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Experimental Investigations on Performance of Diesel Engine with Neem Oil, Cow Ghee and NFA Blends With Atomized Diesel

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Abstract: The depletion of the world petroleum reserves and the increased environmental concern had stimulated the search of alternative fuel which is to reduce the harmful substances in emissions and increase the performance of the engine at the same time. The feasibility of using edible oils such as neem oil and cow ghee with diesel as fuel for CI engine is be studied. The experimental investigation was done on single cylinder water cooled diesel engine using various proportions of blends as fuel for engine and use ultrasonic vibrators to turn the diesel from liquid form to mist form, so that the fuel atomizes rapidly when atomized. Performance of engine is calculated by running engine at different loads. Brake Thermal Efficiency, CO emissions (ppm) and fuel combustion are the deciding responses of the performance of the engine in this paper.

Key words: Neem Oil and Cow Ghee, Brake Thermal Efficiency, Emissions, fuel combustion

I. Introduction

The world is presently confronted with twin crises of fuel depletion and environment degradation. Indiscriminate extraction and lavish consumption of fossil fuels have led to reduction in underground-based carbon resources. The search for alternative fuels, which promise a harmonious correlation with sustainable development, energy conservation, efficiency and environmental preservation, has become highly pronounced in present context. Even though new technologies have come up which have made solar, wind or tidal energy sources are easily usable but still they are not so popular due to problems in integration with the existing technology and processes. Gasoline and diesel driven automobiles are main reason for global warming. Various bio fuel energy resources are explored include biomass, biogas, primary alcohol, vegetable oils as blends with diesel, bio-diesel, etc.

Vegetable oils are good alternatives to fossil fuels for use in diesel engines. They are renewable in nature and may generate opportunities for rural employment when employed on large scale. Since vegetable properties are similar to diesel, they can be used to run compressed ignition engines with little or no modifications. These alternative resources are environment-friendly but they need to be evaluated case to case basis for their advantages, disadvantages, properties, specific applications. Some of these fuels can be used directly while others are needed to be formulated to bring the relevant properties closer to conventional fuels. Due to recent widespread use of fuels in various sectors, this study concentrates on accessing the viability of using alternative fuels in the existing internal combustion engines without any modifications. The present energy scenario has stimulated research in alternative fuels. The world reserves of primary energy and raw materials are obviously limited. According to an estimate the reserves will last for almost 200 years for coal, 40 years for oil, almost 60 years for natural gas.
An acceptable alternative fuel for engine has to fulfil the environment and energy security needs without sacrificing operating performance. Vegetable oils can be successfully used in CI engines without engine modifications and fuel modifications. Technologies must be developed for the use of vegetable oils as an alternative fuel. Vegetable oil cannot be used in its raw form in engine. So blends are made with diesel called bio-diesel. System design approach has taken care to see that these modified fuels can be utilized in the existing diesel engine without substantial hardware modification.

There are different kinds of vegetable oils and biodiesel have been tested in diesel engines it's reducing characteristic for greenhouse gas emissions. Its help on country's reliance on crude oils imports its supportive characteristic on agriculture by providing a new market for domestic crops, its effective lubricating property that eliminates the need for lubricating additive and its wide acceptance by vehicle manufactures can be listed as the most important advantages of bio-diesel fuel. In this work we calculated performance and emission analysis using bio-diesel as fuel. In this fuel we prepared blends of diesel, neem oil, cow ghee of different proportions by volume.

II. LITERATURE SURVEY

The inventor of the diesel engine, Rudolf Diesel, used peanut oil as a diesel fuel for demonstration is the 1900 world exhibition in Paris. Speaking to the Engineering society at St. Louis, Missouri, in 1912, Diesel said the use of vegetable oils for engine fuels may seem insignificant today, but such oils may become as important as petroleum in due course. Now at present mechanical expellers or hydraulic presses are extensively used for industrial purpose solvent extraction technique, which involves drying, grinding and steaming operation.

