Performance And Emission Analysis of A Diesel Engine Fuelled With Tamarind Seed Oil Methyl Ester

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Abstract- *In a modern day world alternative source of energy are given importance due to gradual depletion of fossil fuels. So, there is a huge demand for energy. Biodiesel is a substitute with diesel fuel in CI engines due to its environmental benefits. The utilization of biodiesel leads to decrease in PM, CO and HC emissions. The performance are on for with diesel fuel. The present work is to study the performance and emission characteristics of a four stroke, water cooled compression ignition diesel engine. The experimental investigations held in a diesel engine fuelled with tamarind seed oil. The variations in the performance of the tamarind seed oil and its blends are examined and compared with reference fuel. By conducting experiments on this area results that increase the break thermal efficiency with increasing the percentage in the blends & decrease the break specific fuel consumption. A drastic reduction in CO, PM & NOx emissions.*

Keywords- Tamarind seed oil, blends, performance and emissions.

I. INTRODUCTION

The depletion, price uncertainty and negative effect of fossil fuels on the environment are some of the key is-sues that have led to a worldwide search or move to-wards alternative, renewable energy sources with lesser and greener emissions. The transport sector consumes about 58 percent of the primary energy consumption in the world. These fossil fuels which are becoming exhausted are the major contributors to greenhouse gas, (GHG) and climatic change [1]. Fossil fuels play a vital role in the expansion of industrial, transportation and agricultural sectors. Because of the high demand for energy, the petroleum resources are depleting rapidly. Furthermore the environmental issues due to the emissions from the use of fossil fuels are increasing at an alarming rate. In this context, the notion of alternative energy has gained its significance and a lot of researches are going on around the globe, in the field of biodiesel and bio energy, for finding an alternative for the petroleum fuels [2-4] In this investigation tests were carried on single cylinder water cooled variable compression ratio connected to eddy current dynamometer using Jatropha oil. He was conduct experiments the effects of variations in engine operating parameters on the emissions of NOx while operating with pure biodiesel (Jatropha methyl ester).He was suggested performance of engine is found to be better with biodiesel concentration up to 20% only. For improvement of performance with pure biodiesel, engine parameters needs to be at standard operating parameters, the emissions of NOx are found to be lesser with JME as compared to diesel as fuel. It is observed that increase in compression ratio tends to raise the emission level of NOx whereas increase in injection pressure leads to reduction in NOx emissions.[5] They were carried out on a single cylinder variable compression ratio C.I engine using neat mahua oil as the fuel. Both the performance and exhaust analysis were carried out to find the best suited compression ratio finally suggested that 15.7 is the best compression ratio with mahua in the C. I engines with Thermal efficiency is very high at this compression ratio where as fuel consumption, smoke number and the exhaust gas temperatures are marginally low at compression ratio 15.7. [6] They were conducted experiments on diesel engine by different vegetable oils. Main objective of this investigation was to estimate the mathematical relationships of biodiesel between viscosity, density, heating values and flash point among various biodiesel samples. There is a high regression between various properties of biodiesel and the relationships between them are observed to be considerably regular. The transesterification of vegetable oil decreases its viscosity and the properties of biodiesel depend on feed stock i.e. vegetable oils and process technologies employed. However, there is a correlation among the properties of biodiesel. Correlations have been established between flash point, density and viscosity and heating value. Viscosity is one of the most important parameters required in the design of combustion process. Viscosity must be closely correlated with structural parameters of fuel flow systems. Hence, the neat biodiesel or biodiesel blends should meet the desired viscosity in order to avoid damage of fuel injectors and fuel pump. A correlation developed between heating value and density of biodiesel with viscosity of fuel. These correlations between these properties follow the linear regression with high coefficient of regression. These physical properties of fuel are the significant parameters in the design of fuel system for biodiesel engine [7] biodiesel play a vital role in diesel engine. Finally, it is concluded that biodiesel is one of the potential alternative fuel for the diesel to minimize the tailpipe emissions towards the sustainable green environment. The characteristics of biodiesel are close to mineral diesel, and therefore tamarind seed oil become a potential fuel source to replace partially or completely the mineral diesel if need arises.

