Performance characterization of single cylinder diesel engine fuelled with Sesame oil - diesel and its blend with Ethanol

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Abstract

Recent decades continuous increased in the fuel price and fast depletion of the available fossil fuel reservoir, so it is necessary to find out the alternative fuel for the engine. The use of vegetable oils as a fuel in diesel engines causes some problems due to their high viscosity compared with conventional diesel fuel. Various techniques and methods are used to solve the problems resulting from high viscosity. One of these techniques is fuel blending. In this study, a blend of sesame oil in the various proportion like 20%, 30%, 40%, and up to 50% in the diesel fuel was used as an alternative fuel in a direct injection diesel engine. Find the best suitable blend and add the ethanol in that blend in the 5%, 10%, and 15% find the engine performance. Engine performance was investigated and compared with the ordinary diesel fuel in a diesel engine. It is observed that fuel consumption increased with increase in sesame oil concentration in Diesel fuel but the blend of S30D70 fuel consumption is nearest to the diesel fuel. The break thermal efficiency of S20D80 blend also found nearest to the diesel fuel. It is concluded that it is possible to use Sesame oil in diesel engines as an alternate fuel in the future.

1. Introduction

Now a day's Vegetable oils are the best alternative to diesel oil since they are renewable and have similar properties. Many researchers have studied the use of vegetable oils in diesel engines. Vegetable oils offer almost the same power output with slightly lower thermal efficiency when used in diesel engine [1-5]. Vegetable oils have some merit as follows: they are renewable energy as the vegetables that produce oil are renewable, heat release rate is similar to diesel, its emissions (CO, HC and PM) rate is relatively low [6], they do not contain almost sulfur element, and they can be used with simple or without modifications in the diesel engine. It is known that the original diesel engine designed by Rudolph Diesel run with vegetable oil. Nowadays, vegetable oils are good alternative fuels to the fossile fuel and can be used instead of the ordinary diesel fuel as fuel in diesel engines [7, 8].

The main problem of using neat vegetable oils as fuel in diesel engines is related to their high viscosity. The high viscosity generate the following problems in diesel engine; the choking of fuel lines and filters, poor atomization of the fuel, incomplete combustion, severe engine deposits, injector coking with trumpet formation and piston ring sticking, gum formation and thickening of the lubricating oil. In order to solve these problems caused by the very high viscosity of neat vegetable oils, the following usual methods are adopted: blending in small blend ratios with normal diesel fuel, pre-heating, esterification.The blending method has the advantages of improving the use of vegetable oil fuel with minimal fuel processing and engine modification. Hence, mixing diesel fuel with vegetable oils with specific ratio reduces viscosity and consequently they can be used as alternative fuels in diesel engines. The main purposes of this study are to investigate the sesame oil - diesel fuel and ethanol blend as a fuel in a direct injection diesel

engine and to determine engine performance and exhaust emissions characteristics. In the study, sesame oil is blended with diesel fuel at a various proportion like 20%,30%,40%, and 50% ratio on volume basis in order to reduce the high viscosity of sesame oil. Find the best suitable blend and add the ethanol in that blend. The experimental results are compared with those of ordinary diesel fuel.

2. Sesame oil

Soyabean oil is of primary interest as biodiesel source in USA, while many European countries use rapeseed oil, and countries with tropical climate prefer to use coconut oil or palm oil. Rapeseed oil has been grown in Canada since 1936. Hundreds of years ago, Asians and Europeans used rapeseed oil in lamps. Cottonseed oil is used almost entirely as food material. Sesame, olive, and peanut oil can be used to add flavour to foodstuff. Walnut oil is high-quality edible oil refined by purely physical means from quality walnuts. Poppy seeds are tiny seeds contained within the bulb of the poppy flower, also known as opium plant. Dry oils such as Walnut, sunflower, safflower, dammar, linseed, poppy seed, and stillingia, tang, and vernonia oils are used for paint and wood-finishing applications. The solution to avoid twin problems of environmental pollution and energy shortage should be carefully planned gradual shift of our energy economy from fossil fuels to renewable sources of energy. The property of sesame oil and diesel is shown in the table 1.

