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Research Article

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Study and Analysis of Performance Characteristics of Biodiesel Formed by Different Blends of Honge and Mustard Oil using 4 Stroke C.I. Engine

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Abstract—

Biodiesels are gaining popularity and becoming more attractive recently because of their environmental benefits and the fact that they are made from renewable resources or wastages. There are four primary ways to make bio diesel, direct use and blending, micro emulsions, thermal cracking (pyrolysis) and transesterification (used for vegetable oils and animal fat). The process of transesterification and downstream operations are addressed in this paper. In these context methods of conserving the Mustard and Honge oil are used as alternative fuel for diesel. In this study, different proportions and mixtures of Mustard and Honge oil were used by blending the obtained fuel samples with petroleum diesel and the effects of mixture proportions used to determine the physio-chemical properties from methyl ester. For the performance characteristics of the engine by these fuel samples, Brake Power (BP), Specific fuel consumption (SFC), mf (mass of fuel consumed), Brake Thermal Efficiency (BTE) etc. were determined, the results were tabulated and the graphs were studied. This paper also includes a work on fabrication of transesterification reactor setup consists of a reactor tank and a setup of water wash for the purpose of cleaning biodiesel used for conversion of Mustard oil and Honge oil to biodiesel. Blends of the obtained biodiesel were prepared, properties of the same were checked and studied for various efficiencies and parameters of 4 stroke Diesel engine. The results are compared with pure diesel results. By analyzing the graphs, it is observed that the performance characteristics will be reduced at higher percentage of mixture of mustard and honge oil, this is mainly due to lower calorific value, high viscosity and delayed combustion process. From the critical analysis of graphs, it can be observed that 10% of honge and Mustard oil mixture mixed with 90% of diesel is the best suited blend for Diesel engine without heating and without any engine modifications. It is concluded that Honge and Mustard oil can be used as an alternate to diesel.

Keywords— Boidiesel, Honge and Mustard oil, Brake Power, Transesterification, Blending, Efficiencies.

I. INTRODUCTION

Biodiesel is an alternative fuel similar to conventional or 'fossil' diesel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil [1]. The process used to convert these oils to Biodiesel is called transesterification[14]. The largest possible source of suitable oil comes from oil crops such as rapeseed, palm or soybean. In the UK rapeseed represents the greatest potential for biodiesel production [2]. Most biodiesel produced at present is produced from waste vegetable oil sourced from restaurants, chip shops, industrial food producers such as Birdseye etc. Though oil straight from the agricultural industry represents the greatest potential source it is not being produced commercially simply because the raw oil is too expensive [3], [4]. After the cost of converting it to biodiesel has been added on it is simply too expensive to compete with fossil diesel. Waste vegetable oil can often be sourced for free or sourced already treated for a small price. (The waste oil must be treated before conversion to biodiesel to remove impurities). The result is Biodiesel produced from waste vegetable oil can compete with fossil diesel. More about the cost of biodiesel and how factors such as duty play an important role can be found here [6]-[8]. The concept of using vegetable oil as an engine fuel likely dates to when Rudolf Diesel (1858-1913) developed the first engine to run on peanut oil, as he demonstrated at the World Exhibition in Paris in 1900. In the mid 1970's, fuel shortages spurred interest in diversifying fuel resources, and thus biodiesel as fatty esters was developed as an alternative to petroleum diesel. Later, in the 1990's interest was raising due to the large pollution reduction benefits coming from the use of biodiesel. As most of the transesterification studies have been done on edible oils like rapseed, soyabean, sunflower and canola by using methanol and NAOH/KOH as catalyst [11]. There are very few studies reported on production of biodiesel by utilizing non-edible oils, among which, karanja is one of the most potential species to produce biodiesel in an India, which could offer opportunities for generation of the rural employment, increasing income and improving environment [12]. Presently, only 6perecent of the potential to the oilseed is being collected properly. The above experimental results reveal the alkaline catalyzed transesterification as the promising area of research for production of biodiesel in decentralized scale from economic point of view. An experiment study to examine properties, performance and emission of different blends (B10 B20 and B30) of methyl ester of pongamia (PME), jatropa (JME), neem (NME) in compression to pure diesel. Result indicated that pure diesel blends showed responsible efficiencies, lower smoke, CO and HC. Pongamia methyl ester at an injection pressure of 200 bar, HC emission decreased by 12.8% for 20% and 3% for B40 at full load [14]. NOx decreased by 39% for B20 and 28% for B40 at full load BSEC increased by 7% for B20 and 1.9% for B40 at full load. Brake thermal efficiencies of Pongamia oil methyl ester blends are very close to diesel and 20% blend with diesel, B20 provided the maximum efficiency for biodiesel operation for all compression ratios [12].