1.1 Materials and methods

I tried to investigate the potential use of tamarind seed oil methyl esters as bio-diesel. Based on work have actually prepared tamarind seed oil methyl ester (TSOME). Various experiments were conducted by blending TSOME with diesel in 10%, 20% and 30% on volume basis and the results were recorded. The results of TSOME blends were compared with conventional diesel. A brief introduction about the material used in this is given below.

1.1.1 Tamarind Seed Oil

Tamarindus indica is probably indigenous to tropical Africa, but has been cultivated for so long on the Indian subcontinent that it is sometimes also reported to be indigenous there. Tamarind Tree belongs to the family of Fabaceae. Its scientific name is 'Tamarindus Indica'. The name of this tree was derived from the Persian word 'Tamar-e-Hind', which means 'Indian date'. Tamarind tree is known as a very charming tree and it is a member of the “Leguminosae” family and 'Caesalpinieae' sub family. Today, India is the largest producer oftamarind. The consumption of tamarind is widespread due to its central role in the cuisines of the Indian subcontinent, South East Asia and America, particularly in Mexico.

Fig.1 Tamarind seeds and crude oil

1.1.2Tamarind seed oil Methyl Esters

As the availability of Tamarind seed oil is to be found, a certain percentage of biodiesel can be replaced by some other second generation bio fuels such as methanol which is commonly used in transesterification. In this process catalysts such as KOH or NAOH are used to increase the reaction to quickly break the triglycerides into glycerol and methyl esters. So, the major focus on biodiesel research has been mainly of transesterification process. Two distinct layers are formed, the lower layer is glycerin and the upper layer is ester. The upper layer (ester) is separated and moisture is removed from the ester by using calcium chloride. It is observed that 90% ester can be obtained from vegetable oils. The products of the reactions are the biodiesel itself and glycerol. The chemical reactions of biodiesel are shown in below. The physical and chemical properties of tamarind seed oil is shown in Table 1.

Table1 Properties of Tamarind seed oil

properties	Value
Calorific value(kJ/kg)	38,880
Specific gravity	0.883
Kinematic viscosity (cst)	6.86
Flash point(^{0}c)	159
Fire point(^{0}c)	173
Cetane number	52.4

II. EXPERIMENTAL SET UP AND PROCEDURE


Fig. 2 Experimental set up

The experimental set up is shown in figure.2 consists of a Single cylinder, Four stroke, Constant speed, Water cooled, Diesel engine coupled with eddy current dynamometer. The test rig engine consists of fuel supply system and various sensors attached and integrated with the computerized data acquisition system for the measurement of load, cylinder pressure, injection timing and crank angle etc, The specifications of the test engine are showed in Table 2.For the analysis AVL Di-gas analyzer and AVL 437C Smoke meter is used.

Table 2.Test engine specifications

Engine type	Kirloskar TAF1
power	4.4kw
Cylinder bore	87.5mm
Stroke	110mm
Compressionratio	17.5
No of cylinders	01
Injection timing	23^0BTDC
Methodof cooling	water

2.1 Experimental Test Procedure:

The engine is allowed to reach its steady state by running it's for ten minutes. The engine was warmed up and stabilized before taking all readings. After the engine reached working condition, the load is applied,fuel consumption ,brake power and other parameters were measured. The engine performance and exhaust emissions are noted at different loads. The brake specific fuel consumption and brake thermal efficiency are calculated. The emissions such as CO, HC & NOx were measured with exhaust gas analyzer and Smoke capacity with AVL437C smoke meter. The performance, combustion and emission characteristics for different fuels compared with diesel fuel.

III. RESULTS AND DISCUSSION

The experiments are conducted on the four stroke single cylinder water cooled diesel engine at constant speed (1500 rpm) with varying loads of diesel and TSOME (10, 20 & 30) Blends.