2.1 PROPERTY TABLE:

Table: 1 Comparison of sesame oil with diesel. [6]

Property	Diesel	Sesame oil
Heating value(KJ/Kg)	42900	39349
Viscosity(mm^2/s)	4.3(at 27 ^{o} C)	35.5 (at 38 ^{o} C)
Density (kg/l)	0.815	0.913
Cetane number	47	40.2
Flash point	58	260
Sulfar	< 0.01	0.01

3. Experimental setup

3.1 Engine Set Up:

Specifications of the engine are shown in Table 2. The test engine used was a single cylinder, air cooled, direct injection stationary diesel engine. A Rope break dynamometer was used to provide the engine load. A chromel alumel thermocouple, in conjunction with a digital temperature indicator, was used to measure the exhaust gas temperature. An air box and inlet manifold were fitted to the engine, and an air flow meter was used for airflow measurement. The fuel was passed from the fuel tank to the engine via the fuel injection pump and the fuel injector, and the fuel flow was measured on volumetric basis using a burette and a stopwatch. Initially, experiments were carried out using base diesel fuel. All the experiments were conducted at the rated engine speed of 1500 rpm.

Table: 2 Engine specifications:

Parameter	Details
Engine	Single Cylinder High Speed Diesel Engine
Cooling	Water cooled
Bore × Stroke	80 mm × 110 mm
Compression ration	16 : 1
Maximum Power	5 hp or 3.7 kw
Rated speed	1500 rpm
Capacity	553 CC

TEST PROCEDURE:

In this experiments used the diesel engine and it is connected with the rope break dynamometer with the help of dynamometer, varies the load on the engine or load remain constant .Gas analyzer is used to find the emission characteristic of exhaust gas. The reading takes by constant load or by varying the load on the engine using the dynamometer. the line diagram of the test rig as shown in fig 1. Engine performance such as break power, indicated power, break specific fuel consumption etc find from the experiments .First only diesel fuel is used and engine performance is find .Then the blending of diesel and sesame oil at different proportion like 20%, 30%, 40% and 50%

concentration in the diesel fuel takes and find the engine performance. By taking the analysis of the various blend of diesel and sesame oil it is shows that the best blend is to be S30 blend. After selecting the S30 blend as a best blend then ethanol is to be added in the 5%, 10% and 15% proportion in that blend and find the engine performance of diesel engine.

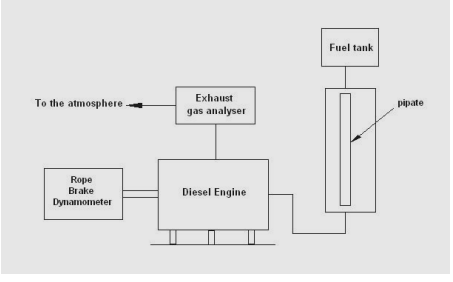

Fig.1 Line diagram of diesel engine test rig with rope break dynamometer.

4. RESULTS:

4.1 Fuel Consumption:

Fig 2 shows the variation of specific fuel consumption with break power at various blend proportion in the diesel. Fuel consumption of the diesel fuel is less as compared to the other blend. It also show that as the break power increased the fuel consumption also increased. In the S30D70 blend the fuel consumption is nearest to the diesel fuel. Also the concentration of sesame oil increased the Fuel consumption also increased. By adding the ethanol in the S30D70 blend in the proportion of 5%, 10% and 15% the Fuel consumption increased. Fuel consumption is maximum in the 15% ethanol with the 85% blend of diesel and sesame oil (S30D70) blend.

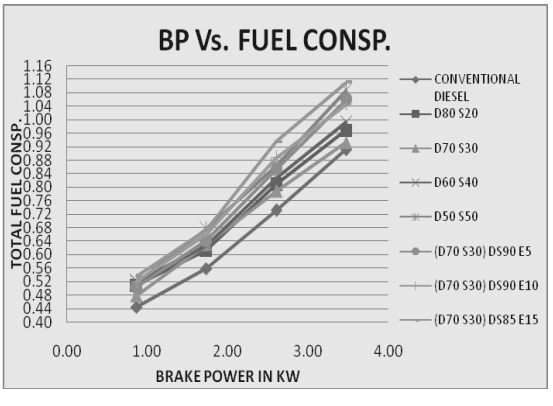

Fig 2 Variation of fuel consumption with break power.

