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Performance and Emission Analysis of Single Cylinder Diesel Engine Using Honge Oil Blends With 1,4 Dioxen Additive

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Abstract— **On the face of the future energy crisis, vegetable oils have come up as a promising source of fuel. They are being studied widely because of their abundant availability, renewable nature and better performance when used in engines. Many vegetable oils have been investigated in compression ignition engine by fuel modification or engine modification. The vegetable oils have very high density and viscosity, so we have used the Methanol and potassium hydroxide for Transesterification process to overcome these problems. Honge oil (Pongamia Pinnata) is non edible in environment and is accessible in large quantities in India. In diesel blends are 20%, 40%, 60%, 80%, and 100% of Honge oil biodiesel with each 10 ml of additives (1,4 Dioxen) in each blends by volume basis . Out of them, we will find out which blend with additives is best for existing CI engine with improving brake specific fuel consumption, brake thermal efficiency and reducing emission of without modification in engine by mass and studied under various load conditions in a compression ignition (diesel) engine.**

Index Terms— **Single cylinder Diesel engine, honge oil blend, 1,4 dioxen.**

I. INTRODUCTION

Fuels derived from renewable biological resources for use in diesel engines are known as biodiesel. Biodiesel is environmentally friendly liquid fuel similar to petrol-diesel in combustion properties. Increasing environmental concern, diminishing petroleum reserves and agriculture based economy of our country are the driving forces to promote biodiesel as an alternate fuel [1]. Oil content in the Jatropha and Pongamia seed is around 30- 40 %. India has about 80-100 million hectares of wasteland, which can be used for Jatropha and Pongamia plantation. India is one of the largest producer Neem oil and its seed contains 30% oil content. It is an untapped source in India [2].Experimental investigations have been carried out to examine properties, performance and emissions of different blends (B20, B40, B60, B80 and B100) of PME, JME and NME in comparison to diesel. Results indicated that B20 and B40 have closer performance to diesel and B100 had lower brake thermal efficiency mainly due to its high viscosity compared to diesel. However, its diesel blends showed reasonable efficiencies, lower smoke, CO and HC. Pongamia methyl ester gives better performance compared to Jatropha and Neem methyl esters [3].

II. ABOUT HONGE OIL

Honge oil is extracted from the seeds of the Honge tree. This tree is found all over India. In many places the leaves are used as green manure and the seed cake is used as fertilizer. Honge oil has fungicidal properties and is also traded as a non-edible vegetable oil. The inventor of the diesel engine, Rudolph Diesel, had used peanut oil in his engines. A lot of work was sub squinty done on vegetable oils before and during the Second World War in a world driven by political uncertainties and shortage of fossil fuels. In India, at least eleven vegetable oils were tried as diesel substitutes in Calcutta in the 1930s.Most of the physical and chemical properties of Honge oil were similar to those of diesel, though the 'Conrad son carbon residue' is higher in the case of Honge. This may call for frequent maintenance of the fuel injector. Considering that diesel fuel is often adulterated with other fuels and oils such as kerosene, the use of Honge oil may not cause problems that are worse than those being experienced already. Honge oil has to be preheated since the viscosity of the oil is much larger than that of diesel at room temperature. The power output of the diesel engine remains almost the same, though the calorific value of Honge is slightly lower. Honge oil will be less expensive than diesel in rural areas if the value of the cake, which is a good fertilizer, is taken into account. One hectare of Honge plantation could yield 10 tones of seeds which can yield gross revenue of Rs 40,000 (which is good revenue for dry land), provided high yielding plants are selected. Planting seedlings a hundred times more densely than is normally required (which is about a hundred trees per hectare). Though the yield per plant may be less in the earlier years, this is compensated for by the higher density. However, as the plants grow, weaker ones have to be selectively culled. The initial problems encountered in using Honge oil such as choking of filters and high viscosities. The suppliers of diesel engines had some reservations about the use of Honge oil earlier, but are now convinced that Honge oil can be used without any adverse impact on the engines.