Savira Raj et. al.[1] investigated the performance and emissions characteristics of diesel engine using Mahua biodiesel. The blends of varying proportions of Mahua biodiesel and diesel were prepared, analyzed compared with the performance of diesel fuel, and studied using a single cylinder diesel engine. The brake thermal efficiency, brake-specific fuel consumption, exhaust gas temperatures, Co, Hc, No, and smoke emissions were analyzed. The tests showed decrease in the brake thermal efficiencies of the engine as the amount of Mahua biodiesel in the blend increased. The maximum percentage of reduction in BTE (14.3%) was observed for B-100 at full load. The exhaust gas temperature with the blends decreased as the proportion of Mahua increases in the blend. The smoke, CO, and NO emissions of the engine were increased with the blends at all loads. However, Hc emissions of Mahua biodiesels were less than that of diesel.

Ashfaque Ahmed et.al.[2] worked on reducing the cost of the fuel consumers by blending the lemongrass oil with diesel with different proportions and testing the performance of blended diesel. The tests were carried out for raw lemongrass oil, 20% lemongrass oil, 40% lemongrass oil, 80% with diesel. The performance were studied and it is concluded that, the bending of 20%, 40%, 60%, 80% and 100% at room temperature gives better fuel consumption and also improves emission norms. Yaliwal et. al.[3] carried out a review on biodiesel production with different techniques, and different edible and non-edible oils.

Advantages and Disadvantages of Biodiesel

Since the use of vegetable oils as blends with diesel there are advantages, disadvantages and limitations on usage of biodiesels.

Advantages	Disadvantages
• Bio diesel is a renewable energy source unlike other petroleum products that will vanish in years to come. Since it is made from edible or non-edible oils, it can be produced on demand. • Usage in existing diesel engines with little or no modifications. • Less green-house gas emissions. • Grown, produced and distributed locally • Cleaner Bio-fuel refineries • Biodegradable and Non-toxic • Better fuel economy • Positive economic impact • Reduced foreign oil dependence • More health benefits	• Not suitable for use in low temperatures • Increased use of fertilizers • Clog of engine • Regional sustainability • Higher capital and operating costs of alternative fuel and supporting facilities. • Risk involved in fuel delivery. • The need to develop, adopt, enforce codes and standards for alternative fuel performance and stability, comparable to those used in specifying diesel fuel quantity.

It can be noted that many works concentrated mainly on biodiesel and its blending with diesel in different proportions to optimize the biodiesel and diesel blend. Some work has been reported using straight vegetable oil and diesel blends. The problem of viscosity of straight vegetable oils were overcome by transesterification method using ethyl/ methyl alcohol by using a suitable catalyst at a predefined temperature over a period of time. So far in the literature blending of one vegetable oil with another vegetable oil were hardly reported.

After realizing this gap and to extend useful and beneficial support to farming community to use the different straight vegetable oils in small quantities for emergency and short term applications for their agricultural machinery, an attempt has been made in the present work to optimize the engine operating parameters. Also data pertaining to the treatment of the non edible vegetable oils with natural products like garlic to observe the changes and its effectiveness to take up the issue in a more natural way was not found. In this work we prepared blends of diesel and additives are added and kept separately for settle down.

III. PROPOSED WORK

The present work aims at testing the performance of 5hp diesel with a bio-fuel made from neem oil and cow ghee blended with diesel in various proportions by volume. Here, the blends are prepared on the volume percentage basis. The various proportions are shown in the table 3.1.

Table 3.1: Blends and its Compositions

Blends	Diesel (ml)	Neem oil (ml)	Cow ghee (ml)
B01	1000	0	0
B02	850	0	150
B03	770	150	80
B04	700	300	0
B05	650	150	200
B06	550	300	150

3.1 Properties of Fuel:

Flash and Fire points: The flash and fire points are found by using by Pensky's Martins apparatus.

Calorific value: Calorific value is the amount of heat produced from complete combustion of a material or fuel. The calorific values are found using bomb calorimeter and its procedure is as shown in literature survey.

