Performance Analysis of a Diesel Engine with the Help of Blends of Linseed Oil Biodiesel

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Abstract - Due to the increase in the demand of the fossil fuel along with decline in the fossil fuel resources the necessity of an alternative fuel arises. This fuel should be economical and at same performance rate as compared to the fossil fuel. In consideration of the following parameters biodiesel fuel offers very promising results. The biodiesel fuel is generated with different feed stocks such as vegetable oils, waste cooking oils and animal fatty oils. In the present work linseed oil is used to make the biodiesel fuel. This fuel is then blended with pure diesel fuel at specific level such as B20 and B40. These fuels are used to drive a single cylinder four stroke diesel engine. The results show that the B20 biodiesel shows very close result to pure diesel fuel. Finally, it has been shown that due to very similar properties of Linseed oil and Diesel oil, Linseed oil is a very promising and potential substitute of Diesel fuel.

Keywords: linseed oil, biodiesel, Transesterification process

I. INTRODUCTION

In Today's world the population and the standard of living of humans are increasing day by day. A large amount of automobiles are produced in the world wide. So, as the numbers of the automobiles is increasing, the utilization of the petroleum product is also increasing. So demands of the petroleum products arise in the world. However, it is fact that the quantity of the petroleum product available in the world is few. And the order of the utilization of the fuels is very high. So an alternative fuel is required to use at the place of petroleum product which give fine results and nice performance of the automobiles and engines.

To meet the proper requirement of the petroleum fuel, researchers were now focusing upon the best alternative fuel for the replacement of the petroleum fuel. In the experiments, biodiesel shows very close result as compare to the petroleum fuels. So researcher's shows there keen interest to find a best biodiesel which used as the petroleum fuel in future. Biodiesel are renewable and having similar properties as diesel fuels. [1] The biodiesel is clean, renewable resource fuel which produces from the domestic products such as plant oils, animal fats, and waste cooking oils. These products can also be called as feedstocks in a large domain. There are different types of vegetables oils such as Soybean, cottonseed, palm, peanut, and sunflower are used in the production of the biodiesels. [2]

The biodiesel is produce from the vegetable oils and animal fats. Every biodiesel have different properties. These properties mainly depend upon the type of feedstocks used. Basically different vegetables oils and animal oils were having different structure of fatty acid. So the properties of biodiesels depend upon the structure of the fatty acid. [3]

M.K.Ghosal et. al [2008], studied the Performance of a Diesel Engine by using Mahua Methyl Ester as biodiesel fuel and its Blends with Diesel Fuel. In this work experiments were performed with four different blends of

biodiesel varies from 20% to 100% by the volume basis. Three different temperature ranges such as 30, 50 and 70°C and two different pressure ranges such as 17640 kPa and 24010 kPa are used as an operating condition. It is found that the brake specific fuel consumption and the exhaust gas temperature of engine are increased with the increases in the concentration of the biodiesel fuel in the blending fuel. However, it is also observed that the brake power output of the engine is increases with the decrease in the concentration of the biodiesel in the blended fuel. The brake powers output, and exhaust gas temperature of the engine increased with the increase, decrease and decrease respectively of the fuel temperatures and operating pressures.

Kazi Mostafijur Rahman et. al [2010] analysis the performance of the Jatropha oil as a alternative fuel for diesel engine. It is seen that the brake power and brake thermal efficiency values of the pure diesel fuel is much higher than the pure diesel fuel and B50 biodiesel blended fuel. However, B50 fuel shows lower value as compared to both pure diesel and pure biodiesel fuel. It is also seen that the pure biodiesel fuel shows a lower value of the brake specific fuel consumption as compared to both diesel and B50 fuel.

Sachindra Dhakad et. al [2013] studied the Performance analysis of an IC Engine Using Jatropha Oil and waste mustard oil as a Biodiesel. In this work different blend of biodiesel is made such as B10, B20, B30, B40 and B50 with both Jatropha and waste mustard oil. The results show that Jatropha oil and waste mustard biodiesel fuel runs with optimum performance as compared to the pure diesel fuel. B30 Jatropha biodiesel shows good results as compared to B30 mustard biodiesel of brake specific fuel consumption. It is also seen that the Jatropha biodiesels shows higher brake thermal efficiencies as compared to all waste mustard biodiesel fuels.

