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Performance and Emission Characteristics of Compression Ignition Engine Using Oleander Biodiesel

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Abstract- Owing to the limitations of the fossil fuel reserves, increasing cost and significant contribution to the emission of combustion-generated pollutant have led biofuels more attractive. Among biofuels, biodiesel is the most appropriate alternative fuel because of its good fuel properties, engine performance characteristics and it's substitution for diesel fuel in the diesel engine without engine modification. In this communication, author’s idea is to analyze the performance characteristics of the Compression Ignition (CI) engine experimentally with respect to following parameters: Blend ratios, injection operating pressures (IOP) and load. The performance characteristics are Brake thermal efficiency (BTE), volumetric efficiency, Exhaust gas temperature (EGT), oxides of Nitrogen and Smoke density. Oleander (**Thevetia Peruviana)** is used as a blend with diesel in different proportions.

Index Terms: Oleander biodiesel, Brake thermal efficiency, volumetric efficiency, Exhaust gas temperature, Oxides of Nitrogen, Smoke density.

1. INTRODUCTION

In past, Rudolf Diesel experimented his prototype engine on peanut oil at the 1900 World Fair in Paris. In today’s scenario, biodiesel is becoming famous due to it’s as an environmental friendliness fuel. It has been used as an alternative fuel for diesel fuel in the automotive industry, commonly known as No.2 diesel. Oleander biodiesel is one of the non-edible oil and its chemical properties are almost near to pure diesel. Oleander is a small evergreen tree cultivated in all the regions of the world.It contains 52-60% of oil; therefore it can be used to produce biodiesel in major scale.Oleander oil is non-edible, used for making of soaps,paints and cosmetic.It has been used in the treatment of cancer.Scientific name of Oleander is Thevetia Peruviana. Fig 1 shows a sample of oleander oil.

In today’s scenario, Biodiesel is emerging as one of the most energy-efficient as well as environmental friendly option to

Figure 1: Sample of Oleander oil

suffice future energy needs. Biodiesel is a renewable diesel substitute which can be obtained by combining alcohol chemically with any natural oil or fat. During the last decade, biodiesel has succeeded from the research stage to a large scale production in many countries but still lot of countries are lagging behind. Since edible oils are a basic necessity of livelihood therefore non-edible oils are emerging as a favorable feedstock for the production of biodiesel.

T. Balusamy and R. Marappan 2009 [1] investigated the performance, combustion and emission characteristics with five different methyl ester of biofuels and observed that methyl ester of thevetia peruviana seed oil has comparable engine performance with less emission compared to other blends.

T.Balusamy and R.Marappan 2007 [2] tested methyl ester of Thevetia peruviana (Oleander) seed oil (TPSO), blended with diesel in naturally aspirated single cylinder diesel engine and found that performance with TPSO has been found comparable to that of diesel. CO, HC emissions are less but NOx and smoke density insignificantly higher than that of the diesel.

Avinash, Kailash B Anwar and Gowreesh 2015 [3] Worked on the optimization of performance characteristics in diesel engine using biodiesel blend with Pongamia and found optimum operating parameters.

Maulik A Modi et al 2014 [4] conducted an experiment to study palm seed oil blended with diesel used in a single cylinder diesel engine to observe the effects of load, compression ratio and injection pressure using Taguchi technique.

Nimesh G Gandhi, Hardik M Patel 2014 [5] studied injection pressure of four stroke four cylinder diesel engine for low emissions using Taguchi method and concluded that high injection pressure for O_2, CO_2 and low injection pressure for NOX, smoke levels should be maintained to decrease the emissions.

Dhruv V. Patel , Tushar M. Patel and Gaurav P Rathod 2015 [6] carried out an experimental study on Jatropha biodiesel blended with diesel used in single cylinder diesel engine.

Hussain M, Peethambaran K M and Ushakumari E R 2014 [7] revealed through study that the combination of a blend consisting of 10% chicken waste biodiesel (B10), a compression ratio of 18, an injection pressure of 220 bar and an injection timing of 19° b TDC produces maximum multiple performance of the diesel engine.

P. Shanmughasundaram PALANISAMY 2014 [8] studied various parameters such as rubber seed biodiesel blend %, injection pressure and applied load of the single cylinder diesel engine and found that the applied load was the most dominant factor influencing the specific fuel consumption and brake thermal efficiency followed by injection pressure and biodiesel blend.

Ramchandra S. Jahagidar, Eknath R. Deore, Milind S. Patil, Purushottam S. Desale 2011 [9] Experimentally investigated a single cylinder DI diesel engine and observed that break thermal efficiency using karanja biodiesel was improved by 3 to 8%, Volumetric efficiency is also improved with reduction in exhaust gas temperature.

Sanjay Basumatary 2014-15 [10] found that an engine fueled with 20% Thevetia peruviana biodiesel blended with 80% pure diesel reveals a significant improvement in performance and reduction in emissions.