3.1 Brake Thermal Efficiency

The variation of brake thermal efficiency with load is shown in Fig.3. From the plot it is observed as the load increases there is considerable increase in the BTE. The BTE of diesel at full load is 34.00%and for the blends of TSOME is 33.02%, 34.40%, 33.33%, among the blends maximum BTE is 34.40% which is obtained for TSOME20. The BTE of TSOME is increases up to 4.40% as compared with diesel at full load condition. Almost all blends show slightly better BTE than diesel at higher load conditions. The higher thermal efficiencies may be due to oxygenated fuel. Oxygenated fuel gives a better fuel combustion delivering improved thermal efficiency and the additional lubricity provided by the fuel blends.

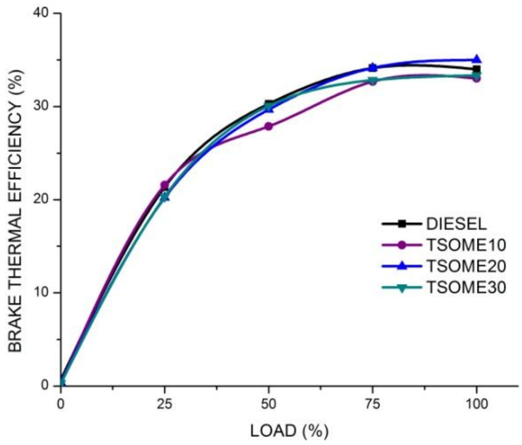

Fig.3 Variation of Brake thermal efficiency with Load Using TSOME Blends

3.2 Brake Specific Fuel Consumption

Figure.4 shows the variation of the brake specific fuel consumption with load. When two different fuels of different heating values are blended together, the fuel consumption may not be reliable, since the heating value and density of the two fuels are different. In such cases, the brake specific fuel consumption (BSFC) will give more reliable value .The brake specific fuel consumption was determined for Tamarind seed methyl ester-diesel fuel blends as the product of the specific fuel consumption and the calorific value. At full load condition the BSFC obtained are 0.25 kg/kW-hr, 0.26 kg/kW-hr, 0.25 kg/kW-hr, and 0.26 kg/kW-hr for fuels of diesel, TSOME10, TSOME20 and TSOME30 respectively. It can be observed from the fig.6.2 that the BSFC for TSOME is lower for all blends as compared to that of diesel fuel at full load. The availability of the oxygen in the Tamarind seed methyl ester-diesel fuel blend may be the reason for the lower BSFC. In the case of low load conditions, the incomplete mixture of high viscous TSOME may lead to incomplete combustion and require additional fuel air mixture to produce the same power output as that of diesel fuel.

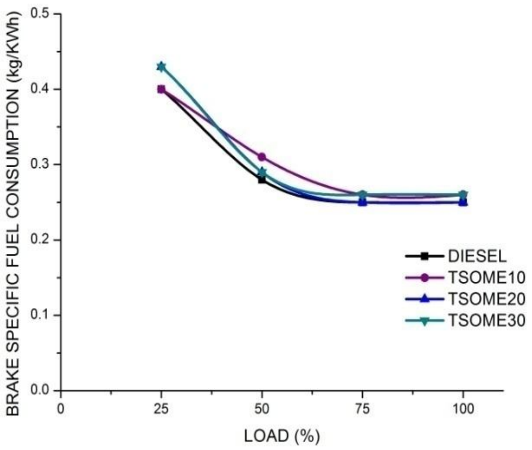

Fig.4 Variation of Brake specific fuel consumption with Load Using TSOME Blends

3.3 Oxides of Nitrogen

The variation of NOx Emission with load is shown in Fig.5. The plot it is observed that for different blends is indicated. At full load condition the NOx emission obtained are 2049ppm, 2056ppm, 2026ppm, and 2048ppm for the fuels of diesel, TSOME10, TSOME20, and TSOME30 respectively. The NOx emission for all the tested fuels followed an increasing trend with respect to the load. The reason could be the higher average gas temperature, residence time at higher load conditions. A reduction in the NOx emission for all the blends as compared to diesel was noted. With increase in the TSOME content of the fuel, corresponding increase oxides of nitrogen emissions.