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III. ADDITIVES

The consumption of fuel is increasing resulting in pollution of environment with smoke and NOx due to the development in automobile and power sector. These emission contents smoke and NOx can be reduced by adding additives with diesel fuel. As these additives are very costly and hence becomes unviable. These additives decrease the performance of combustion. Oxygenated compounds are most widely used among additives. The reason for this is the participation of their oxygen in reactions leading to better combustion and hence lowering the emission contents the molecular structure of the oxygen contents of additives directly influence on smoke reduction and the oxygen concentration of the fuel flame also effects the emission specially Nitro paraffin compound additives have high oxygen contents is then molecular structure. The development of engine design has also help in reducing emission level considerably. The other way to reduce emission is by blending the diesel with different additives has to prove very successful and hence become a point of research in this field from last two decades. We have so many additives available blended with diesel and used in CI engine. Those additives with oxygenated compounds are most widely used in Diesel, as the participation of their oxygen in reactions leads to a better combustion thus lowering emission. Their molecular structure and oxygen content have direct influence on soot reduction. In order to decrease soot formation, 11-21% volume of oxygenate chemicals should be blended with diesel fuel. When additives are added they alter the physical and chemical properties such as density, viscosity, volatility and cetane index significantly. Nitro paraffin is one additive which has high oxygen content in then molecular structure. By addition of additives, we can improve the performance via the increase of thermal energy output and combustion product alteration.

Merits of Additives

Following are the merits of additives:-

Engine Performance It has been found out that some of additives improves thermal efficiency upto 19% without affecting the torque.

Emissions Reduction:- Diesel additives can decreases pollutants and greenhouse gas emissions upto 55% or more.

Demerits of Additives

Following are the demerits of additives:-

Fuel Cost: The high cost of additives increases the cost of fuel.

Preparation of blend: Preparation of diesel additives blend are difficult in some cases.

IV. DIESEL ENGINE POLLUTANTS

The pollutants from diesel fuel vehicles are Particulate Matter (PM), smoke, NOx, Sulphur di-oxide, CO and HC. Most pollutants are emitted from the exhaust. Because diesel engines operate at high air-fuel ratios, they tend to have low HC and CO emissions. They have considerably higher PM emissions than gasoline-fueled vehicles; however, for heavy-duty vehicles CO, HC and NOx emissions in the exhaust also vary with driving modes, engine speed and load.

V. TECHNIQUES IN PREPARING BIODIESEL

Generally the following techniques are used for preparing of Biodiesel.

Micro emulsification
Blending
Cracking
Pyrolysis
Transesterification
Super Critical Method

VI. TRANSESTERIFICATION PROCESS

To reduce the viscosity of the raw Honge oil, transesterification method is adopted. The procedure involved in this method is as follows: Potassium hydroxide [4g] is added to methanol [130ml] and stirred until properly dissolved. The solution thus prepared is called meth oxide which is added to raw Honge oil [850ml] and stirred at a constant rate at 600C for one hour. After the reaction is over, the solution is allowed to settle for 4-5 hours in a separating flask. The glycerin settles at the bottom and the methyl ester floats at the top (coarse biodiesel). Coarse biodiesel is separated from the glycerin and it is heated above10000C and maintained for 10-15 minutes for removing the untreated methanol. Certain impurities like sodium hydroxide (NaOH) etc are still dissolved in the coarse biodiesel. These impurities are cleaned two or three times by washing with 50 ml of petroleum ether and 100 ml of water for 1000 ml of coarse biodiesel. This cleaned biodiesel is taken up for the study.

VII. REASON TO USE HONGE OIL

Physical and chemical properties of Honge oil are similar to those of diesel.
Availability in India is more.
Harmless engine performance.
No need of major modifications in Engine.
Less expensive.
Cake can be used as fertilizer.
Tree based oil seed so the yield is more.
Planting seedling a more densely than is normally required.