Santhosh Kumar, Dr.P.Navaneetha krishnan, Dr.T.Senthil Kumar, Dr.B.Kumaragurubaran [11] found that diesel engine when operated on B20 biodiesel blend, with compression ratio of 18 at full load of 9 kg and Injection timing of 23ºBTDC has given optimum engine performance which is defined by maximum thermal efficiency, minimum brake specific energy consumption and lowest emissions.

P. Vijaya Rao B. Sudheer Prem Kumar and K. Vijayakumar Reddy 2017 [12] blended karanja oil with Diesel in various proportions such as 5%, 10%, 15% and 20% by volume and tested under similar conditions and compared with that of performance of Diesel.

G Dwivedi, S Jain, M.P. Sharma 2013 [13] found that the use of biodiesel results in to substantial reduction in PM, HC and CO emissions accompanying with the imperceptible power loss, the increase in fuel consumption and the increase in NOx emission on conventional diesel engine.

KARTHIKAYAN.S, SANKARANARAYANAN G 2013 [14] used higher percentage of neat Paradise Tree oil (50% by volume 50PTO) with diesel blend in an engine using modified engine and studied operating variables.

D. Bahar, Jakirahemed MD [15] conducted an experimental study to evaluate the influence of blending kerosene with diesel fuel on the performance characteristics of a single cylinder 4-stroke air cooled DI diesel engine running.

2. EXPERIMENTAL PROCEDURE

Experimental test has been conducted on Kirloskar four-stroke single cylinder diesel engine (shown in Fig 2) fuelled with Oleander oil (5%, 10% and 15%) as biodiesel blends with diesel fuel different injection operating pressures 190bar, 230bar and 270bar, different loading conditions 0%, 60% and 100% and constant engine running speed 1500rpm. Engine specification is given in Table 1.

Table 1: Engine specification

Engine: Kirloskar make, Four-stroke, vertical, single-cylinder, constant speed, water-cooled diesel engine.

1. Bore : 80mm
2. Stroke : 110mm
3. Rated output: 3.68kW
4. Rated speed: 1500rpm
5. Fuel injection timing: 27° BTDC
6. Fuel injection pressure: 190 bar
7. Compression ratio : 16:1
8. Combustion system: Open chamber

Figure 2: Photographic view of experimental setup

The Oleander biodiesel properties density, Flash point, Fire point, Viscosity and Calorific value are measured and compared with pure diesel and ASTM standards. The properties of biodiesel are listed in Table 2 and density of various blends in Table 3.

Table 2: Properties of Biodiesel

Oils	**Kinematic viscosity (mm²/s 40ºC)**	**Density (g/cc)**	**Calorific value (J/Kg)**	**Flash Point(º C)**	**Fire Point(º C)**

Diesel	2.75	0.84	42000	66	-
Olean der	4.5	0.87	42460	>100	>100
ASTM D6751	1.9-6.0	0.87-0.89		>130	

Table 3: Density of Oleander blends

Blends	**Density(g/cc)**
O5	0.81
O10	0.82
O15	0.83

In order to estimate the performance and emission characteristics following steps are followed:
Step 1: experiments were conducted with pure diesel.
Step 2: In the second phase of work, the engine was operated with diesel-Oleander biodiesel blend ratio O5 (5% oleander + 95% Diesel), O10 (10% oleander + 90% Diesel) and O15 (15% oleander + 85% Diesel) and injection operating pressures 190bar, 230bar and 270bar at different loading conditions.
Levels of varying parameters (Blend, Pressure and Load) are given in Table 4.

Table 4: Levels of varying parameters/factors

	Parameters/Factors		
Levels	**Blend**	**Pressure(bar)**	**Load (%)**
1	O5	190	0
2	O10	230	60
3	O15	270	100

3. RESULTS AND DISCUSSIONS

Fig. 3 demonstrates brake thermal efficiency (BTE) versus percentage of oleander blends at different Injection pressures. From figure it is clear that BTE increasing with respect to percentage of oleander blend and BTE also increasing with injection pressure.

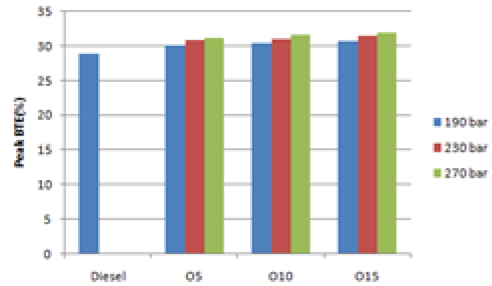

Figure 3: BTE versus percentage of oleander blends

Fig. 4 demonstrates that corresponding to BTE, volumetric efficiency manifesting the similar trend.