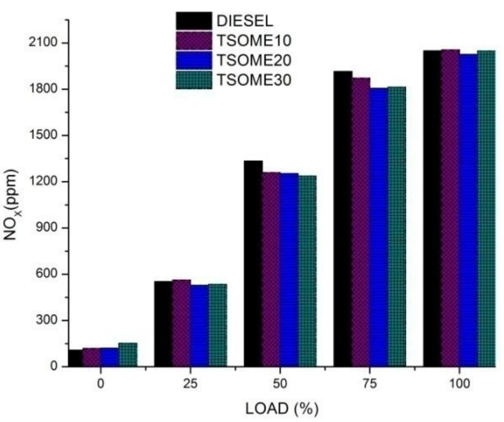

Fig.5 Variation of Oxides of Nitrogen with Load Using TSOME blends

3.4 Carbon Monoxide Emissions

The emission of carbon monoxide for various blends at different loads can be seen in Fig.6. The emissions are slightly higher for almost all blends of TSOME. At full load condition the CO emission obtained are 0.153%, 0.192%, 0.161% and 0.162% for the fuels of diesel, TSOME10, TSOME20, and TSOME30 respectively this can be attributed to higher viscosity of the fuel which results in poor atomization and incomplete combustion of the fuel. At higher load, more fuel is consumed which results in relative lowering of the availability of oxygen for the combustion of the fuel, which results in slightly higher carbon monoxide.

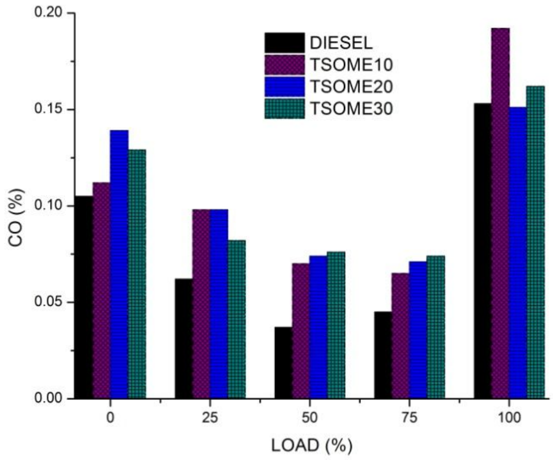

Fig.6 Variation of Carbon Monoxide Emission with Load Using TSOME Blends

3.5 Hydrocarbon Emissions

The variation of HC emission with load is shown in Fig.7. The plot it is observed that the HC emission variation for different blends is indicated. That the HC emission decreases with increase in load for diesel and it is almost slightly increased for all biodiesel blends. At full load condition the UHC are obtained 45ppm, 81ppm, 89ppm and 92ppm for the fuels of diesel, TSOME10, TSOME20 and TSOME30 respectively. HC emission increases gradually up to full load and exhibits a shorter delay period and results in better combustion leading to low HC emission. The oxygen contained in the biodiesel was responsible for the reduction in HC emissions.

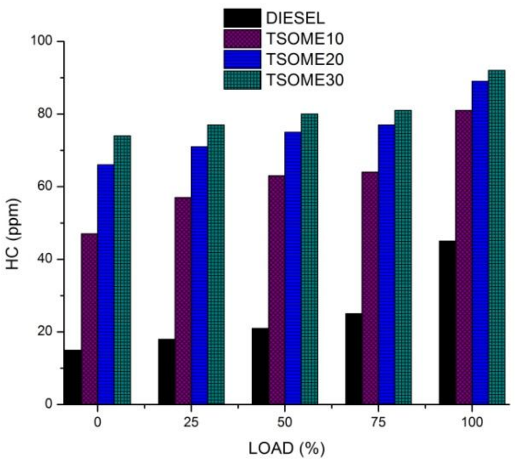

Fig.7 Variation of Hydrocarbon Emissions with Load Using TSOME Blends

3.6 Smoke Opacity

The variation of smoke opacity with load is shown in Fig.8.At full load condition the smoke opacity obtained are 76.6%, 59.3%, 61.4% and 62.3% for the fuels of diesel, TSOME10, TSOME20 and TSOME30. It is observed that smoke is gradually decreases at full load conditions as compared to diesel.

