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Biodiesel Preparation from Neem Oil and Performance on Its Blend

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Abstract— **This research dealt with the preparation of neem oil Biodiesel. This paper mainly include two-step transterification. The transterification process turns neem oil into methyl esters. The notable properties of the biodiesel like flashpoint, viscosity, calorific value, density are compared with the diesel. The consistency (viscosity) of biodiesel oil is closer to diesel and the calorific value is about 15% less than diesel. This thesis supports the Neem oil biodiesel prime production of neem oil and then studying engine performance using the biodiesel blends mix with diesel. A four stroke engine (single-cylinder) was taken to measure performance parameters. Biodiesel added to the diesel at four variety of volume concentrations i.e. 10, 20, 30 and 40% of biodiesel. Based on the analysis of performance the biodiesel blend 20% (B20) was most optimum for the efficient operation of the engine.**

Index Terms—Biodiesel, Neem oil, Esterification, free fatty acid, pretreatment, transterification, Compression ratio.

I. Introduction

Due to increases in number of industries and automobiles in recent times have resulted into greater demand of petroleum products. The decrease in reserves of crude oil is estimated in recent period. Therefore research are on way to develop alternatives to diesel. Due increasing cost of crude oil product like diesel, petrol etc. and effect on environment due to emission from industries and automobiles, the biodiesel has become high area of concern. Presently, most of the biodiesel is produced from the used or fresh edible oil using alkaline catalyst and methanol [2]. However, huge quantity of non-edible oils and fats are available in India. And our country is mass producer of non-edible oils such as Rapeseed oil, Jatropha oil, Cotton seed oil, Castor seed oil, Karanja oil, Mahua oil and neem (Azadirachta indica) etc.There are some oils are produced from different plant and available in forest is not properly used and it has conclude that have high production potential [4]. Therefore Biofuel from edible and non-edible oil can be used as substitute for diesel.

II. Materials And Methods Used

A. Materials

Pure neem oil was brought from local market, magnetic stirrer with induction plate arrangement. Chemicals are used in transesterification process like Potassium hydroxide flakes (96-99% purity), Methanol (98% purity), and Concentrated sulphuric acid purchased from Sharad chemical pvt. Ltd.

B. Equipment

A Beaker or conical flask is taken for these reaction purposes. A magnetic stirrer with induction or hot plate arrangement is used for warming the flask. The mixture is mixed at the constant speed. The limits of temperature 40–60˚C(55 ºC) is maintained during this reaction and its observed by thermometer [6]. After acid pretreatment methanol-water mixture and glycerin after transesterification is separated by separating funnel.

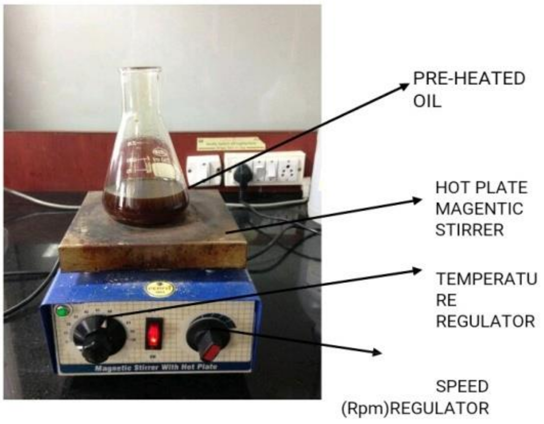

Figure 1: Reactor with magnetic stirrer

C. Methodology

The objective of this research is preparation of neem methyl ester (biodiesel) from neem oil. This is three step process in which first step is oil filtration (when oil is not refined), second is acid esterification and third is alkaline transesterification.