Viscosity: The kinematic viscosity is found using engler's viscometer. The procedure is as shown in literature survey.

Density: The densities are found by using the mass per unit volume method. It is as shown in the literature survey.

The properties for different blends and the corresponding plots are shown in table 3.2 and figures 3.1and 3.2.

Table 3.2: Properties of fuel blends

Blend	Flash point	Fire point	Calorific Value	Kinematic Viscosity (at 40˚C)	Density
B01	40	40	9429.011	0.0044	814.59
B02	41	41	10521.88	0.0114	827.63
B03	45	45	9476.114	0.0099	838.84
B04	52	52	9505.969	0.03303	848.78
B05	46	46	9569.64	0.0246	848.18
B06	55	55	9332.941	0.0434	863.11

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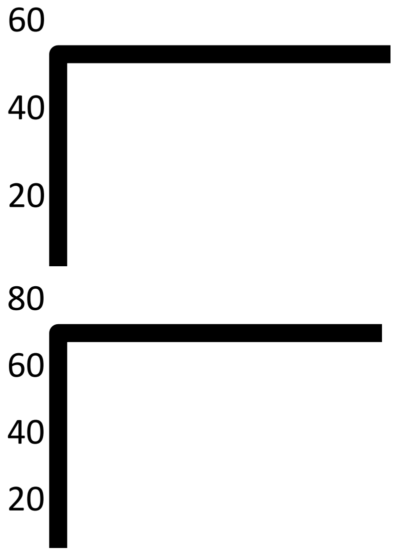
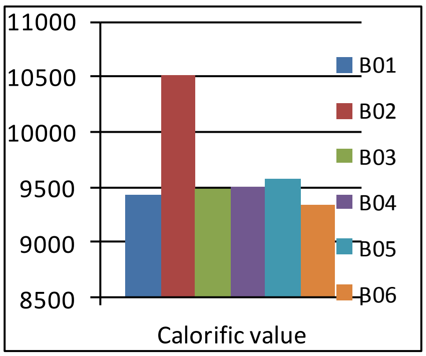


Figure 3.1: Flash and fire points of different blends



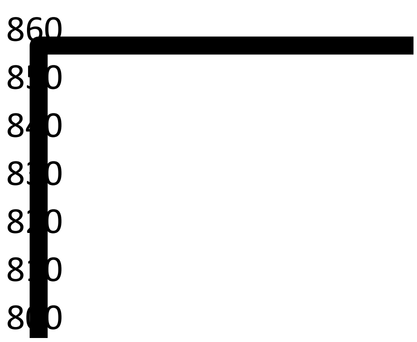


Figure 3.2: Calorific Values and Densities of different Blends

3.2 Experimental Setup:

A single cylinder 4-stroke water cooled diesel engine having 5HP as rated power at 1500 rpm was used for the present work. The engine is coupled to a belt to apply mechanical loading. A photo sensor along with digital sensor is used to measure speed of the engine. The fuel flow rate is measured on volumetric basis using burette and stopwatch. Thermocouples in conjunction with a digital temperature indicator were used for measuring the engine and exhaust gas temperatures. The engine is water cooled.

Table 3.3: Engine specifications

Make	KIRLOSKAR
Bore	87.5mm
Stroke	110mm
Cubic capacity	1323cc
Speed	1500rpm
Power	5HP/3.7kW
Compression ratio	16:1
Type of loading	Mechanical
Type of cooling	Water cooling

3.3 Formulae used:

Brake power (BP) = (2*π*N*T) / 60 W

Where N= speed of the engine.

T= F*r*9.81 N-m. R=0.15mm.

