Review of Performance Study of Single Cylinder Four Stroke C.I. Engine by using Castor Methyl Ester Blends with Diesel

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Abstract-- *The depletion of oil resources as well as the environmental regulation has led to the development of alternate energy sources. In this present work the performance characteristics of a single cylinder diesel engine when fulled with blends of Castor oil and diesel are evaluated. Experiments were conducted with different blends (B10&B20) of Castor oil and diesel as various loads. The results show that the brake thermal efficiency of diesel is slightly higher at all loads followed by blends of Castor oil and diesel, it has been established that 20% of Castor oil biodiesel can be use as a substitute for diesel without any engine modification thus Castor oil as non-edible oil can be a good renewable raw material for biodiesel production.*

Keywords-alternate fuels, blends, diesel engine, Castor oil, performance, Transesterification

I. INTRODUCTION

Conventional energy sources such as oil, coal and natural gas have limited reserves. World primary demand is projected to increase by 1.5% per year between 2007 to 2030, from just over 12,000 million tonnes of oil equivalent to 16800 million tones-as overall increase of 40%. As world reserves of fossil fuels and raw material are limited, it has stimulated active research interest in non petroleum and non polluting fuels. Diesel engines are the major source of power generation and transportation hence diesel is being used extensively, but due to the gradual impact of environmental pollution there is an urgent need for suitable alternate fuels for use in diesel engine without any modification

There are different kinds of vegetable oils and biodiesel have been tested in diesel engines its reducing characteristic for green house gas emissions. Its help on reducing a country's reliance on crude oil imports. Its supportive characteristic on agriculture by providing a new market for domestic crops, its effective lubricating property that eliminates the need of any lubricate additive and its wide acceptance by vehicle manufacturers can be listed as the most important advantages of biodiesel fuel. There are more than 350 oil bearing crops identified, among which only Jatropha, ongamia, sunflower, Soyabean, cottonseed, rapeseed, palm oil and peanut oil are considered as potential alternative fuels for diesel engines. The present study aims to investigate the use of Castor oil blend with diesel as an alternate fuel for compression ignition engine.

II. LITERATURE REVIEW

A through literature review connected to biodiesel and performance of CI engines with these biodiesel and its blends in various conditions are reported below.

Avinash Kumar Agrawal et al-

This paper touches upon well-to-wheel green house gas emission, well-to-wheel efficiencies, fuel versatility, infrastructure, availability, economics, engine performance and emission, effect on wear, lubricating oil etc. Ethanol is also an attractive alternative fuel because it is a renewable bio based resource and it is oxygenated, thereby providing the potential to reduce particulate emission in CI engines. In this review the properties and specification of ethanol blended with diesel and gasoline fuel are also discussed. Special emphasis is placed on the factor critical to the potential commercial use of these blends. The effect of the fuel in engine performance and emissions (SI as well as CI engines) and material compatibility is also considered. This paper concludes that Using ethanol as a fuel additive to unleaded gasoline causes an improvement in engine performance and exhaust emissions. Ethanol addition result in an improvement in brake power, brake thermal efficiency, volumetric efficiency and fuel consumption. However, the brake specific fuel consumption and equivalence air-fuel ratio decreases because of lower calorific value of the gasohol. Using an Ethanol-unleaded gasoline blends to significant reduction in exhaust emission of CO and HC for all engine speeds. On the other hand, CO2 emission increases marginally. Ethanol diesel blend up to 20% can very well be used in present day constant speed CI engines without any hardware modifications. Exhaust gas temperatures and lubricating oil temperatures were lower for ethanol diesel blends than mineral diesel. The engine could be started normally both hot and cold.

Significant reduction in CO and NOx reduction was observed while using ethanol diesel blends.

Senatore et al-

Reported that with rapeseed oil methyl ester heat release always takes place in advance as compared to diesel. Also injection starts earlier and the average cylinder gas temperature are higher in case of biodiesel as a fuel.

Puhan et al-

Have tried mahua oil ethyl ester (MOEE) in four stroke naturally aspirated direct injection diesel engine and have reported an increase in BSFC of MOEE compared to diesel. Also an increase in break thermal efficiency, reduction in CO emission, increase in CO2 emission, 63% reduction in HC emission, reduction in NOx and 70% reduction in smoke are reported.