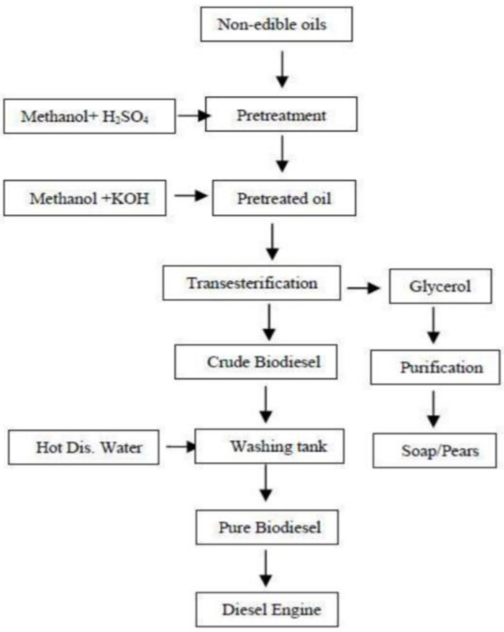

Figure 2: flow chart of two-step transterification process

1. Oil filtration

Neem oil has higher moisture content and some other impurities. So in order to remove the moisture and impurities from the neem oil we have to refine the oil [4]. The purification process is done by boiling oil and by mixing into 15-20% of water [4]. The boiling should be kept until bubbles of water vapor are completely eliminated. After 1 hours of boiling the oil becomes refined. This refined neem oil is used for further transesterification process.

2. Acid esterification

In this reaction 100-150 ml of refined neem oil is poured into a flask and heated up to 55˚C. Mixture of 10% methanol and 1% sulphuric acid of the neem oil is taken into reactor and stirred for few minutes and then constant stirring of this mixture is done for about 30-35 min at 50-60 ˚C temperature. After completion of reaction, the mixture is taken into the separating funnel in order to separating the extra alcohol, impurities and sulphuric acid. This extra alcohol, sulphuric acid and impurities separate and move up to the top layer and then removed [5]. The separated lower layer is used further reaction of transesterification process into neem methyl ester. This process decreases the acid value less than 1-2% of FFA.

3. Transesterification

Transesterification also called as alcoholysis. This is the reaction of oil with alcohol to form methyl esters and glycerin. A catalyst is used to improve reaction rate and yield [3]. Among the alcohols methanol and ethanol are used commercially due to their low cost and their physical and chemical properties.

1-Add 1 liters oil to beaker or flask & turn on the heat

2- Measure out 200ML of Methanol(20-30% of oil)

3- Titrate oil using KOH as strong base(*usually done for large batches*)

4- Assume a Titration of 3.

5- 3 + 7 = 10 grams per liter. 10 X 100 = 1,000 grams or 1% of oil

5- Add 1,000 grams of KOH to the methanol

6- Allow the KOH to fully dissolve

7- Once the oil hits 55^{o} C, kill the heat

8- Slowly add the KOH/Methanol mixture to the processor.

9- Mix everything in the processor for at least 2 hours

10- After 2 hours, allow it to sit for 18-24 hours

11- After it's sat, drain off the glycerin

12- Transfer it to a wash tank

13- Wash and dry the Biodiesel

The top layer of biodiesel was washed 2-3 times or more depending upon soap content and clarity of oil with hot distilled water. The bottom layers is removed by separating funnel and after washing process, the top layer is formed is biodiesel.

Figure 3: Separating funnel for layer separation

TABLE I

COMPARABLE PROPERTIES

Sr. No.	Properties	Diesel	Neem oil	NOME
1	Flash Point °C	64	348	150
2	Fire Point °C	68	368	185
3	Viscosity at 40 °C Cst	4.63	45	4.9
4	Calorific value [MJ/KG-K]	42.5	39.5	38.5
5	Density [G/CM^3]	0.8	0.778	0.6

III. RESULTS

A. *Brake Power vs Load (CR 17.5)*

The given graph represents brake power variation at varying load with diesel and its biodiesel blend. The graph indicate that at no load BP is same for diesel and blend with biodiesel. After their increment of load the BP of diesel increase more compared to its blends because of high heating value than biodiesel blend. At load the BP decreases as quantity of biodiesel blend increases viscosity and its density. Therefore in order achieve maximum BP we have to use less blended ratio biodiesel.

