et al, 2010) and observed better performance results. T. Senthil Kumar, et al (2015) studied the performance of the DI engine using Kapok methyl ester blends and persisted that the performance of the engine was improved and the emissions were reduced. The impact of soybean oil on the DI engine was studied (Özener .O, et al, 2014) by varying speed from 1300 rpm - 3000 rpm and with different blend ratios and inferred that the HC and CO emissions were reduced. Venkanna B.K, et al 2015 conducted experiments on diesel engine using Honna oil by varying the blend percentage from H10 to H50 with an increment of 10% and noticed that H20 fuel blend results were very close to diesel fuel. Trails were conducted on 1-cylinder CI engine with Kapok biodiesel blended in the proportion of K20 and K50 (Vedharaj, et al, 2013) and the audited results were analysed. From their observations they persisted that, both K20 and K50 fuel blends were giving better results compared to the diesel fuel. Dinesh K, et al, 2016 studied the engine characteristics by using Tamanu oil biodiesel blends and inferred that the emissions were reduced and the performance was improved in considerable range with the use of biodiesel as fuel. Jatin.s, et al 2011 studied about jatropa biodiesel blends oxidation stability with diesel fuel and persisted that jatropa biofuel could be used to run diesel engines. The performance & emissions of diesel engine was investigated (Thangavelu Mathimani, et al, 2016) using chlorella vulgaris biodiesel in proportions of B40 and B50 and the results are on par with diesel fuel. A. Sanjid, et al, (2014) investigated the mxed effect of jatropa-palm oil blends on the DI engine and proposed that biofuels are the alternative fuels for diesel. The JBD30A30C fuel having 31% BTE while neat diesel having 32%, the reduction of NO, CO and UBHC were decreased by 13%, 60%, and 33% for JBD30A30C fuel when compared to neat diesel (A. Prabu et al 2015). The SFC and BTE of micro algae biodiesel were lower than automobile gas oil. All samples of micro algae given very close emission values between them and lower than AGO (automobile gasoline oil) (Eloka et al, 2017) and suggested as an alternative to diesel. In this work, Madhuca Longifolia biodiesel blends (MLB25, MLB50, MLB75, MLB100) were tested on DI diesel engine.

II. MATERIALS AND METHODS USED

Madhca Longifolia is a non - edible seed available more in India at dry areas. The oil was acquired by cold pressing of

Revised Manuscript Received on March 30, 2020.
* Correspondence Author
G. Jamuna Rani*, Department of Mechanical Engineering, VR Siddhartha Engineering College, Vijayawada, AP, India E-mail: jamunarani.g@gmail.com
Y.V.Hanumatha Rao, Department of Mechanical Engineering, Koneru Lakshmaiah Education Foundation,Vaddeswaram, Andhra Pradesh, India. E-mail: rao_yvh@yahoo.co.in
B. Balakrishna, Department of Mechanical Engineering, Jawaharlal Nehru Technological University, Kakinada, Andhra Pradesh, India. E-mail: balakrishnajntu06@gmail.com.

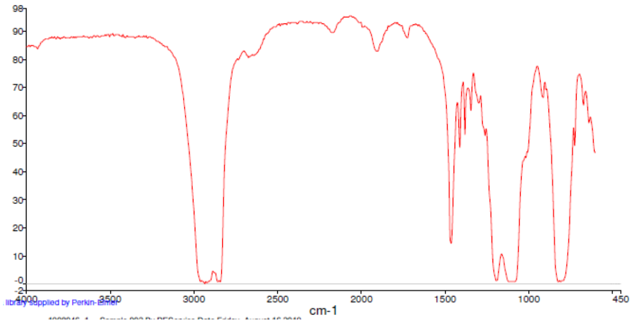

Fig.1. FT-IR analysis of Madhuca Lonifolia raw oil

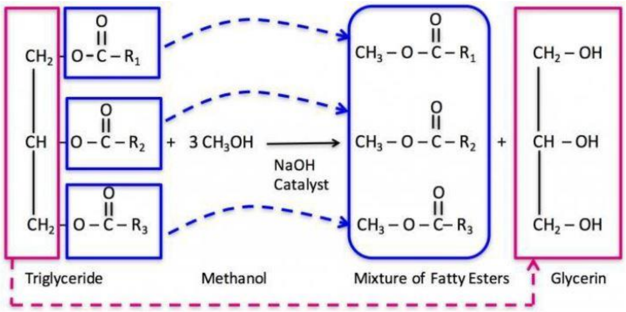

Fig.2. Transestrification Chemical reaction.