Ashish Jawalkar et. al [2012] investigate the Performance and Emission Characteristics of Mahua and Linseed Biodiesel Operated at Varying Injection Pressures on Compression ignition Engine. In this work the experiments were performed at three different pressure conditions such as 160, 180 and 200 bar. The readings were taken at the 27° BDTC at 16.5:1 compression ratio for both the biodiesels. The result shows that as the proportion of Mahua biodiesel increases in the blend, the brake thermal efficiency decreases. However, the linseed biodiesel shows increasing trends of thermal efficiency with concentration of the biodiesel fuel in blends.In the analysis of the emission characteristics it is seen that the carbon monoxide emissions are more with Mahua biodiesel when compared to Linseed biodiesel at full load condition. Also at 20% load, HC emissions for Mahua biodiesel and blends are quite high.

Dr. Hiregoudar Yerrennagoudaru et. al [2014] analysis the Performance & emission of compression ignition Engine Using Diesel & Ethanol blended with linseed oil. The results show that as load increases brake thermal efficiency is also increases for diesel as well as Biodiesel fuel. It is concluded that the lower heating value of the biodiesel is responsible for increase in the Brake thermal efficiency. In the analysis of the specific fuel consumption (SFC) it is clearly seen that at different loads the specific fuel consumption of Biodiesel fuel is more than the diesel. It is concluded that due to the lower energy value of the biodiesel fuel engine responds to the load by increasing the fuel flow. Thus specific fuel consumption decreases with the increase in thermal efficiency. Also it is seen that the carbon monoxides (CO) level increases when Biodiesel is used as a fuel. From the graph it is clear that the carbon dioxides (CO_2) level decreases when Bio fuel has a fuel.

Due to the increase in the rate of consumption and decrease in the rate of the available quantity of the diesel fuel would generates the requirement of the biodiesel fuel as an alternative fuel. The main objective of the present work is to analysis the behavior and performance characteristics of the test diesel engine which is fueled with the biodiesel fuel. The linseed oil is used for the preparation of the biodiesel fuel. In the present work, the blends of biodiesel with diesel fuel can be used in the experiments. The biodiesel can be blend as two different level as B20 and B40. For the experiment purpose a single cylinder compression ignition engine (diesel engine) is used. The experiment can be performed at different load conditions. The performance characteristics like brake power (B.P.), brake specific fuel consumption (BSFC), brake specific efficiency were measured. For the comparison purpose the biodiesel results were compared with the pure diesel fuel.

II. BIODIESEL PRODUCTION METHOD

In the present work, Linseed oil which can grow in arid and wastelands has been used for the analysis purpose. Linseed oil biodiesel is prepared by the Transesterification process. It was then blended with pure diesel fuel at two different levels i.e. B20, B40. Linseed oil, also known as flax seed oil is a clear to yellowish oil obtained from the dried ripe seeds of the flax plant. Linseed oil is essentially non toxic. In this work, Biodiesel was derived from linseed oil which underwent single stage Transesterification process. Linseed oil was purchased by the local market.

It is easily available oil in the local market at cheap rates. The main reaction in making biodiesel fuel is Esterfication process. Actually, a normal vegetable oil is not sufficient to produce power in engine with perfect efficiency. It is so because normal vegetables oil did not have sufficient properties as petroleum fuels. The properties of these oils can be increased by Esterfication process.

The most common way of producing biodiesel is the Transesterification of vegetable oils and animal fats. Oil or fat reacts with alcohol usually methanol or ethanol. This reaction is called Transesterification process. The reaction requires heat and a strong catalyst (alkalis, acids, or enzymes) to achieve complete conversion of the vegetable oil into the separated esters and glycerin. [2]

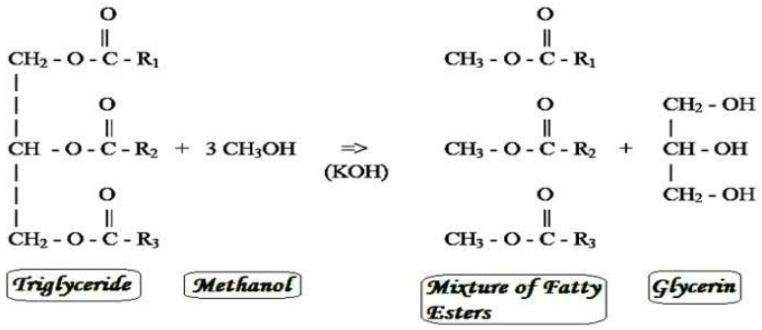

Figure 1. Reaction of the Transesterification process [2]

After the production of required biodiesel fuel, properties are estimated with different the help of apparatus. These properties are compared by with the pure diesel fuel and ASTM standard for fuel. The comparative properties of the pure diesel and biodiesel are as shown in the table 1.