Altel et al-

Have conducted performance and emission test in a diesel engine fuelled with methyl ester of sunflower oil, cotton seed oil, soya bean oil, refined corn oil, distilled opium poppy oil and refined rapeseed oil and concluded that compared to diesel fuel, little power loss, higher particulate matter emission, lesser NOx emission were noted for vegetable oils. Also vegetable oil methyl ester with their performance and emission closer to diesel fuel are acceptable substitute of diesel.

Deepak Agrawal, Lokesh Kumar, Avinash Kumar Agrawal et al-

In this paper study was carried out to investigate the performance and emission characteristics of linseed oil, rice bran oil and line seed methyl ester (LOME) in a stationary single cylinder, four stroke diesel engine and compare it with mineral diesel. The linseed oil, mahua oil, rice bran oil and LOME were blended with diesel in different proportions. Baseline data for diesel fuel was collected. Engine test were performed using all these blends of linseed, mahua, rice bran and LOME. Straight vegetable oil posed operational and durability problems when subjected to long term usage in CI engine. These problems are attributed to high viscosity, low volatility and poly saturated character of vegetable oils. However, these problems were not observed for LOME blends. Hence process of transesterification is found to be an effective method of reducing vegetable oil viscosity and eliminating operational and durability problems. Economic analysis was also done in this study and it is found that use of vegetable oil and its derivative as diesel fuel substitute has almost similar cost as that of mineral diesel. This paper concluded that the performance and emission parameters for different fuel blends were found to be very close to diesel. Smoke density and BSFC were slightly higher for vegetable oil blends compared to diesel. However, BSEC for all oil blends were found to be lower than diesel. Vegetable oil blend shows performance characteristics close to diesel. Therefore, vegetable oil bends can be used in compression ignition electricity generation. Economic analysis was also conducted to find out cost of biodiesel after transesterification.

Stainlaw Pehan, Marta Svoljsak Jerman et al-

This paper deals with the influence of the biodiesel on some tribology characteristics of bus diesel engine with a mechanically fuel injection system. The tests have been performed on fully equipped engine test bed, on a fuel injection test bed and on a discharge coefficient testing device. The latest fuel was neat biodiesel produced from rapeseed. Attention was focused quite similar when using D2 or B100. By changing from B2 to B100 on the biodiesel influence on the pump plunger surface roughness, on the carbon deposits in the combustion chamber, on the injector and in the injector nozzle hole. This Paper concludes that the carbon deposits in the combustion chamber are only the redistribution of the deposits was observed. This is probably due to quite different injection characteristics resulting from high viscosity and high molecular weight of biodiesel.

Demirbas et al-

Reviewed the bio-diesel production, characteristics and the experimental works carried out in the field of bio-diesel. It is reported that the transesterification of triglycerides by methanol, ethanol, propanol and butanol has proved to be the most promising process. Also molar ratio of alcohol to vegetable oil and reaction temperature, catalyst, pressure, reaction time and the content of the free fatty acids and water in oils are variable affecting the methyl ester yields during the transesterification reaction. It is also reported that in supercritical methanol transesterification method, the yield of conversion raises 96% in 10 min.

Kamee and Chala et al-

Prepare bio-diesel from Pongamia by transesterification of the crude oil with methanol and KOH as the catalyst and reported a 92% conversion at 60 IC with 1:10M ratio for KOH and the properties such as viscosity, flash point of the bio-diesel compare well with accepted standards.

Kumar et al-

Have tested a common speed diesel engine with Jatropha oil methyl ester and reported a high ignition delay as compared to that diesel.

Dorado et al-

Have tested a three cylinder, four stroke, 2500 cc DI diesel engine with olive oil and methyl ester and reported a constant combustion efficiency for methyl ester of olive oil and diesel, a slight reduction in brake specific fuel consumption (BSFC), reduction of 58.9% in CO, 8.9% of CO2, 37.5% in NO and 32% in NOx for olive oil methyl ester as compared to diesel.

Ravi Kadiyala et al-

Studied the performance of pungamia methyl ester by evaluating the combustion properties and engine vibration. A corroborative method was generated to ascertain the engine combustion quality and it was concluded that both viscosity and density were higher compared to diesel.