the seeds as they contain 80% of the oil. The raw oil is not suggested to use directly in engine as it contains fatty acids. Madhca Longifolia contains greater quantity of (20%) fatty acids, not suitable to run the engine. So, to convert the raw oil to usable biodiesel, the fatty acids have been removed by acidic esterification followed by transesterification. The raw Madhuca Longifolia oil characterization was done by using FT-IR analysis and is dislayed in Fig.1.

Table - 1: Two step process of producing biofuel

Acid-Catalysed Esterification	Base-catalysed transesterification
Mahua oil 1000 ml	Methanol 0.25 v/v
Preheated temperature 100 °C	KOH pallets 0.7%
Methanol 0.35 v/v	Magnetic stirring at 500 rpm
Sulphuric acid 1% v/v	Temperature for reaction 60 °C
Magnetic stirring at 500 rpm	Time for Reaction 1 h
Temperature for reaction 60 °C	Time for separation 12 h
Time for reaction 1 h	
Time for separation 10 h	

Fig.3. Tested Engine setup

The different steps followed to prepare MLB100 biofuel from raw oil by using acid catalysed method followed by base catalysed method are presented in Table 1. Basic reactions taking place chemically in the trasestrification process are shown in Fig.2. The biodiesel blends (MLB25, MLB50, MLB75) were prepared by adding transesterfied biofuel to diesel in different proportions of 25 ml MLB and 75ml diesel (MLB25), 50 ml MLB and 50 ml diesel (MLB 50) and 75ml MLB and 25 ml diesel (MLB 75) on volume basis. MLB 100 means 100 ml Madhuca Longifolia biofuel and 0 ml diesel.

Fig.4. Gas Analyser and Smoke meter

The tested engine setup is shown in Fig. 3. And the enumerations of the engine are tabulated in Table 2. The emissions (UBHC, CO, NOX) were measured by using five gas analyser and ad the smoke emissions were measured by using a Smoke opacity meter. 5-gas analyser, (AVL 444N) and smoke meter are displayed in Fig. 4.

Table-2: Basic fuel properties of tested fuel samples

Fuel Sample	Density @15°C in kg/m^3	Flash point (°C)	Fire point (°C)	Calorific value (KJ/kg)
Diesel	840	58	62	42400
MLB 25	853	65	72	38549
MLB50	857	66	74	37267
MLB75	864	68	75	36875
MLB100	870	69	78	36462

Table-3: Specifications of tested engine

Engine Type	1 cylinder, 4 stroke Diesel, water cooled
Compression ratio	17.5
Rated power	5.2kW at 1500 rpm
Bore & stroke	87.5 mm & 110 mm
Cubic Capacity	661 cm^3
Orifice diameter	20 mm
Dynamo meter	Eddy current Type

Inaccuracy possibility in measuring different parameters is shown in Table 4.

Table 4. Instruments accuracy and percentage uncertainties

Instrument	Accuracy	Percentage of uncertainties
Smoke meter	± 1%	± 1
Exhaust Gas Analyzer • CO • HC • NOx	 ± 0.2% ± 8ppm ± 5ppm	 ±0.2 ±0.3 ± 0.1
Exhaust gas temperature indicator	± 4°C	±0.2
Pressure transducer	±0.1MPa	± 1
Load indicator	± 0.1 Kg	±0.2
Speed indicator	± 10rpm	±0.1
Fuel Measurement	± 0.2 cc	±1.5

III. RESULTS AND DISCUSSIONS

The engine was tested by using diesel, MLB25, MLB50, MLB75, MLB100 fuel samples at different percentages of load (0%, 25%, 50%, 75% & 100%) running at 1500 rpm constanst speed and the noted results were analysed.