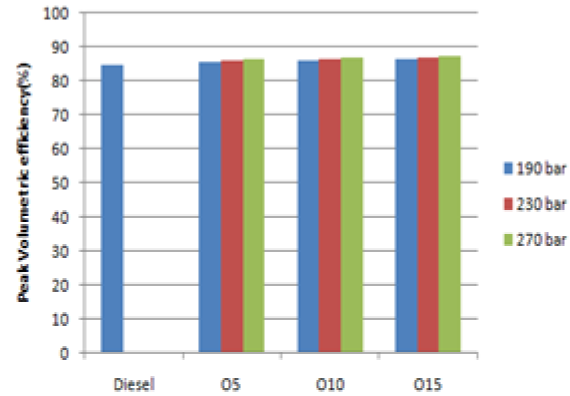

Figure 4: volumetric efficiency versus percentage of oleander blends

Fig. 5 shows that exhaust gas temperature (EGT) decreases with percentage of blend as well as with injection pressure.

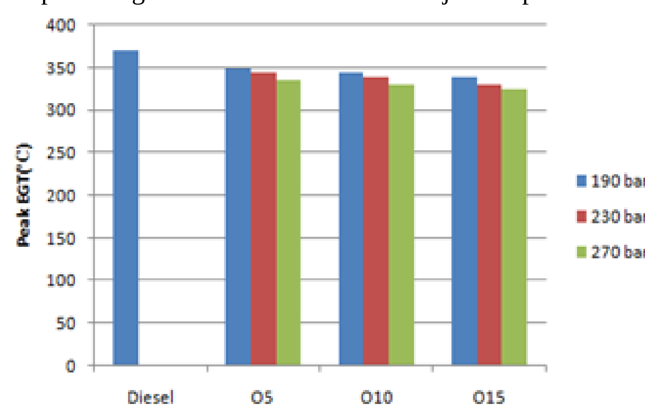

Figure 5: EGT versus percentage of blends

Corresponding to EGT, Fig. 6 exhibiting the similar kind of trend i.e smoke density decreasing with increasing percentage of blend as well as injection pressure

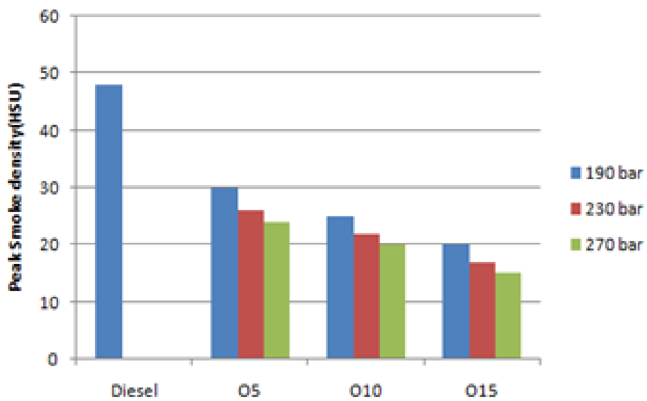

Figure 6: Smoke density versus percentage of blends

From figure 7, it is observed that percentage of oxides of nitrogens (NO_x) increasing with percentage of oleander blend. It is also observed that NO_x increasing with injection pressure.

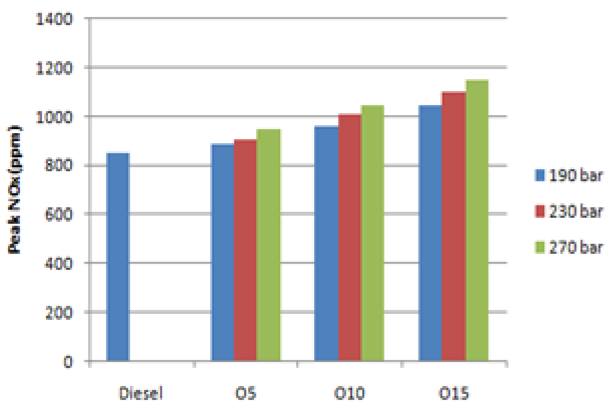

Figure 7: NOx versus percentage of blends

In this section, variation in above Figures can be attributed to number of factors like due to high cetane number, high volatility and presence of oxygen improved Brake thermal efficiency, though the calorific value of the Oleander biodiesel is nearly equal to neat diesel. Volumetric efficiency increased with increase in Injection operating pressure (IP) due to reduction of Exhaust gas temperature (EGT) and spraying characteristics of the fuels. As IP increased peak Brake thermal efficiency (BTE) increased thus reducing heat reduction causing a decrease of Exhaust gas temperature (EGT).Increase of Injection operating pressure (IP) improves spraying characteristics of fuel and thus increasing combustion temperature where the fuel penetrates into the air zone thus finding oxygen counterpart easily causing increase of combustion temperature.When injection pressure is increased the formation of mixing of fuel to air becomes better during ignition delay period and tends to complete combustion. So the injection pressure was increased, smoke emission gets decreased. Percentage of oxides of nitrogen increases with percentage of oleander blend may be owing to intrinsic characteristics of oleander.

4. CONCLUSIONS

This study concludes that most of the performance parameters: BTE, volumetric efficiency, EGT, smoke density are in favor of oleander blend except oxides of nitrogen. But in a wider perspective, results vindicates the use of oleander blend can be a paradigm shift for the countries which are energy deficit.

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