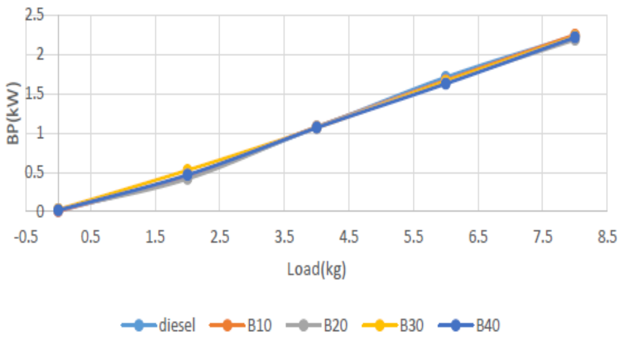

Figure 4: change of BP vs Load for different biodiesel blends and diesel

B. *Brake Specific Fuel Consumption vs Load (CR 17.5)*

The given graph represents BSFC variation at varying load with diesel and its biodiesel blend. The BFSC decrease as the lower load then remains constant. At full load the rate of increase of BP compared to fuel consumption remain constant. During rate of increase load BP increase compared to more fuel consumption. It is find out that B40 has BSFC is maximum at all load.

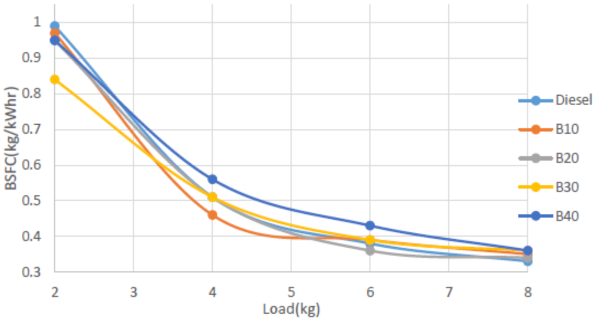

Figure 5: change of BSFC vs Load for different biodiesel blends and diesel

C. *Brake thermal efficiency vs Load (CR 17.5)*

The given graph represents BTH eff variation at varying load with diesel and its biodiesel blend. A brake thermal efficiency increase with increase in load. Initially rate of increase of BTH is high at lower load then rate become constant at high load. It is seen B20 obtained high brake thermal efficiency. This because at full load condition the rate of increase of BP compared to fuel consumption remain constant. So lower rate of increment of BP at higher load lead to decrement in rate of increment of brake thermal efficiency.

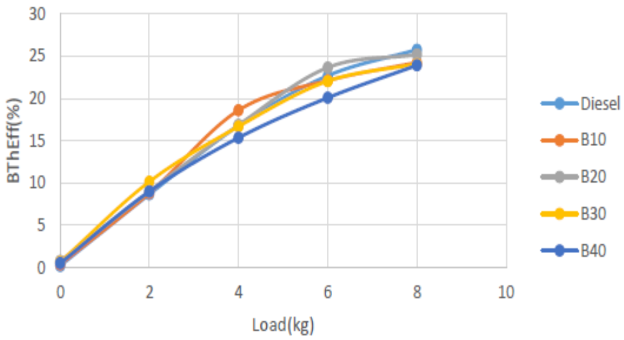

Figure 6: variation of BTH eff. vs Load for different biodiesel blends and diesel

D. *Mechanical efficiency VS Load (CR 17.5)*

The given graph represents mechanical efficiency variation at varying load with diesel and its biodiesel blend. It has observed mechanical efficiency increase with load increment. The rate is high at lower load compared to higher load. This is due to higher load increase BP compared lower load whereas IP power increase at same rate at all loads. It is observed that B10 has maximum mechanical efficiency at all load.