A. *Effect of MLB blends on engine Performance*

Fuel samples diesel, MLB25, MLB50, MLB75 and MLB100

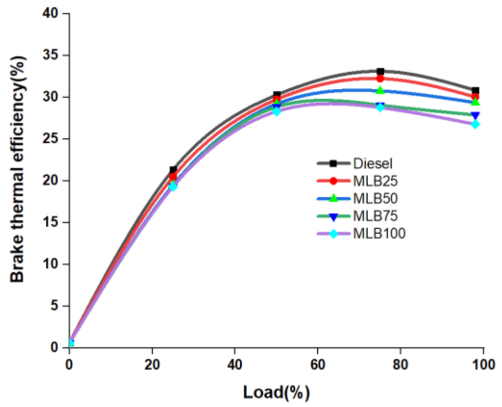

Fig. 5(a). Change in Brake thermal efficiency with load %

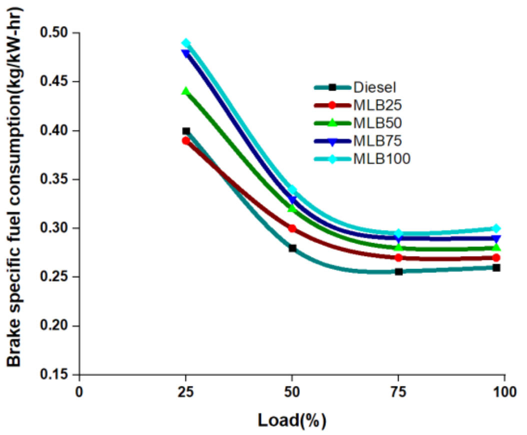

Fig. 5(a). Change in BSFC with load %

MLB100 were used to test the brake thermal efficiency of the engine and the graphs were plotted as shown in fig 5 (a) .

Brake thermal efficiency (BTE) is to measure of power out of engine from the chemical reaction taken by the heating of fuel.

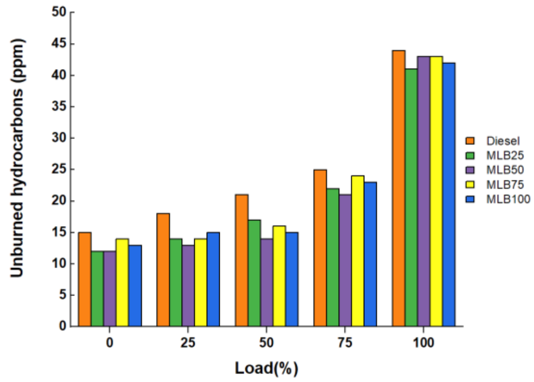

Fig. 6(a). Variation of ubhc with load %

From the graph, it was noticed that the brake thermal efficiency of the engine was good with the fuel sample MLB25 compared to all other biodiesel blends (MLB50,MLB75 and MLB100) due to less viscosity.

As the percentage of biodiesel blend increases the BTE decreases due high viscosity and poor fuel spray properties [15]. BTE measures the fuel conversion to heat and useful power output [16]. The BTE values for MLB25 fuel sample was very near to the diesel fuel BTE, compared to other biodiesel blends.

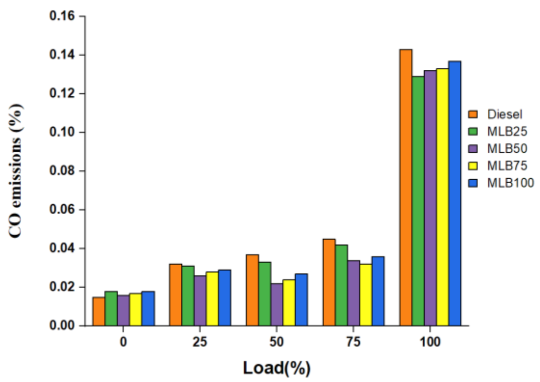

Fig. 6(b). Variation of CO emissions with load %

The variation of the BSFC, with diesel, MLB25, MLB50, MLB75, MLB100 fuel samples is shown in fig 5(b) The BSFC must be reduced for better performance of the engine. For all fuel samples MLB25, MLB50, MLB75 and MLB100 was increased than the diesel fuel sample due to less calorific value. Of all biodiesel blends, the BSFC for fuel sample MLB25 was lesser than the other biodiesel blends. BSFC increases as the percentage of biodiesel increases [17].