B. Premanand et al-

The experiments were conducted on a single cylinder diesel engine. The performance, smoke emissions and combustion parameters of diesel, 100% bio-diesel, 30% and 50% blends are calculated. Performance was increased in lower blends with reduced fuel consumption, but NOx was much higher for diesel and blends, and lower for 100% bio-diesel. Particulate matter was higher for neat diesel and lower for 100% bio-diesels

K. Suresh Kumar et al-

This paper presents the results of performance and emission analyses carried out in an unmodified diesel engine fueled with Pongamia pinnata methyl ester (PPME) and its blends with diesel. The results reveal that blends of PPME with diesel up to 40% by volume (B40) provide better engine performance (bsfc and bsec) and improved emission characteristics.

III. MATERIALS AND METHODS

Biodiesel Preparation: Biodiesel is the ester of vegetable oils produced through a process called transesterification. Transesterification is a chemical reaction which occurs between triglyceride and methyl alcohol in the presence of potassium hydroxide (KOH). It consists of a sequence of three consecutive reactions where triglycerides are converted to diglycerides; diglycerides are converted to monoglycerides followed by the conversion of monoglycerides to glycerol. In each step an ester is produced and thus three ester molecules are produced from one molecule of triglyceride.

Castor oil used in the present investigation was taken from the local market of Bhopal, Madhya Pradesh, India and filtered by cheesecloth to remove solid particles. The moisture content was removed by heating the oil in an oven up to 110°C for one hour now the oil is taken in a round bottom flask and heated around 50-60°C on a hot plate having magnetic stirrer arrangement, then methanol and potassium hydroxide are added to the oil. The mixture was stirred continuously. Alcohol to vegetable oil molar ratio is one of the important factors that affect the conversion efficiency of the process for the transesterification process 3 mol of alcohol are required for each mole of the oil. However, in practice the molar ratio should be higher than this theoretical ratio in order to drive the reaction towards early completion.

After the completion of reaction, the products are allowed to separate into two layers, the lower layer contains glycerol and the top layer contains ester which is separated and purified using water. Water 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. Biodiesel (methyl esters of Castor oil) have several outstanding advantages among other new-renewable and clean engine fuel alternatives. The properties of diesel and biodiesel (Castor oil methyl ester) used in present investigation were compared with diesel fuel in Table.1

Table.1 Properties of diesel and biodiesel

Properties	Diesel	Biodiesel(Castor oil methyl ester)
Specific gravity (gm/cm^3)	0.823	0.920
Calorific value (kj/kg)	43000	39000
Cetane number	48	47
Kinetic viscosity (at40°C) [cSt]	3.9	38
Flash point (°C)	56	245
Fire point (°C)	64	276
Stoichiometric A/F	15	12.41
Carbon (%)	86	78.92
Hydrogen (%)	14	13.41

Table.2 Specification of test engine.

Company and Model	Kirloskar oil Engine , SV1
Type	Single cylinder, 4-Stroke, diesel engine
Bore	87.5mm
Stroke	110mm
Rpm	1800rpm
Rated power	8 HP
Type of cooling	Water cooled
Compression ratio	16.5:1

IV. EXPERIMENTAL SETUP AND PROCEDURE

A four stroke, Single cylinder, water cooled diesel engine was used for the performance test. The technical specification of the test engine is shown in Table.2 The experimental setup diagram is shown in picture.1 Experiments were carried out initially using neat diesel fuel to generate the base line data. After recording the base line data, tests were carried out using 10 and 20% biodiesel blends. The engine tests were conducted at various loads and the parameters related to performance were recorded.

Picture:1 Experimental setup

V. CONCLUSION

From the review paper analysis it was found that the blends of Castor oil and diesel could be successfully used with acceptable performance up to a certain extent. Based on the result of this study properties of Castor oil suggest that it cannot be used directly as CI engine fuel due to higher viscosity, density which will result in low volatility and poor atomization of oil during oil injection in combustion chamber causing incomplete combustion and carbon deposits in combustion chamber. Biodiesel blends produce lower brake thermal efficiency and higher brake specific fuel consumption than diesel because of low calorific value.

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