Total Fuel Consumption

TFC=(q/t)*((p*3600)/1000) Kg/hr

Where q= Fuel consumption rate (10 cc).

t= Time taken for 10cc of fuel consumption (sec).

p= Density of fuel (Kg/m^3)

Specific Fuel Consumption

SFC = TFC/BP (Kg/kW hr)

Heat input, HI = (TFC* Calorific value)/3600 (kW)

Indicated power, IP = BP+FP

Where FP is Frictional power and is calculated from William's graph where it is drawn between SFC and BP.

Brake thermal efficiency (ηbth) = BP/HI (%)

Indicated thermal efficiency (ηith) = IP/HI (%)

Mechanical efficiency (ηm) = BP/IP (%)

IV. EXPERIMENTAL OBSERVATIONS

The observations noted and are shown in tables 4.1 to 4.6 for blends.

Table 4.1: TFC and BTE for Blend B01

S.No	Load	Manometer Reading cm of Hg			Time for 10 cc of fuel (sec)	Speed (rpm)	TFC (kg/hr)	BTE (%)
		L1	L2	L1-L2				
1	0	30	95	65	40	1500	0.733	0
2	2	30	95	65	36	1500	0.814	21.66
3	4	30	95	65	35	1500	0.837	42.13
4	6	30	95	65	33	1498	0.888	59.5
5	8	30	95	65	32	1495	0.916	76.78
6	10	30	95	65	30	1490	0.977	89.68

Table 4.2: TFC and BTE for Blend B02

S.No	Load	Manometer Reading (cm of Hg)			Time for 10 cc of fuel (sec)	Speed (rpm)	TFC (kg/hr)	BTE %
		L1	L2	L1-L2				
1	0	30	95	65	37.78	1499	0.788	0
2	2	30	95	65	36.82	1498	0.809	19.52
3	4	30	95	65	35.42	1495	0.841	37.48
4	6	30	95	65	33.38	1493	0.892	52.91
5	8	30	95	65	32.17	1492	0.926	67.94
6	10	30	95	65	29.42	1492	1.012	77.67

Table 4.3: TFC and BTE for Blend B03

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S.No	Load	Manometer Reading cm of Hg			Time for 10 cc of fuel (sec)	Speed (rpm)	TFC (kg/hr)	BTE %
		L1	L2	L1-L2				
1	0	30	95	65	34.5	1500	0.875	0
2	2	30	95	65	34	1498	0.888	19.74
3	4	30	95	65	32.5	1496	0.929	37.7
4	6	30	95	65	32	1495	0.941	55.64
5	8	30	95	65	31	1493	0.97	71.77
6	10	30	95	65	29	1492	1.041	83.87

Table 4.4: TFC and BTE for Blend B04

S.No	Load	Manometer Reading cm of Hg			Time for 10 cc of fuel (sec)	Speed (rpm)	TFC (kg/hr)	BTE %
		L1	L2	L1-L2				
1	0	30	95	65	35	1500	0.873	0
2	2	30	95	65	33	1498	0.925	18.88
3	4	30	95	65	31	1496	0.98	35.32
4	6	30	95	65	30	1493	1.01	51.32
5	8	30	95	65	29	1492	1.05	66.12
6	10	30	95	65	26	1490	1.17	73.98

Table 4.5: TFC and BTE for Blend B05

S.No	Load	Manometer Reading cm of Hg			Time for 10 cc of fuel in sec	Speed (rpm)	TFC (kg/hr)	BTE %
		L1	L2	L1-L2				
1	0	30	95	65	36	1500	0.848	0
2	2	30	95	65	35	1500	0.872	20.5
3	4	30	95	65	33	1496	0.872	39.7
4	6	30	95	65	32	1495	0.954	54.49
5	8	30	95	65	31	1493	0.984	70.29
6	10	30	95	65	29	1488	1.052	81.92

Table 4.6: BHP,TFC and BTE for Blend B06

S.No	Load	Manometer Reading cm of Hg			Time for 10 cc of fuel (sec)	Speed (rpm)	TFC (kg/hr)	BTE %
		L1	L2	L1-L2				
1	0	30	95	65	35.5	1493	0.875	0
2	2	30	95	65	35	1491	0.887	19.967
3	4	30	95	65	32.26	1489	0.963	36.755
4	6	30	95	65	30.96	1487	1.003	52.845
5	8	30	95	65	29.72	1484	1.045	67.495
6	10	30	95	65	27.5	1481	1.129	77.887

V. RESULTS

5.1 Performance analysis:

Blends prepared are run on the engine and observations are noted. In this project the performance analysis is conducted by drawing graphs between Load vs. BTE and Load vs. TFC. The blends near to diesel can be seen in below graphs.