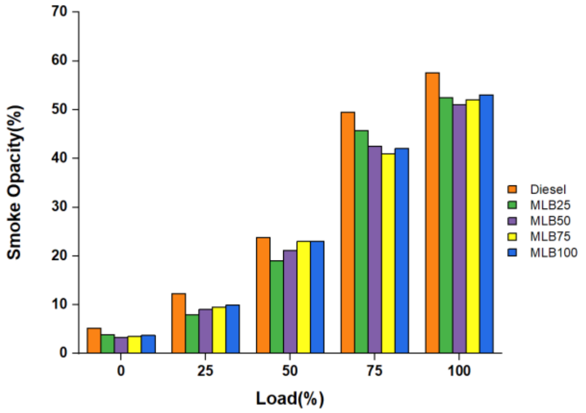

Fig. 6(c). Variation of Smoke opacity with load %

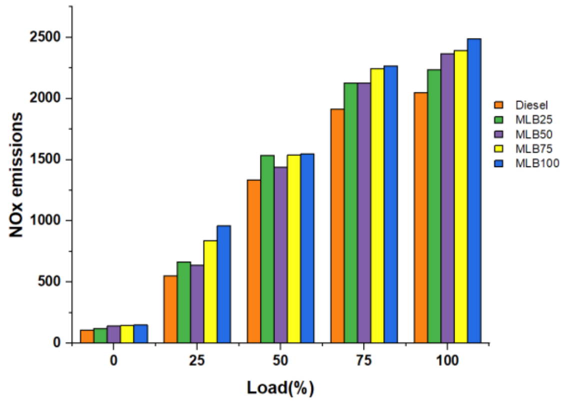

Fig. 6(d). Variation of NOx emissions with load %

B. Effect of MLB blends on the engine emissions

Emissions are harmful to the human health and causing problems related to the respiratory system of humans. The emissions of the engine using diesel , MLB25, MLB50, MLB75, MLB100 fuel samples were observed using five gas analyser and smoke meter.

And the graphs are drawn for the variation of emissions with varying percentage of load for all the fuel samples. The change in hydocarons, CO%, and Smoke emissions with change in load % is shown in fig 6 (a), 6(b) & 6(c) respectively .

The change in NOx emissions with change in load % are shown in 6(d). It was noticed that with the increasing load, the ubhc, CO, Smoke and NOx emissions also increased for all the tested fuel samples. At peak load, the unburned hydrocarbon emissions for diesel, MLB25, MLB50, MLB 75 and MLB100 are 44 ppm, 41ppm, 43ppm, 43ppm, 42ppm respectively. CO emissions and smoke was reduced for MLB25 to the diesel due to the complete combustion and oxygen presence in the MLB25. For MLB25, NOx emissions were increased than the diesel fuel due to the increase in combustion chamber temperature and it is further increased for the fuel blends MLB50, MLB75 and MLB100.

III. CONCLUSION

Experiments were carried out using diesel, MBL25, MBL50, MBL75, and MBL100 fuel samples and the following observations were concluded

a. Brake thermal efficiency for the fuel sample MLB25 was reduced by 2.6% and the brake specific fuel consumption was increased by 3.9 % compared to the diesel fuel.

b. HC emissions, % CO and Smoke emissions for MLB25 fuel sample was reduced by 6% , 9.7%, 8.8% compared to the diesel fuel. But the NOx emissions for MLB25 fuel sample was increased by 9% compared to diesel.

From the observed results, it can be proposed that MLB25 can be suggested as an alternative fuel for diesel engine.

ABRIVATIONS

ML : Madhuca Longifolia biofuel
NOx : Nitrogen oxide
MLB25 : 25% ML + 75% Diesel
MLB50 : 50% ML + 50% Diesel
MLB100 : 100% ML + 0% Diesel
BTE : brake thermal efficiency
ubhc : unburned hydrocarbons
BSFC : Brake specific fuel consumption
CO : Carbon monoxide

