Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 09, September-2019

Comparison of Engine Performance Characteristics of a Single Cylinder 4-Stroke Diesel Engine with Blends of Cottonseed, Jatropa and Mahua Biodiesel

Praveen Kumar. M. R
Department of Mechanical Engineering
Bangalore Institute of Technology
Bengaluru, Karnataka, India

Dr. S. Vidyashankar
Vice Chancellor
Karnataka State Open University,
Mysore, Karnataka, India

Dr. Shivappa
Department of Mechanical Engineering,
Dr. SMCE,
Bengaluru, Karnataka, India

S Puneeth
Abhiyantrana Technologies,
Bengaluru, Karnataka,
India

Abstract*-In this study, the biodiesel produced from non-edible oils like cottonseed, jatropa and Mahua oils are prepared by a method of alkaline catalyzed transesterification. The study is carried out to investigate the engine performance characteristics of selected fuel in a stationary single cylinder, four stroke, naturally aspirated direct injection diesel engine. The engine performances (Brake Thermal efficiency, Brake Specific Fuel Consumption, Brake Power, and Exhaust Gas Temperature) are evaluated. Blends of 25%, 50%, 75% and 100% Biodiesel are used for comparison in the present work with loads varying from 0 to 100% (i.e., stalling load). The results obtained Jatropa oil methyl Ester has a better performance characteristic, except Exhaust Gas Temperature, than cottonseed and Mahua oil methyl esters. The experimental study indicates that Jatropa biodiesel can be used as a fuel in compression ignition engine without any engine modification when compared to the other biodiesel blends.

Keywords-Biodiesel, Performance characteristics, Cottonseed, Jatropa, Mahua, Comparative analysis

I. INTRODUCTION

Vegetable oil is one of the alternatives which can be used as fuel in automotive engines either in the form of straight vegetable oil, or in the form of ethyl or methyl ester. The energy needs of the world are increasing rapidly. The decrease in fossil fuels, emission pollution caused by them and increasing fuel prices make biomass energy sources more attractive. The increase in energy demand and decrease in oil reserves have been focused on biofuels. Biodiesel is a fuel that is manufactured from vegetable oils with the help of catalysts, and may be directly used in diesel vehicles with little or no modification. The biodiesel is reported to be sulfur-free, nontoxic, biodegradable oxygenated and renewable. And the characteristics of biodiesel are very close to diesel fuel [1,2]. And some are better than diesel such as higher cetane number, no aromatics, almost no sulfur, and more than 10% oxygen by weight, which reduce the emission of carbon monoxide, unburned hydrocarbon, and volatile organic compounds [3,4]. An experimental study is carried out to evaluate and compare the use of cottonseed oil, soybean oil, sunflower oil and their corresponding methyl esters. It shows that all tested biodiesel or vegetable oil blends, can be used safely [5, 6]. An experimental study is also carried out to examine fuel properties, performance and emissions of different blends of methyl ester of pongamia, jatropha and neem in comparison to diesel fuel. The results indicated that diesel blends showed reasonable efficiencies, lower smoke, CO and HC7. The vegetable oil esters from edible oils may not be the right option for their substitution in diesel engine due to the lack of self-sufficiency of edible oil production in India. Hence, attention has been diverted to test the suitability of non-edible vegetable oils for diesel engine. With the abundance of forest and tree-borne non-edible oils available in India, limited attempts have been made to use the ester of selected non-edible as the alternative fuels for diesel engine8. In this experimental study, the biodiesel from different non-edible oils was produced by a method of alkaline-catalyzed transesterification.

Fig. 1. Computerized CI engine test rig

II. MATERIALS AND METHOD

A. Fuel properties

The fuel properties of Cottonseed, Jatropa and Mahua methyl ester are summarized in Table 1. The blends of methyl esters were compared with different percentages of blends and optimized as a better alternative option for diesel fuel. Many researchers investigated fuel properties of different non-edible oils and its biodiesels and compared with diesel fuel to improve engine performance [9-14].