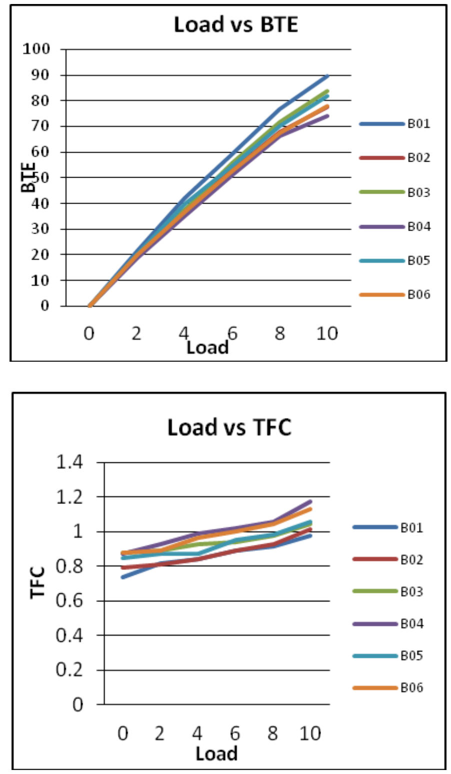

Figure 5.1: Performance Graphs

Load Vs BTE shows variation of the brake thermal efficiency (BTE) with respect to load for blends of diesel fuel, neem oil and cow ghee. It can be observed from that the B01 (D-1000 ml, N-0 ml, C-0 ml) has higher brake thermal efficiency than other blends. We can also see that B03 (D-770 ml, N-150 ml, C-80 ml) has brake thermal efficiency near to B01 blend.

Load Vs TFC shows the variation of the total fuel consumption (TFC) with respect to load for blends of diesel, neem oil and cow ghee. It can be seen that the B01 has lowest fuel consumption of all blends. The blend B02 (D-850 ml, N-0 ml, C- 150 ml) has total fuel consumption near to the B01 blend. All the other blends have total fuel consumption near to the blend B01.

5.2 Emission analysis:

When the blends are run on the engine CO emissions are measured for blends prepared using digital emission analyzer. The average CO emissions for the blends are as shown in below table.Graphs are drawn for comparison of emissions between blends.

Table 5.1: CO Emission results for the tested blends

Blends	CO emissions (ppm)
B01	245.333
B02	187.333
B03	239.833
B04	268.2
B05	212.333
B06	227.333

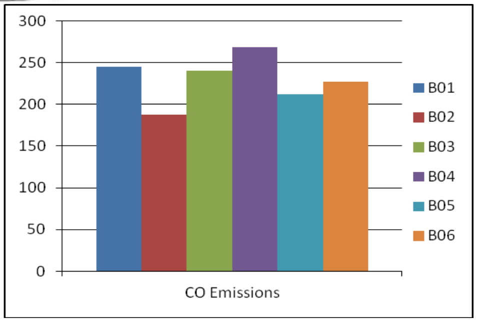

Figure 5.2: CO Emissions for different blends

The above bar chart represents the CO emissions of blends prepared. It can be seen that the blend B04 has higher CO emissions than most of the blends. The blend B02 has lowest CO emission of all the blends prepared. B03 which has brake thermal efficiency nearly equal to the pure diesel has lower CO emissions.