VIII. REASON TO USE 1,4 DIOXANE

Dioxane is a miscible and in fact is hygroscopic.
Colorless liquid with a faint sweet odor.
Dioxane is used as a solvent for variety of practical applications as well as in the laboratory.
Lower toxicity and higher boiling point (101Oc)

IX. PROPERTIES OF BIODIESEL

The following table.1 shows the properties diesel and transesterified honge oil blends with additive were measured by various equipment in our Physics and chemistry Laboratory.

Table 1 : Properties of Biodiesel

	Diesel	B20	B40	B60	B80	B100
Kinematic Viscosity (Cst), 400C	4	4	4.2	4.4	4.6	4.8
Specific Gravity	0.825	0.825	0.83	0.835	0.84	0.845
Calorific Value (kJ/kg)	43200	35870	36720	37900	38670	39536
Cetane Number	50	50	51	52	52	53

X. TECHNICAL SPECIFICATIONS

Table. 2 shows the technical specifications of the tested engine. Table.3 shows the technical specifications of the loading rheostat.Table.4 shows the technical specifications of the AC Generator.

XI. EXPERIMENTAL SETUP

A load test on an engine provides information regarding the performance characteristics of the engine. The performance characteristics of such engines are obtained by varying the load on the engine. The experiments were carried out on a single cylinder 4 stroke diesel engine of a model manufactured by Kirloskar oil engines Ltd., the largest manufacturer of portable multi-fuel engines. The Kirloskar engine is a single cylinder, vertical and water cooled diesel engine. It is coupled to a 3 phase loading rheostat. A fuel tank with a measuring burette enables the engine fuel consumption to be measured. The loading rheostat is coupled by means of rigid coupling carefully without any misalignment between axes. The proper alignment helps to damp-out any vibration that may occur during transmission. Fig. 1 shows the Engine used for testing Fig.2 shows the Experimental setup Fig.3 and Fig.4 shows the gas analyzer which is used to measure the amount of exhaust emissions in test engine.

Table 2: Specification of the test engine

Type	Vertical, Water cooled, Four stroke
Number of cylinder	One
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5:1
Maximum power	5.2 Kw
Speed	1500 rev/min
Dynamometer	Eddy current
Injection timing	23° before TDC
Injection pressure	220kg/cm^2

Table 3: Technical details of loading Rheostat

Sl.No.	Parameters	Range
1	Watts	5 KW
2	Phase	3 Phase
3	Volts	230 V

Table 4: Technical Details of the AC Generator

Sl.No.	Parameters	Range
1	Volts	230 V
2	Frequency	50 Hz
3	Speed	1500 Rpm
4	Phase	Single
5	Amps	21.7 A

Figure 1: Photographic view of test engine

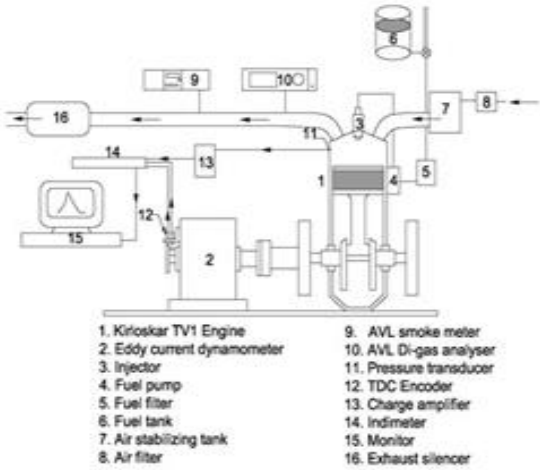


Figure 2: Experimental setup

Figure 3: Photographic view of AVL smoke meter

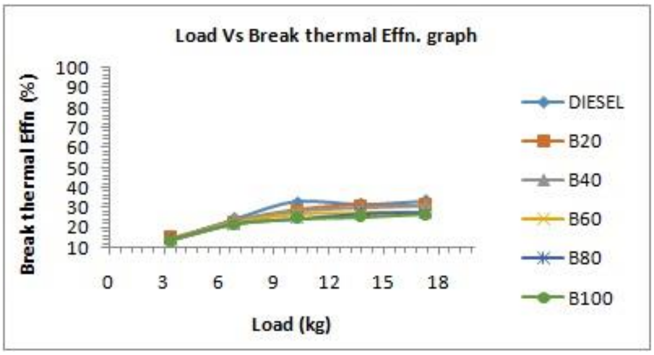
Figure 4: Photographic of AVL gas analyzer

XII. RESULTS AND DISCUSSIONS

Experimental investigation were carried out for performance and exhaust emission of the engine for blends of diesel and honge oil with 1,4 dioxen in various proportions as fuel and are compared with mineral diesel.