B. Engine set-up

Schematic diagram of computerized CI engine test rig is shown in Fig. 1. The engine tests were conducted on single cylinder, direct injection water cooled compression ignition engine. It studies characteristic fuel properties and experimental procedure adopted to evaluate performance of a 5.2kW, diesel engine on the blends. The engine was always operated at a rated speed of 1500RPM. The engine was having a conventional fuel injection system. The engine had been provided with a hemispherical combustion chamber with overhead valves operated through push rods. Cooling of the engine was accomplished by circulating water through the jackets of the engine block and cylinder head.

TABLE I. FUEL PROPERTIES OF COTTONSEED, JATROPA AND MAHUA METHYL ESTER

Properties	**CottonSeed**	**Jatropa**	**Mahua**	**ASTM D6751**	**EN14214**
Density (15°C), kg/m^3	874	879	861	-	860-900
Viscosity (40°C), cSt	4.34	4.84	4.958	1.9-6.0	3.5-5.0
Flash point, °C	162	191	170	>130	>101
Calorific value, kJ/kg	41200	38500	36700	-	-

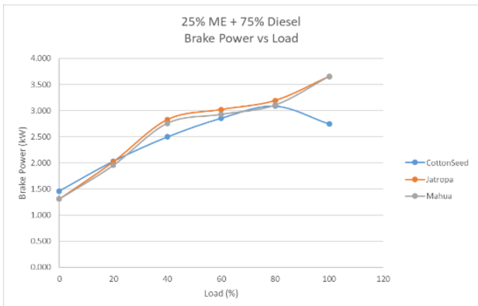
III. RESULTS AND DISCUSSION

A. Fuel properties

The experimental results reveal that the density of all the biodiesel are within the standards given in table 1 (ASTM D6751 and EN14214). The density of Jatropa methyl Ester is higher than the other two by about 5%. The kinematic viscosities of mahua biodiesel is slightly higher than the other two by about 13%. The highest calorific value is seen in cottonseed methyl ester and the lowest is seen in the mahua methyl ester at 41200 and 36700 kJ/kg respectively.

B. Performance characteristics

1) Brake Power



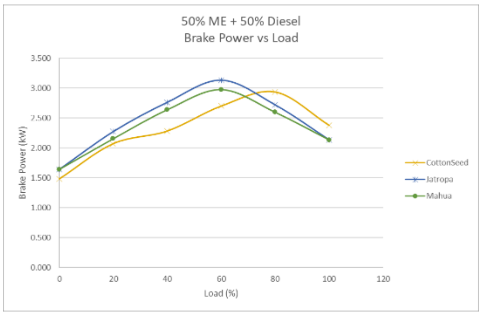


Fig. 2. Graphical representation of brake power vs load for 25% and 50% blends of cottonseed, Jatropa and Mahua biodiesel

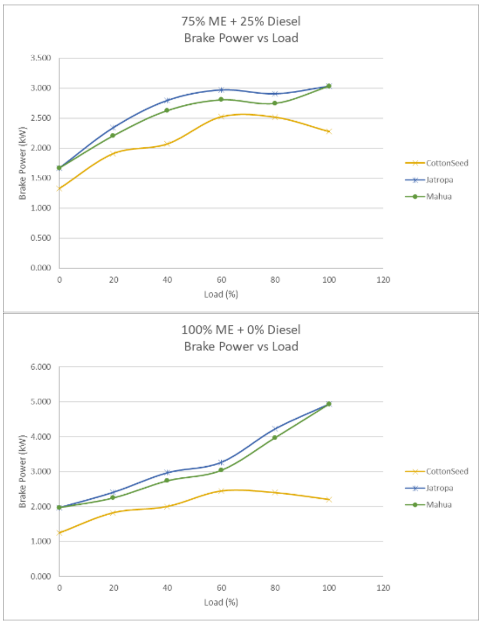
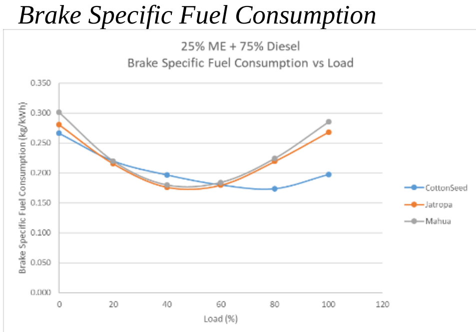