CONCLUSION

In this paper, blends of Neem oil, Cow ghee and Diesel according to the volume proportions are prepared and NFA is added (Nano Fuel Additive) to all the blends to act as anti-freezing agent. The volume proportions matrix is found using response surface method. The blend B03 (D-770 ml, N-150 ml, C-80ml) seems to have a potential to use as alternative fuel in diesel engines. Blending with diesel decreases the viscosity considerably.

The brake thermal efficiency of the blend B03 is nearly equal to diesel having 84% and CO emissions as 240 ppm. B03 can be accepted as a suitable fuel in standard diesel engines in place of diesel.

REFERENCES

i. *S. Savariraj, T. Ganapathy and C. G. Saravanan, "Experimental Investigation of Performance and Emission Characteristics of Mahua Biodiesel in Diesel Engine", ISRN Renewable Energy, Volume 10, August,2011.*

ii. *S. Ashfaque Ahmed, S. Prabhakar, Binu. K. Soloman and M. Irshad Ahmed, "Performance Test For Lemon Grass Oil In Twin Cylinder Diesel Engine", ARPN Journal of Engineering and Applied Sciences, Vol. 8, No. 6, June 2013, Pp435-437.*

iii. *S. Yaliwal, S. R. Daboji, N. R. Banapurmath, and P. G. Tewari, "Production and utilization of renewable liquid fuel in a single cylinder four stroke direct injection compression ignition engine," International Journal of Engineering Science and Technology, vol. 2, no. 10, pp. 5938–5948,2010.*

iv. *M. Leenus Jesus Martin, V. Edwin Geo, and D. Prithviraj, "Effect of diesel addition on the performance of cottonseed oil fuelled DI diesel engine," International Journal of Energy and Environment, vol. 2, no. 2, pp. 321–330,2011.*

v. *T. Ganapathy and A. Senthil Kumar, "Rice bran oil methyl ester as fuel in compression ignition engines," Engineering Today, no. 11, pp. 27–28,2003.*

vi. *T. Ganapathy, K. Murugesan, and R. P. Gakkhar, "Performance optimization of Jatropha biodiesel engine model using Taguchi approach," Applied Energy, vol. 86, no. 11, pp. 2476–2486, 2009*

vii. *T. Ganapathy, R. P. Gakkhar, and K. Murugesan, "An analytical and experimental study of performance on Jatropha biodiesel engine," Thermal Science, vol. 13, no. 3, pp. 69– 82, 2009.*

viii. *M. Mani, C. Subash, and G. Nagarajan, "Performance, emission and combustion characteristics of a DI diesel engine using waste plastic oil," Applied Thermal Engineering, vol. 29, no. 13, pp. 2738–2744,2009.*

ix. *J. T. Song and C. H. Zhang, "An experimental study on the performance and exhaust emissions of a diesel engine fuelled with soybean oil methyl ester," Journal of Automobile Engineering, vol. 222, no. 12, pp. 2487–2496, 2008. S. V. Ghadge and H. Raheman, "Process optimization for biodiesel production from mahua (Madhucaindica) oil using response surface methodology," Bioresource Technology, vol. 97, no. 3, pp. 379–384, 2006.*

x. *N. Kapilan and R. P. Reddy, "Studies on exhaust emissions of mahua oil operated compression ignition engine," Journal of Environmental Science and Engineering, vol. 51, no. 3, pp. 223–226, 2009.*

xi. *N. Kapilan, T. P. Ashok Babu, and R. P. Reddy, "Characterization and effect of using Mahua oil biodiesel as fuel in compression ignition engine," Journal of Thermal Science, vol. 18, no. 4, pp. 382–384,2009.*

xii. *P. V. Bhale, N. V. Deshpande, and S. B. Thombre, "Improving the low temperature properties of biodiesel fuel," Renewable Energy, vol. 34, no. 3, pp. 794–800,2009.*

xiii. *H. Raheman and S. V. Ghadge, "Performance of diesel engine with biodiesel at varying compression ratio and ignition timing," Fuel, vol. 87, no. 12, pp. 2659–2666,2008.*