Table 1. Comparative properties of the pure diesel and test biodiesel fuel

S.No.	Property	ASTM Standard	Diesel Fuel	Biodiesel fuel
1	Density (300C), kg/m3	-	850	855
2	Kinematic Viscosity, cSt	<5	2.045	3.10
4	Carbon residue, %(m/m)	<0.05	0.022	0.046
5	Cloud point, °C	-3 to 12	-11	-
6	Pour Point, °C	-15 to 10	-14	-
7	Flash point, °C	>130	61	91
8	Fire point, °C	>53	68	100
9	Calorific value, KJ/kg	>33000	42000	41188

The biodiesel fuel has to blend with pure diesel for the good performance and better result. Simple biodiesel fuels were not combusted fully and give better performance. So these fuels can be blend with the pure diesel fuel in a specific quantity for the utilization in the engine. In the present work, the biodiesel fuel blended with two different ways such as B20 and B40. B20 means 20% biodiesel and 80% diesel fuel and B40 means 40% biodiesel and 60% diesel fuel. For the comparison purpose, two different biodiesel blended fuels and pure diesel fuel was used in the diesel engine.

III. TEST ENGINE SPECIFICATION

For the analysis of the biodiesel fuel, a test diesel engine is used in the experiments. This engine is fueled with different blends of biodiesel and pure diesel fuel for the comparison purpose. The performance characteristics were analyzed on this engine. The specifications of the test engine shows in the table 2.

Table 2. Specifications of the test engine

S.No.	Parameter	Specification
1	Type of Engine	Compression ignition Engine (Diesel Engine)
2	No. Of Cylinders	Single Cylinder
3	Position of the Engine	Vertical
4	Power of the Engine	5HP
5	Rated Speed	1500 RPM
6	Cooling System	Water cooled
7	Governing System	Self governed
8	Bore Diameter, stroke length	85 mm, 110 mm
9	Dynamometer	Hydraulic Dynamometer with weighing attachment and load control gear
10	Type of Lubricating oil	20w/40 lubricating oil
11	Capacity of Lubricating oil	3 lit.

The experiments were performed on test diesel engine with varying loads ranging from 0% to 100% of full load. Actual load values varying from 0 to 20 kg were applied on the engine with dynamometer. The engine and biodiesel fuel pictures are shown in fig. 2 and fig.3.

Figure 2. Test Diesel Engine

Figure 3. the Biodiesel

IV. RESULT AND DISCUSSION

1. Brake Power

On the analysis of the brake power of engine in figure 4, it is found that the diesel fuel shows maximum brake power as compare to biodiesel blended fuels. It is also seen that as the load was increasing the brake power is also increasing for all the fuels. B20 fuel shows a higher value of brake power as compared to the B40 fuel. As the concentration of the biodiesel fuel in blends increases, the brake power decreases. It is so because at low concentration of the biodiesel fuel, high combustion of fuel takes place and high brake power produced in the engine. However, it is seen that the B20 fuel shows close results of brake power with diesel fuel.

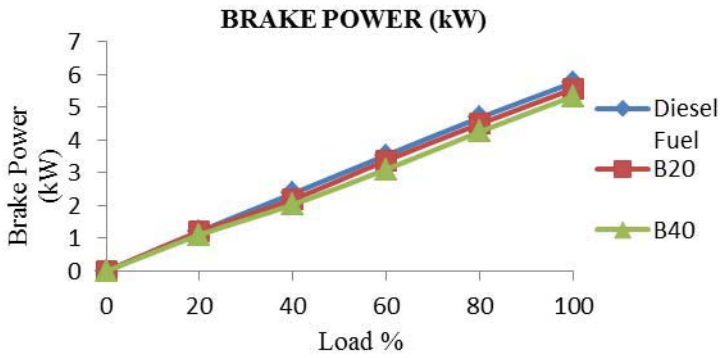

Figure 4. Analysis of the Brake Power with different fuels

2. Brake Thermal Efficiency

For the analysis of the performance characteristics of the engine, brake thermal efficiency is a main important parameter. In the analysis of the brake thermal efficiency in figure 5, it is seen that the diesel fuel has high efficiency as compare to the biodiesel blended fuels. As the load was increasing, the efficiency of the diesel fuel is also increasing. It is also seen that the B20 fuel shows high efficiency upto 60% of the load as compared to the B40 fuel. However, at high load conditions, B40 blended fuel shows little bit higher increase in the efficiency value as compared to the B20 fuel. It is also observed that at full load condition, all the fuel i.e. diesel, B20 and B40 were having approximately similar values of efficiencies. At high load conditions, better combustion of fuel takes place and efficiency is increasing. This is on account of the diminishing Calorific Value of the Blends due to increase in the quantity of linseed oil.