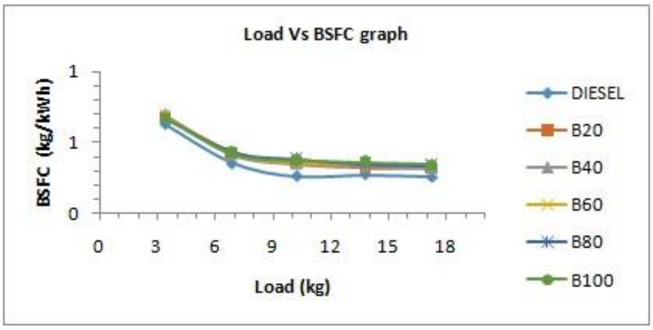
i. Brake thermal efficiency (BTE)

The BTE of different fuels is shown as a function of load. The variation in brake thermal efficiency for various blends was less than at part load than at higher load due to the raised temperatures inside the cylinder. The brake thermal efficiencies of diesel and the blends of biodiesel with diesel were seen increased with increase in load but tended to decrease with further increase in load. The BTE of blends were lower than with diesel throughout the entire range showing the poor combustion characteristics of honge oil due to high viscosity and poor volatility. The BTE of B20, B40 are closer to that of diesel. At full load conditions BTE of B20 is about 5% less than that of diesel. The BTE of B20, B40 are found better.



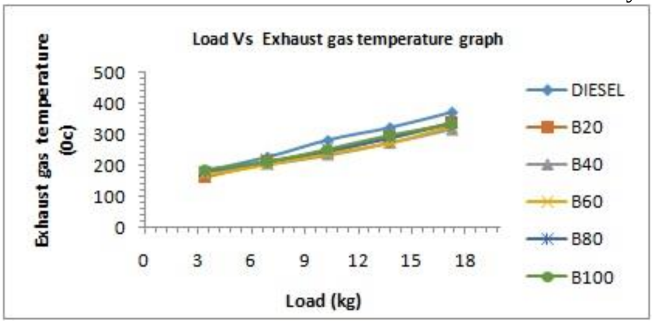
ii. Break specific fuel consumption (BSFC)

The variation in brake specific fuel consumption with load for different fuels shows decline with increase in load. One possible explanation for this could be due to more increase in brake power with load as compared with fuel consumption. The BSFC in case of blends were higher compared to diesel in the entire load range, due to its lower heating value, greater density and hence higher bulk modulus. The higher bulk modulus results in more discharge of fuel for same displacement of the plunger in injection pump, there by resulting increase in BSFC



iii. Exhaust gas temperature

It is evident from the graph that exhaust gas temperature is increased along with the increase in load for all fuels. The mean temperature increased linearly for 1800C at no load to 3500C at full load with average increase of 30% with 25% increase in load. The increase in exhaust gas temperature with load is obvious from the fact that more fuel is required to take additional load. The exhaust gas temperature was found to increase with increasing concentration of biodiesel in the blends. This could be due to lower heat transfer rate in case of biodiesel which in evident from trends of thermal efficiency.