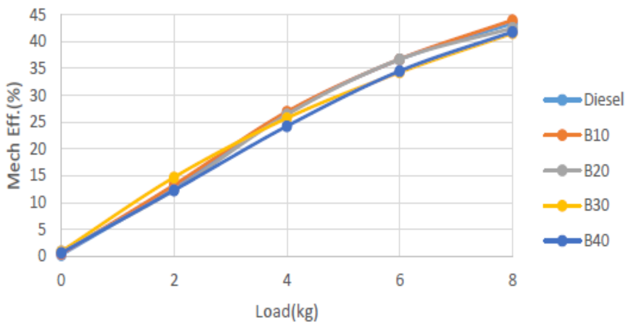

Figure 7: change of Mech Eff. vs Load for different biodiesel blends and diesel

E. *Volumetric Efficiency vs Load (CR 17.5)*

The given graph represents volumetric efficiency variation at varying load with diesel and its biodiesel blend. It is seen that decrease in volumetric efficiency with increase in load but very small decrease. It is observed diesel has maximum volumetric efficiency whereas B30 has minimum volumetric efficiency.

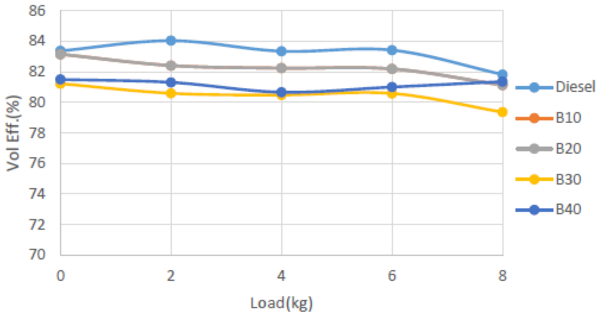

Figure 8: change of Vol Eff. vs Load for different biodiesel blends and diesel

F. *Exhaust temperature vs Load (CR 17.5)*

The given graph represents volumetric efficiency variation at varying load with diesel and its biodiesel blend. It has observed that Exhaust temperature has parabolic increment with increase in load. As blending ratio of biodiesel increase the combustion process also increase. As the amount of biodiesel is increased in blend ratio low calorific value become more predominates. On further increase of biodiesel B40 has recorded decrease in exhaust temperature due to less calorific value which tends to decrease of exhaust temperature.

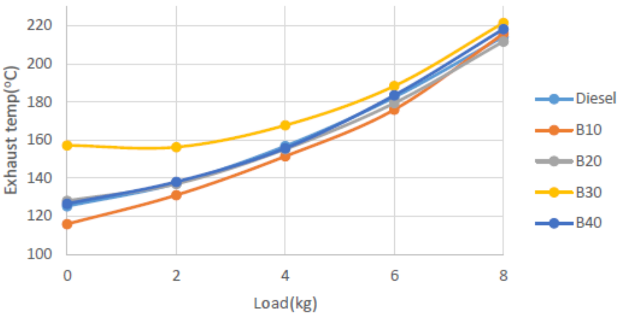

Figure 9: change of Exhaust temperature vs Load for different biodiesel blends and diesel

IV. CONCLUSIONS

Depending upon on neem biodiesel compared with diesel parameter following observed that neem methyl ester (biodiesel) can be replacement of diesel because the properties like viscosity, density, calorific value are very much similar with diesel. A two-stage transesterification process is used to convert the non edible oils (high FFA) into esters. The first stage (acid catalyzed transesterification) is used for reduction of the free fatty acid content of the oil to range of 1-2%. And second stage is transesterification process converts free fatty oil into its mono-esters and glycerol after first stage. The viscosity of biodiesel oil is closer to diesel and the calorific value is about 15% less than diesel and after analyzing the performance parameters. It have been concluded that the brake thermal efficiency, mechanical efficiency have maximum BSFC and exhaust temperatures were optimum at biodiesel blend (B20). Also observed that the variation (change) in performance parameters for different compression ratios was seen to be constant at various loads when it was seen for a particular biodiesel blend except the EGT and BSFC. These two parameters i.e. EGT and BSFC were seen to be lowest at all the loads for a particular biodiesel blend.

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