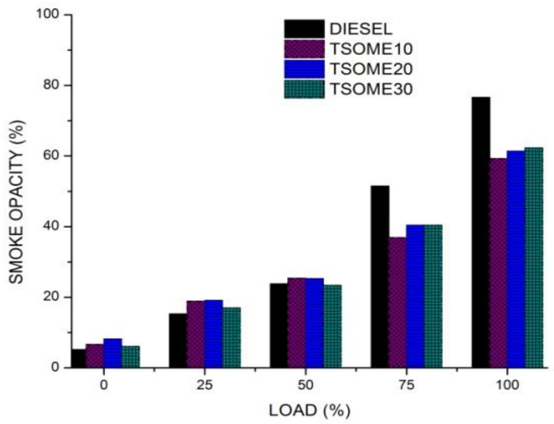

Fig.8 Variation of Smoke opacity with Load Using TSOME Blends

IV. CONCLUSION

The experiments are conducted on the four stroke single cylinder water cooled diesel engine at constant speed (1500 rpm) with varying loads of diesel and TSOME (10, 20 & 30) Blends.

- The maximum brake thermal efficiency for TSOME20 was higher than that of diesel .The brake thermal efficiency increased compared with diesel.
- Brake specific fuel consumption is decreases in blended fuels. In TSOME20 fuel the BSFC is lower than the diesel.
- Significant reductions were obtained in smoke level, CO emissions with TSOME20 blend. Smoke level was decreased with TSOME20 compared to diesel at maximum load of the engine.
- The slight increase in CO emissions was obtained with TSOME20 as compared to diesel fuel. On the other hand, NOx emissions were nearer with TSOME20 compared to diesel fuel. The marginal decreases in carbon dioxide emissions were 7% compared to diesel.
- Reductions in unburned hydrocarbon emissions were 8.6% compared to diesel.

REFERENCES

[1] P. Singh and A. Singh., “Production of Liquid Biofuels from Renewable Sources,” Progress in Energy and Com-bustion Science, Vol. 37, 2011, pp. 52-68.

[2] Pugazhvadivu M, Rajagopan S. Investigations on a diesel engine fuelled withbiodiesel blends and diethyl ether as an additive. Indian J Sci Technol 2009;(5):32–5.

[3] Arbab MI, Masjuki HH, Varman M, Kalam MA, Imtenan S, Sajjad H. Fuel,properties, engine performance and emission characteristic of commonbiodiesels as a renewable and sustainable source of fuel. Renew SustainEnergy Rev 2013;22:133–47.

[4] Agarwal AK. Biofuels (alcohols and biodiesel) applications as fuels for internalcombustion engines. Prog Energy Combust Sci 2007;33:233–71.

[5] Basha AS, Gopal KR, Jebaraj S. A review on biodiesel production, combustion,emissions and performance Renew sustain energy Rev2009:13:1628-34.

[6] S. Jindal. “Effect of engine parameters on NOx emissions with Jatropha biodiesel as fuel”,International Journal of energy and environment, Volume 1, Issue 2, 2010 pp.343-350.d performance. Renew Sustain Energy Rev 2009;13:1628–34.

[7] GVNSR RatnakaraRao, V. RamachandraRajuand M. MuralidharaRao. “Optimizing The Compression Ratio ForAMahua Fuelled C.I. Engine” ARPN Journal of Engineering and Applied Sciences Vol.4, NO. 3, May 2009, 2006-2009 ISSN 1819-6608

[8] G.LakshmiNarayanaRao, A.S. Ramadhas, N. Nallusamy , P.Sakthivel” Relationships among the physical properties of biodiesel and engine fuel system design requirement “International Journal of energy and environment, Volume 1, Issue 5, 2010 pp.919-926: