Performance & Emissions Characteristics of a Four Stroke Diesel Engine Fuelled With Different Blends of Ankola Oil with Diesel

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Abstract: ***The uses of biodiesel are increasingly popular because of their low impact on environment. However, it causes combustion problems in conventional diesel engine. The vegetable oils were not acceptable in diesel engine because it poses problems such as injector choking, cylinder deposits, piston ring sticking and higher smoke emissions. Biodiesel has become more attractive recently because of its environmental benefits. ethyl ester of ankola oil is derived through transesterification process. The biodiesel can be used in diesel engine without major hardware modifications. Experimental investigations have been carried out to examine the properties, performance and emission of different blends (B10, B20, B30, and B40) of ankola oil methyl ester in comparison to diesel. Results indicate that B20 is an optimum fuel blend in terms of better performance and reduced emission than diesel fuel. However, B20 blend shows reasonable efficiencies, lower smoke, CO and HC emission.***

Keywords: Ankola oil, Blends, Emissions, Ethanol, Efficiencies

1. Introduction

Biodiesel generally comprises of mono alkyl esters of long chain fatty acids derived from vegetable oil or animal fat (or mixture thereof). The designation of biodiesel blended with diesel indicates the percentage of it in the blend, e.g. B20 (20% biodiesel 80% diesel) and B100 is pure biodiesel. Globally, the feedstock for biodiesel production in great supply is soyabean oil, palm oil, ankola oil and rapeseed oil. Biodiesel has a tremendous potential in terms of energy contents and conversion efficiencies, even though the petroleum based fuels require more energy to produce than what they contain. The life cycle analysis concluded that biodiesel yields 3.2 units of fuel product energy for every unit of fossil fuel used to produce it; other projections go as high as 3.6. The major sources of energy in the world are oil, coal, natural gas, hyrdo energy etc. Oil is the most popular and abundant source of energy worldwide. However so, the price of crude oil is very volatile and supply is driven by price. While developed industrialized countries consume around 43 million barrels daily on an average, whereas developing countries only consume 23 million barrels a day on average. Something similar goes for coal and natural gas as well. Renewable energy sources are gaining popularity. In Asia, 3.7% growth has been projected over the ten year period from 2000 to 2010.As we are well aware of the depletion of fossil fuels, also the use of fossil fuels is degrading the environment in various ways. The pollution created by the increasing number of vehicles on the road, use of old technology also vents many pollutants in the atmosphere. There have been reported cases of new diseases linked with pollution, and increasing use of fossil fuel is solely responsible for these causes. Knowing the present global energy scenario, it is almost desperately important and essential to come up with an alternative solution. Alternative fuels are an option and the abundance of resources for producing biofuels can be successfully implemented. Biofuels consumption leaves us with less pollution or no pollution and can be produced without using the already depleting resources of fossil fuels. Global bioenergy potentials estimated could provide adequate supplies to the entire population in the future. There are affluent resources of biofuels in India seeing the country's strong agricultural aspect. For instance, biodiesel is beneficial in terms of enhanced biodegradation, lower levels of toxics and lower emission levels. The demand of diesel in India is way higher than that of petrol. Biodiesel industry in India is still in its growing stages. Keeping in mind that the country's expected energy demand growth at the rate of 4.8% over the next two decades, the Government of India has formulated an ambitious National Biodiesel Mission to meet 20% of the country's diesel requirement by 2011–2012 On the other hand, at present, the main hurdle in the commercialization of biodiesel is the cost of its raw material. 60–90% of the biodiesel cost arises from the cost of the feedstock oil. Biodiesel produced from ankola oil is one example.

2. Ankola Oil

The ankola tree, fruits and oil are as shown in the fig 1

Figure 1: Ankola tree and the oil

3. Esterification Process

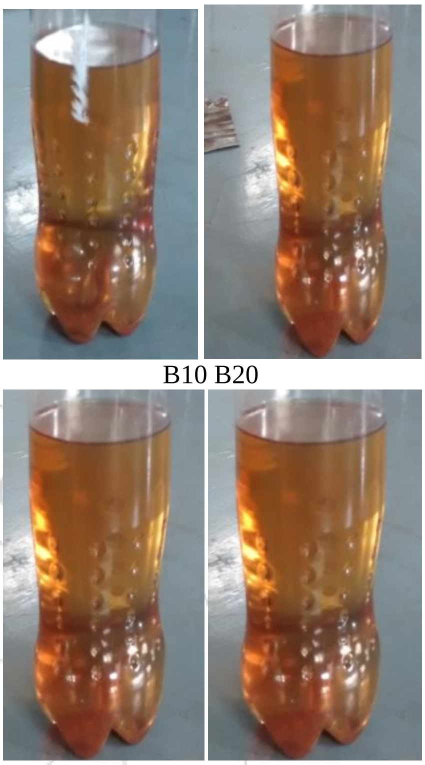
Biodiesel is produced by transesterification which is a process of using either ethanol or methanol, in the presence of a catalyst, such as potassium hydroxide, to chemically break the molecule of an oil or fat into an ester and glycerol. This process is a reaction of the oil with an alcohol to remove the glycerine, which is a by product of biodiesel production. The step wise reactions are reversible and a little excess of alcohol is used to shift the equilibrium towards the formation of esters. In presence of excess alcohol, the foreword reaction is pseudo-first order and the reverse reaction is found to be second order.

The first we are taken pretreatment oil temperature is 50-55oC. The products of the first stage pretreatment oil are used as the input of the alkaline transesterification process. A molar ratio of 6:1(Ratio of oil to ethanol) and 10grms by weight of potassium hydroxide (KOH) is found to give the maximum ester yield. The reaction time is maintains 2hr at 60oC. After the reaction is completed, the products are allowed to separate into two layers. The lower layer contains impurities and glycerol. This top layer (ester) is separated and purified using distilled water. Hot distilled water (20% by volume) is sprayed over the ester and stirred gently and allowed to settle in the separating funnel. The lower layer is discarded and upper layer (purified biodiesel) is separated. Transesterification of the oil produces ethyl esters (biodiesel) and glycerol. The ethyl ester layer is a light yellow liquid that is on top or bottom of the glycerol layer, which is dark brown in color. The mixtures may be kept overnight and allowed to separate by gravity. Otherwise, the ethyl ester is separated from the glycerol and washed with water and acetic acid until the washing water is neutral. The ethyl ester is then dried by heating. The Experimental set up esterification process is fig2.

Figure 2: Esterification process

4. Ankola Oil Blends

The blends are prepared after the esterfication process the blends B10(AOEE10% - Diesel 90%), B20(AOEE 20% - Diesel 80%), B30(AOEE 30% - Diesel 70%), and B40(AOEE 40% - Diesel 60%) are shown fig3



B10 B20

B30 B40

Figure 3: Blends B10, B20, B30 and B40

5. Fuel Properties

Some fuel properties Specific gravity, Flash point, Fire Point, kinematic viscosity, calarofic values of blends are mentioned in the table 1.

Table 1: Properties of Blends

Properties	Diesel	Ankola oil	B10	B20	B30	B40
Specific Gravity	0.83	0.876	0.834	0.84	0.848	0.84
Kinematic Viscosity (Cst)	4.3	31.2	5.3	6.1	7.0	7.5
Flash Point(oC)	54	172	78	90	98	112
Fire Point(oC)	65	198	93	121	135	154
Calorific Value(kj/kg)	42500	37710	42250	41638	41015	40020

6. Engine and Experimental Setup

Experiment were conducted on Kirloskar, four stroke, single cylinder, water cooled diesel engine. The rated power of the engine was 3.7kw at 1500 rpm. The engine was operated at a constant speed of 1500 rpm. The fuel flow rate was measured on volume basis using a burette and a stop watch. A smoke analyzer was used for the measurement of smoke in the exhaust. The performance and emission tests were started using 100%diesel and then fuel was replaced by blended fuels. Experimental set up shown in fig. Experiments were conducted using various blends increased the power output and reduced emission. Optimum performance was obtained for 30% Ankola oil blend biodiesel. The possible reasons for increased thermal efficiency more complete combustion and additional lubricity of Ankola oil. Hence Friction horsepower is reduced. So, the energy saved by decreased friction horsepower additional contribution towards useful energy, cooling losses and exhaust losses. Fig:4 Experimental setup of four stroke, single cylinder, water cooled diesel engine. Specifications of engine are presented in the table2.

Figure 4: Experimental setup of four stroke, single cylinder, water cooled diesel engine

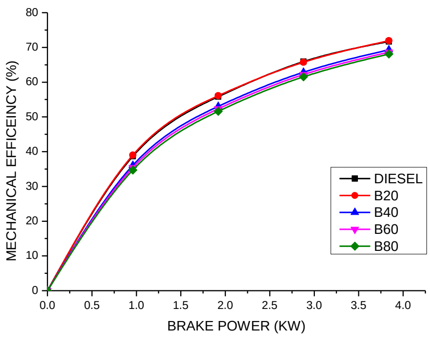
Table 2: Specification of Diesel Engine

Make	Kirloskar
Power	5hp
Speed	1500rpm
no. of cylinders	1
compression ratio	16.5:1
Bore	80mm
orifice dia	20mm
type ignition	compression ignition
method of loading	rope brake
method of starting	crank shaft
method of cooling	Water

7. Results And Discussion

Mechanical Efficiency

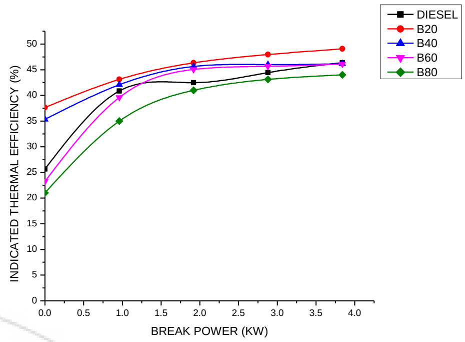
The variation of mechanical efficiency with brake power is shown in graph1. The plot it is reveals that as the brake power increases mechanical efficiency increases at full brake power condition. The mechanical efficiency of Ankola oil blend B20 increased when compared to the diesel at full brake power condition.



Graph 1: Brake power Vs Mechanical Efficency

Indicated Thermal Efficiency

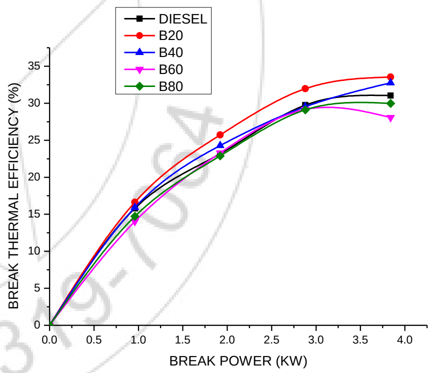
The variation of indicated thermal efficiency with brake power is shown in graph2. The plot it is reveals that as the brake power increases indicated thermal efficiency increases. The indicated thermal efficiency of Ankola oil blend B20 increased when compared to the diesel at full brake power condition.



Graph 2: Brake power Vs Indicated thermal Efficiency

Brake Thermal Efficiency

The variation of brake thermal efficiency with brake power is shown in graph3.The plot it is reveals that as the brake power increases brake thermal efficiency increases. The brake thermal efficiency of Ankola oil blend B20 increased when compared to the diesel at full brake power condition.



Graph 3: Brakepower Vs Break thermal efficiency

Volumetric Efficiency

The variation of volumetric efficiency with brake power is shown in graph4.The plot it is reveals that as the brake power increases volumetric efficiency decreases. The volumetric efficiency of Ankola oil blend B20 slightly decreased when compared to the diesel at full brake power condition.

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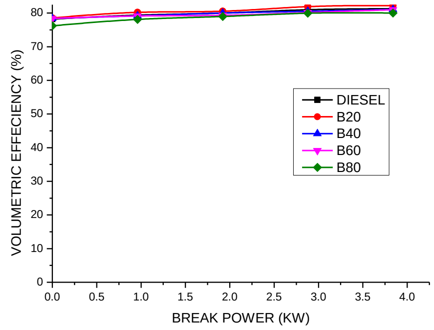
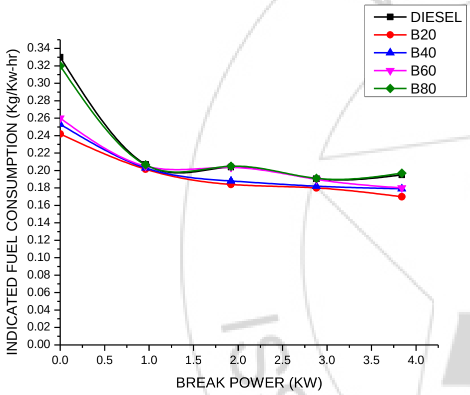


Graph 4: Brake power Vs Volumetric efficiency

Indicated Specific Fuel Consumption

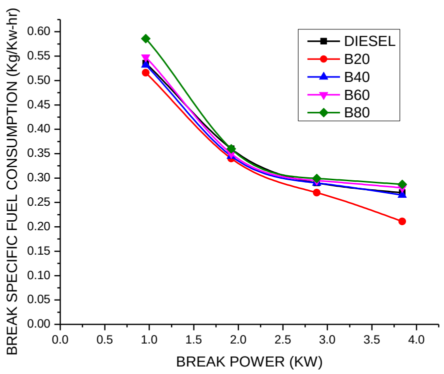
The variation of indicated specific fuel consumption with brake power is shown in graph5.The plot it is reveals that as the brake power increases indicated specific fuel consumption decreases. The indicated specific fuel consumption of Ankola oil blend B20 slightly decreased when compared to the diesel at full brake power condition.



Graph 5: Brake power Vs Indicated specific fuel consumption

Brake Specific Fuel Consumption:

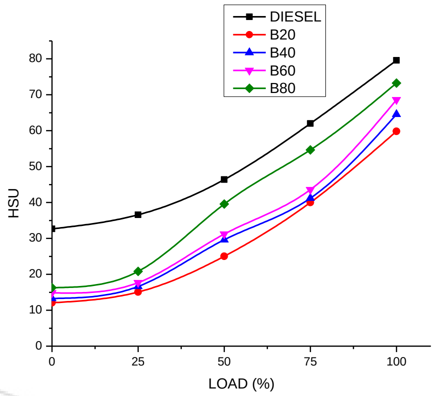
The variation of brake specific fuel consumption with brake power is shown in graph6.The plot it is reveals that as the brake power increases brake specific fuel consumption decreases. The brake specific fuel consumption of Ankola oil blend B20 slightly decreased when compared to the diesel at full brake power condition.



Graph 6: Brake power Vs Brake specific fuel consumption

Smoke Density (H.S.U)

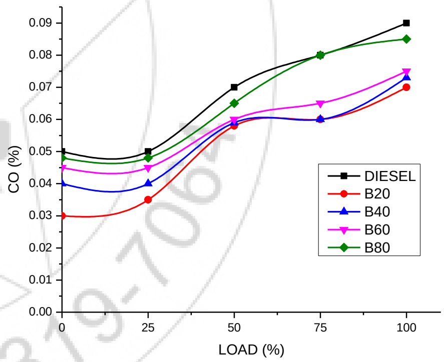
The variation of smoke density with load is shown in graph7. The plot it is reveals that as the load increases smoke density decreases. The smoke density of Ankola oil blend B20 slightly decreased when compared to the diesel at full load condition.



Graph 7: Load Vs Smoke Density(HSU)

Carbon Monoxide (CO)

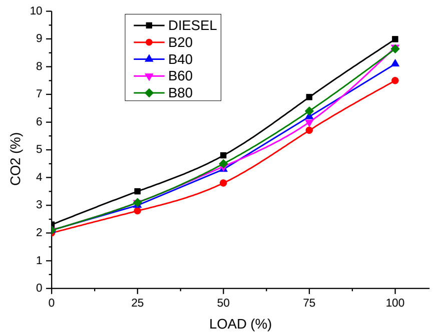
The variation of carbon monoxide with load is shown in graph8. The plot it is reveals that as the load increases carbon monoxide decreases. The carbon monoxide of Ankola oil blend B20 slightly decreased when compared to the diesel at full load condition.



Graph 8: Load Vs CO

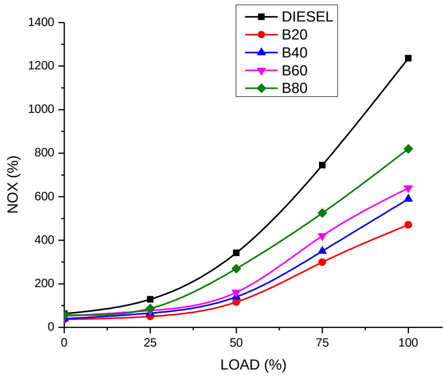
Carbon Dioxide (CO2):-

The variation of carbon dioxide with load is shown in figure. The plot it is reveals that as the load increases carbon dioxide decreases. The carbon dioxide of Ankola oil blend B20 slightly decreased when compared to the diesel at full load condition.



Graph 10: Load Vs CO2

Nitrogen Oxide (NOx):
The variation of N0x with load is shown in graph11. The plot it is reveals that as the load increases N0x decreases. The N0x of Ankola oil blend B20 slightly decreased when compared to the diesel at full load condition.



Graph 11: Load Vs NOx

8. Conclusion

- The experiments are conducted on the four stroke single cylinder water cooled diesel engine at constant speed (1500rpm) with varying 0% to 100% loads with diesel and different blends of Ankola oil like B10, B20, B30 and B40.
- The performance parameters such as ηMECH, ηBTE, ηITE, ηVOL, BSFC and ISFC were calculated from the observed parameters and shown in the graphs.
- The emissions characteristics such as carbon monoxide(CO), hydro carbons(HC), carbon dioxide(CO2), oxygen(O2), nitrogen oxide (NOx), smoke density(H.S.U) are also decreased, will compared to diesel and other blends.
- It is observed that having 20% Ankola oil blend with diesel CI engine gives energetic results for as performance parameters.
- And emissions characteristics also decreases will compared to diesel at 20% Ankola oil blend with diesel.

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