Fig. 3. Graphical representation of Brake Power vs load for 75% and 100% blends of cottonseed, Jatropa and Mahua biodiesel

Figure 1 and 2 shows the graphical representation of the brake power vs load for methyl ester blends with 25%, 50%, 75% and 100% biodiesel mixtures of cottonseed, Jatropa and mahua oil. The graph indicates that the Jatropa methylester biodiesel blends give higher brake power when the load is varied from 0% to 100% followed by mahua biodiesel. The lowest Brake Power is obtained from the cottonseed biodiesel at around 25% less than Jatropa biodiesel.

2) Brake Specific Fuel Consumption



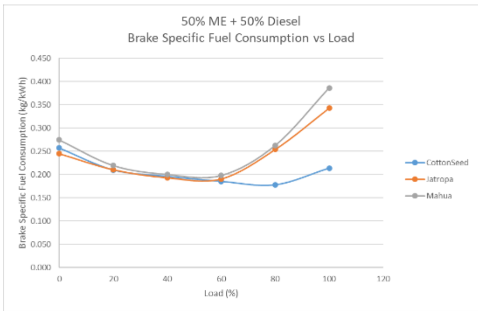


Fig. 4. Graphical representation of BSFC vs Load for 25% and 50% blends of cottonseed, Jatropa and Mahua biodiesel

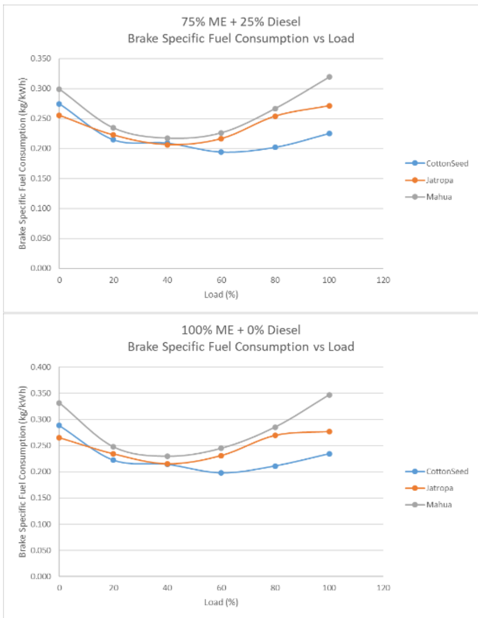
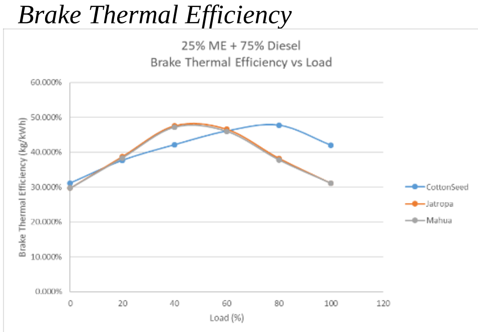


Fig. 5. Graphical representation of BSFC vs Load for 75% and 100% blends of cottonseed, Jatropa and Mahua biodiesel

Figure 3 and 4 shows the graphical representation of the brake specific fuel consumption vs load for methyl ester blends with 25%, 50%, 75% and 100% biodiesel mixtures of cottonseed, Jatropa and mahua oil. The graph indicates that the cottonseed methylester biodiesel blends give lowest brake specific fuel consumption when the load is varied from 0% to 100% followed by Jatropa biodiesel. The highest Brake specific fuel consumption is obtained from the mahua biodiesel at around 31% less than cottonseed biodiesel.