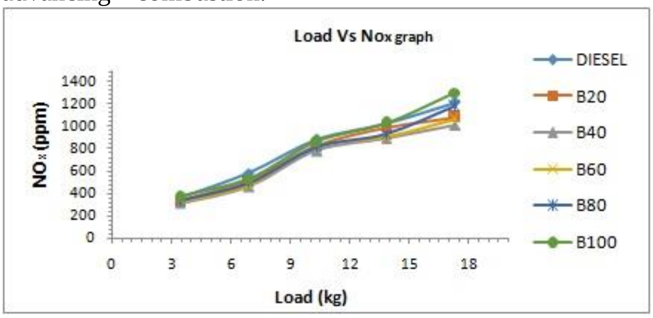


iv. Emissions of Nitrogen Oxides (NOx)

The NOx values as parts per million for different blends of diesel and biodiesel in exhaust emission are plotted as function of load. From these figures it can be seen that the fueling biodiesel or its blends increase NOx emission slightly 5-10% compared with that of diesel. These could be attributed to

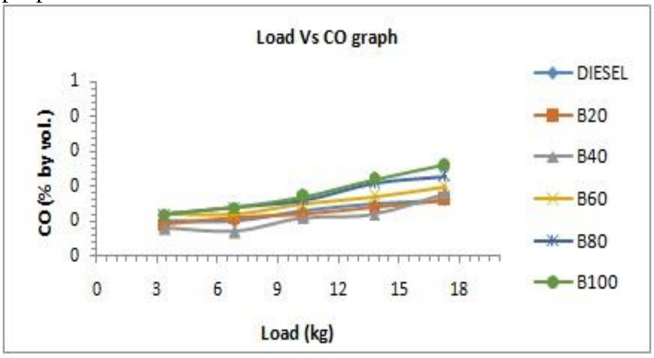
Increase exhaust gas temperature due to lower heat transfer and the fact that biodiesel has some oxygen content in it which facilitates NOx formation.

Higher cetane number of biodiesel shortens ignition delay advancing combustion.



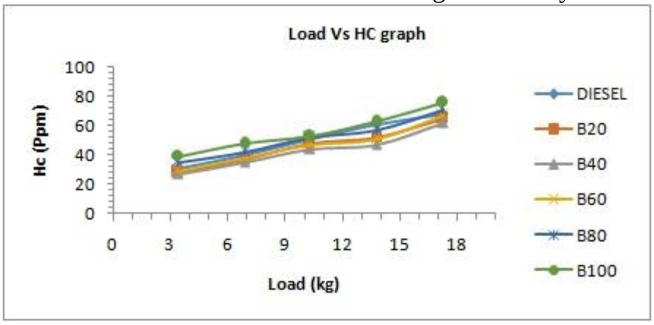
v. Exhaust emission of Carbon Monoxide (CO)

Figure shows the variation of CO emission with engine loading. It was observed that CO emissions are increased with increase in engine load. The lower CO emission of biodiesel compared to diesel is likely due to oxygen content inherently present in the biodiesel which helps in the more complete oxidation of fuel. Further it can be seen that volume of CO initially decrease but increase at full load indicating better burning conditions at higher temperature assisted by improved spraying qualities with uniform charge preparations of biodiesel.



vi. Exhaust gas emission of Hydrocarbon (HC)

The variations of HC emission for diesel and biodiesel are shown in the figure. The emissions of unburnt hydrocarbon for biodiesel exhaust due to lower than that of diesel fuel the increased gas temperature and higher cetane number of biodiesel could be responsible for this decrease. Higher temperature of burnt gases in biodiesel fuel helps in preventing condensation of higher hydrocarbon reducing unburnt HC. The higher cetane number of biodiesel results decrease in HC emission due to shorter ignition delay.



XIII. CONCLUSIONS

Performance and emissions of diesel engine fueled with blends of biodiesel and 1,4 dioxen are experimentally investigated. The results of study may be summarized as follows:

Honge oil based biodiesels can be directly used in diesel engines without any modifications.

The performance is slightly reduced while brake specific fuel consumption is increased when using biodiesel.

The brake thermal efficiency of B20 and B40 are better than B60, B80, and B100 but still inferior to that of diesel.

Compared with conventional diesel, exhaust emissions of CO and HC are reduced while NOx emissions are increased with biodiesel and its blends with diesel.

The availability of abundant resources and environmental friendly emissions are recognized as strength of biodiesels leading them to potential candidates as alternative fuels.

However further investigations to explore the knowledge of dynamics combustion with biodiesel as fuel is needed for the better optimization.

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