REFERENCES

1. Masimalai, Senthil Kumar. Preparation, characterization and engine test analysis of methyl esters of unrefined palm oil and d-limonene oil mixture as CI engine fuel. No. 2010-01-2121. SAE Technical Paper, 2010.
2. R. E. H. Sims, W. Mabee, J. N. Saddler, M. Taylor, An overview of second generation biofuel technologies. Bioresource Technology. 101, 2010, pp. 1570–1580.
3. W. M. Adaileh, K. S. Alqdah, in Energy Procedia (Elsevier BV, 2012), vol. 18, 2012, pp. 1317–1334.
4. N. L. Panwar, H. Y. Shrirame, N. S. Rathore, S. Jindal, A. K. Kurchania, Performance evaluation of a diesel engine fueled with methyl ester of castor seed oil. Applied Thermal Engineering. 30, 2010, pp 245–249.
5. T. Senthil Kumar, P. Senthil Kumar, K. Annamalai, Experimental study on the performance and emission measures of direct injection diesel engine with Kapok methyl ester and its blends. Renewable Energy. 74, 2015, pp 903–909.
6. O. Özener, L. Yüksek, A. T. Ergenç, M. Özkan, Effects of soybean biodiesel on a DI diesel engine performance, emission and combustion characteristics. Fuel. 115, 2014, pp 875–883 .
7. B. K. Venkanna, C. Venkataraman Reddy, Performance, emission, and combustion characteristics of a diesel engine running on blends of honne oil and diesel fuel. International Journal of Green Energy. 12, 2015, pp 728–736.
8. S. Vedharaj et al., Experimental investigation of kapok (Ceiba pentandra) oil biodiesel as an alternate fuel for diesel engine. Energy Conversion and Management. 75, 2013, pp 773–779
9. K. Dinesh, A. Tamilvanan, S. Vaishnavi, M. Gopinath, K. S. R. Mohan, Biodiesel production using Calophyllum inophyllum (Tamanu) seed oil and its compatibility test in a CI engine. Biofuels, 2016, pp 61–7.
10. S. Jain, M. P. Sharma, Oxidation stability of blends of Jatropha biodiesel with diesel. Fuel. 90, 2011, pp 3014–3020
11. T. Mathimani, T. Senthil Kumar, M. Chandrasekar, L. Uma, D. Prabaharan, Assessment of fuel properties, engine performance and emission characteristics of outdoor grown marine Chlorella vulgaris BDUG 91771 biodiesel. Renewable Energy. 105, 2017, pp 637–646 .
12. A. Sanjid et al., Production of palm and jatropha based biodiesel and investigation of palm-jatropha combined blend properties, performance, exhaust emission and noise in an unmodified diesel engine. Journal of Cleaner Production. 65, 2014, pp 295–303.
13. A. Prabu, R. B. Anand, Emission control strategy by adding alumina and cerium oxide nano particle in biodiesel. Journal of the Energy Institute. 89, 2016, pp 366–372 .
14. A. C. Eloka-Eboka, F. L. Inambao, Performance and emission profile of micro-algal biodiesel in compression ignition engine. International Journal of Engineering Research in Africa. 30, 2017, pp110–124 .

Retrieval Number: E2158039520/2020©BEIESP
DOI: 10.35940/ijitee.E2158.039520
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

15. O. Armas, K. Yehliu, A. L. Boehman, Effect of alternative fuels on exhaust emissions during diesel engine operation with matched combustion phasing. Fuel. 89, 2010, pp 438–456 .
16. N.Saravanan, G. Nagarajan, and Sukumar Puhan. "Experimental investigation on a DI diesel engine fuelled with Madhuca Indica ester and diesel blend." *Biomass and Bioenergy* 34, no. 6 , 2010:, pp838-843.
17. B. S. Chauhan, N. Kumar, H. M. Cho, A study on the performance and emission of a diesel engine fueled with Jatropha biodiesel oil and its blends. Energy. 37, 212, pp 616–622.

AUTHORS PROFILE

Mrs G. Jamuna Rani is working as Assistant professor in VRSEC, and Research scholar in JNTUK. She has more than ten technical papers with indexing in database. Her areas of interests are IC Engines and Alternative fuels.

Dr.Y.V.Hanumatha Rao, working as a professor in Dept. of Mechanical Engg. KL University, AP. He is having 25 years of academic, research and administrative experience. He has published 35 research publications from various journals with good impact factor. His areas of interest are Alternate fuels, Heat Engines & Refrigeration.

Dr. B. Balakrishna is currently Principal of the university college of Engineering, JNTUK, Kakinada. He is having 25 years of academic, research and administrative experience. He has published more than 30 research papers with a good number of citations.