3) Brake Thermal Efficiency



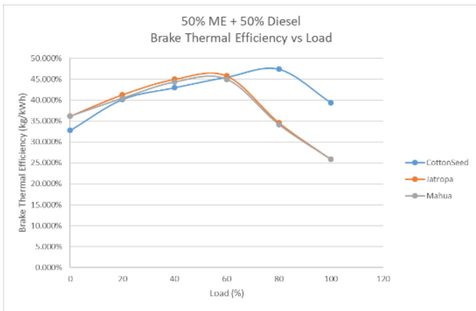


Fig. 6. Graphical representation of Brake Thermal Efficiency vs load for 25% and 50% blends of cottonseed, Jatropa and Mahua biodiesel

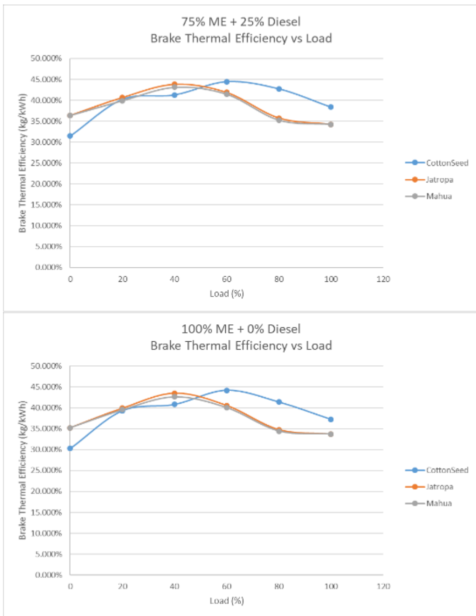
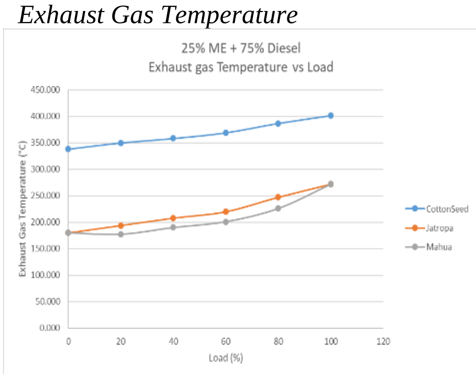


Fig. 7. Graphical representation of Brake Thermal Efficiency vs load for 75% and 100% blends of cottonseed, Jatropa and Mahua biodiesel

Figure 5 and 6 shows the graphical representation of the brake thermal efficiency vs load for methyl ester blends with 25%, 50%, 75% and 100% biodiesel mixtures of cottonseed, Jatropa and mahua oil. The graph indicates that the cottonseed methylester biodiesel blends give highest brake thermal efficiency when the load is at 100% followed by Jatropa biodiesel. The lowest Brake thermal efficiency is obtained from the mahua biodiesel at around 26% less than cottonseed biodiesel.

4) Exhaust Gas Temperature



International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 09, September-2019

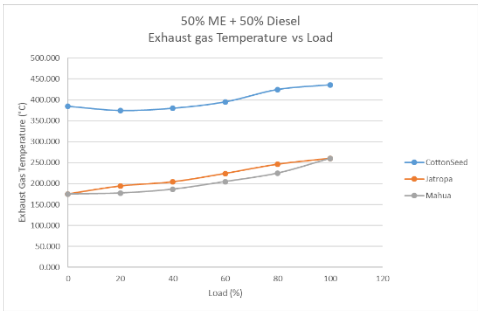


Fig. 8. Graphical representation of Exhaust Gas Temperature vs load for 25% and 50% blends of cottonseed, Jatropa and Mahua biodiesel