4.2 Specific Fuel Consumption:

From the fig 3 it shows that the specific fuel consumption decreases with increase in break power. By adding the sesame oil at the proportion of 20%, 30%, 40% and 50% specific fuel consumption considerably increased for all load conditions. It means as the concentration of sesame oil increased the SFC also increased. But from the fig 3 it shows that the SFC is best in the S30 blend which is nearest to the diesel fuel.

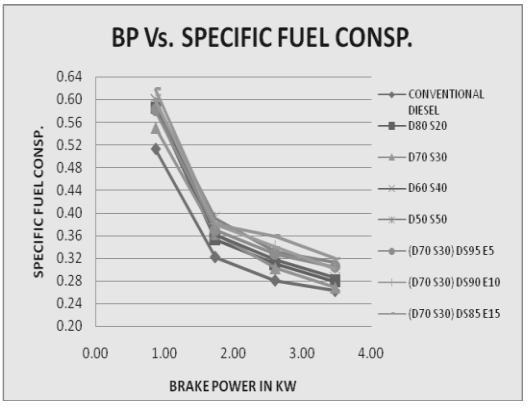

Fig 3 Variation of specific fuel consumption with break power.

By adding ethanol in the S30D70 blend at the proportion of the 5%, 10% and 15% it effect shows that the SFC increased but as compared to the S40D60 and S50D50 blend ,5% ethanol blend with the 95% blend of S30D70 blend gives the low SFC.

4.3 Break Thermal Efficiency:

Break thermal efficiency is defined as the ratio of break power to product of fuel consumption and calorific value. From the fig 4 shows that the break thermal efficiency increased with increased in the break power. As the sesame oil concentration increased in the diesel fuel the break thermal efficiency is to be decreased. The Break thermal efficiency in the S20 blends which is nearest to the diesel fuel. If ethanol added in the S30D70 blend in the proportion of 5%, 10% and 15% then break thermal efficiency reduced in the 10% and 15% blend but the 5% blend gives the more compared to the S50D50.

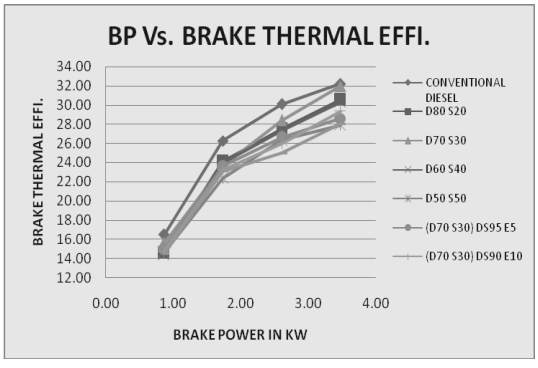

Fig. 4 Variation of break thermal efficiency with break power.

4.4 Mechanical efficiency:

Mechanical efficiency is define as the ratio of the break power to the indicated power of the engine. From the fig 5 it is concluded that the mechanical efficiency is high using blends of S20D80 and S60D40 that of the blends of diesel. From the graph it is also concluded that the S40D60 blend mechanical efficiency is maximum as compared to the conventional diesel fuel as well as the other blend also.

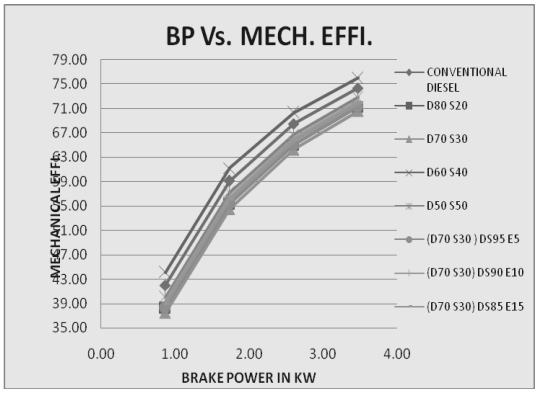

Fig. 5 Variation of mechanical efficiency with break power.

5. CONCLUSION:

- From the analysis, it concluded that D70 S30 found best optimum blend compare to the other blend.
- This blend can directly used in the single cylinder 4-stroke diesel engine without modification of the engine.
- It is also concluded that as the sesame oil concentration increased in the diesel the fuel consumption increased.

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