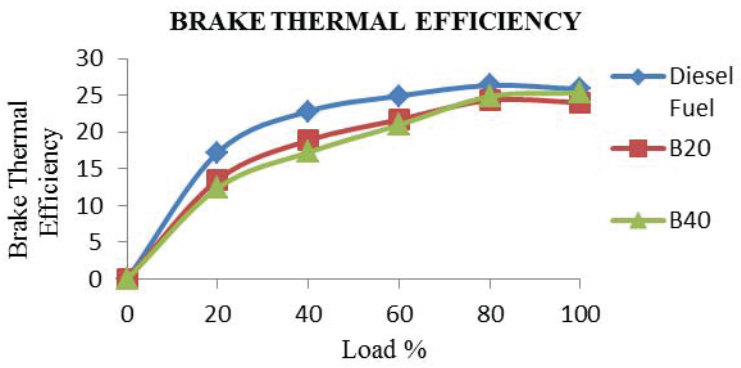

Figure 5. Analysis of the Brake Thermal Efficiency with different fuels

3. Brake Specific Fuel Consumption

Brake specific fuel consumption basically shows the amount of fuel used in the experiment to run the engine. In the analysis of the brake specific fuel consumption of the engine, three different fuels were used in the engine. The fuels were used as g/hr basis in the engine. The analysis of brake specific fuel consumption in figure 6 shows that B40 fuel shows higher value of specific fuel consumption as compared to B20 and diesel fuel.

It is also observed that the initial value of the specific fuel consumption of all the three fuels was having highest values. However, as the load increases, the specific fuel consumption decreases. This is because, as the loads on engine increases, fuel consumption also increases, but the Brake power output outweighs the fuel consumption increase.

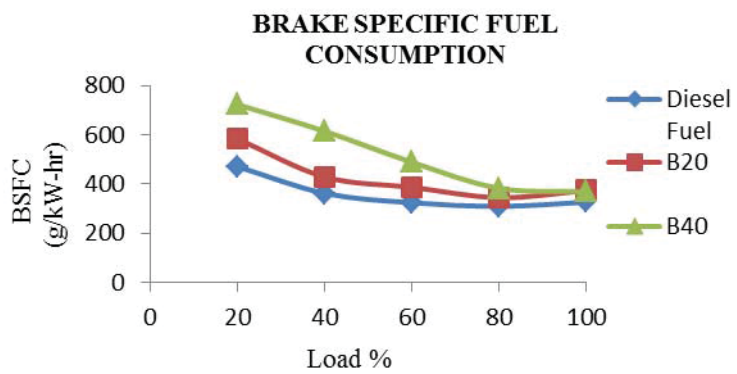

Figure 6. Analysis of the Brake Specific fuel consumption with different fuels

V. CONCLUSION

In the present work, the performance and emission characteristic of a single cylinder diesel engine was analyzed with two different blended biodiesel fuels. For the preparation of the biodiesel Linseed oil was used. Then pure biodiesel was blended with pure diesel fuel at two different stages B20 and B40. The performance and emission characteristic of the diesel engine was analyzed at different load conditions. For the comparison purpose these blended biodiesel result were compared with the pure diesel fuel. The following are the conclusion would make in the present work:-

1. As the load was increasing the brake power is also increasing for all the fuels.
2. B20 fuel shows a higher value of brake power as compared to the B40 fuel. As the concentration of the biodiesel fuel in blends increases, the brake power decreases.
3. B20 fuel shows approximately similar values of brake power as compared to the diesel fuel.

4. It is seen that the diesel fuel has high efficiency as compare to the biodiesel blended fuels. As the load was increasing, the efficiency of the diesel fuel is also increasing.
5. It is observed that at full load condition, all the fuel i.e. diesel, B20 and B40 were having approximately similar values of efficiencies. Some amount of deviation occurs due to the variation in the density of the blended biodiesel fuel.
6. The analysis of brake specific fuel consumption shows that B40 fuel shows higher value of specific fuel consumption as compared to B20 and diesel fuel.

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