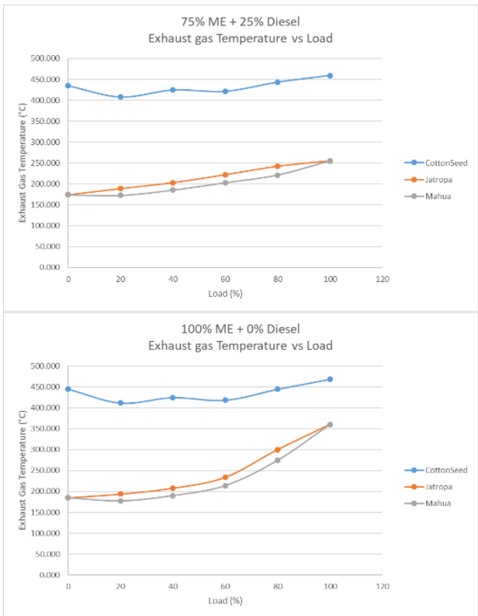


Fig. 9. Graphical representation of Exhaust Gas Temperature vs load for 75% and 100% blends of cottonseed, Jatropa and Mahua biodiesel

Figure 7 and 8 shows the graphical representation of the exhaust gas temperature vs load for methyl ester blends with 25%, 50%, 75% and 100% biodiesel mixtures of cottonseed, Jatropa and mahua oil. The graph indicates that the cottonseed methylester biodiesel blends give the highest exhaust gas temperature when the load is varied from 0% to 100% followed by Jatropa biodiesel. The lowest exhaust gas temperature is obtained from the mahua biodiesel at around 32% less than cottonseed biodiesel.

IV. CONCLUSIONS

Densities and calorific values of all the methyl esters show slightly increasing trend with respect to each other. Mahua methyl ester shows excellent kinematic viscosity as compared to Cottonseed methyl ester and Jatropa. The brake thermal efficiencies of cottonseed methyl ester is seen to be the highest of the three at all loads. In case of brake specific fuel consumption, all methyl esters show slightly decreasing trend but the lowest is cottonseed methyl ester. The overall performance of the engine is seen to be higher with cottonseed oil methyl ester when compared to the other two biodiesel mixtures.

REFERENCES

[1] Chang D Y Z, Gerpen J H V & Lee I, JAOCS, 73 (1996) 1549-1555.
[2] Freedman B & Pryde E H, ASAE Publ, 4-82 (1982) 117-122.
[3] Labeckas G & Slavinskas S, Energy Convers Manage, 47 (2006)1954-1967.
[4] Schumacher L G, Borgelt S C & Fosseen D, Bioresource Technol, 57 (1996) 31-36.
[5] Rakopoulos D C, Antonopoulos A K & Rakopoulos C D, Energy Convers Manage, 47 (2006) 3272-3287.
[6] Rakopoulos D C, Rakopoulos C D & Hountalas T D, Fuel, 87 (2008) 147-157.
[7] Venkateswara Rao T, Prabhakar Rao G & Hema Chandra Reddy K, Jordan J Mech Ind Eng, 2 (2008) 117-122.
[8] Bhatt Y C, Use of some non-edible vegetable oils as a source of energy for CI engines, Ph.D. Thesis, IIT, Kharagpur, 1987.
[9] Foidl N & Foidl G, Hackel S, Bioresource Technol, 58 (1996) 77-82.
[10] Fukuda H, Kondo A & Noda H, J Biosci Bioeng, 92 (5) (2001) 405-416.
[11] Karmee S & Chadha A, Bioresource Technol, 96 (2005) 1425-1429.
[12] Antolin G & Briceno F, Bioresource Technol, 83 (2002) 111114.
[13] Meher L & Naik S, Bioresource Technol, 97 (2006) 13921397.
[14] Ramadhas A & Jayaraj S, Fuel, 84 (2005) 335-340.