A. Production of Biodiesel

1) Methods of biodiesel production: Considerable efforts have been made to develop vegetable oil derivatives that approximate the properties and performance of the hydrocarbon-based diesel fuels. The problems with substituting triglycerides for diesel fuels are mostly associated with their high viscosities, low volatilities and polyunsaturated character. The viscosity of vegetable oils, when used as diesel fuel, can be reduced in at least four different ways [5]:

(1) Dilution with hydrocarbons (Blending)
(2) Emulsification
(3) Pyrolysis (Thermal cracking)
(4) Transesterification (Alcoholysis).

Transesterification is the most common method and leads to monoalkyl esters of vegetable oils and fats, now called bio-diesel when used for fuel purposes.

Transesterification is otherwise known as alcoholysis. It is the reaction of fat or oil with an alcohol to form esters and glycerin. A catalyst is used to improve the reaction rate and yield. Among the alcohols, methanol and ethanol are used commercially because of their low cost and their physical and chemical advantages. They quickly react with tri-glycerides and NaOH and are easily dissolved in them. To complete a transesterification process, 3:1 molar ratio of alcohol is needed. Enzymes, alkalis or acids can catalyze the reaction, i.e. lipases, NaOH and sulphuric acid, respectively. Among these, alkali transesterification is faster and hence it is used commercially. A mixture of vegetable oil and sodium hydroxide (used as catalyst) are heated and maintained at 650C for 1 hour, while the solution is continuously stirred. Two distinct layers are formed, the lower layer is glycerin and the upper layer is ester. The upper layer (ester) is separated and moisture is removed from the ester by using calcium chloride. It is observed that 90% ester can be obtained from vegetable oils.

2) Biodiesel production process:

a) Measure and Mix the Reactants:

1) Transfer 100ml of oil sample measured with the help of measuring flask into the Mason jar.
2) Transfer 20ml of methanol measured with the help of measuring flask into small jar.
3) Transfer the calculated amount of KOH into the small jar containing methanol.
4) Carefully dissolve the KOH in methanol completely.
5) Pour the obtained potassium meth oxide solution into the large Mason jar which contains oil sample.
6) Make it air tight by closing the lid on the Mason jar and use suitable heating device.

Stir the mixture vigorously.

b) Separation:

1) When the reaction is completed, the mixture is allowed to settle for around 15 to 20 hours.
2) After settling two major products like glycerin and Bio-diesel will going to exist.
3) After settling, the glycerin and Bio-diesel will be gravity separated. As the glycerin is heavier than Bio-diesel it will going to settles in the bottom and Bio-diesel will be settling at the top of the glycerin.
4) Glycerin can be taken out from the bottom of the container with suitable arrangements or the Bio-diesel can separate by pouring it out from the top.

c) Water Wash:

1) After the separation of the Bio-diesel, it should be washed with warm water for 2 to 3 times gently.
2) Residual catalyst or soaps can be removed by washing with water.

d) Drying:

Drying process of Bio-diesel can be carried out in several ways.

1) Use the container with large opening to increase more air contact.
2) Temperature of the air should be increased, as warm air can hold more water vapors.
3) By the bubbling of air in the Bio-diesel air contact of Bio-diesel can also be increased.
4) Use fan to move the air around the container to increase more air contact.

3) Benefits or Advantages of biodiesel: It is renewable, energy efficient, displaces petroleum-derived diesel fuel, used as a 20% blend in most diesel equipment with no or only minor modification, reduces global warming gas emissions, tailpipe emissions, including air toxics. It is nontoxic, biodegradable, and suitable for sensitive environments. It can be used in existing engines and fuel injection equipment without negative impacts to operating performance. It can replace or blend with petroleum diesel with little or no engine modifications. Biodiesel stays blended with petroleum diesel, making it possible to store and dispense wherever diesel fuel is now stored or sold. Pure biodiesel is biodegradable, non-toxic, and essentially free of Sulphur and aromatics.

According to US department of energy study completed at the University of California, the use of pure Biodiesel instead of petroleum based diesel fuel could offer a 93% reduction in cancer risks from exhaust emissions exposure.

II. EXPERIMENTAL METHODOLOGY

A. *Oils Selected for Experiment*

1) Mustard oil: .Mustard seed oil is not currently a common biodiesel feedstock, but because it has the potential to be a cheaper feedstock than the two most common oilseeds used for biodiesel (canola and soybeans), mustard oil biodiesel has been researched extensively at the University of Idaho. Mustard is related to canola, but mustard can grow in drier areas and needs fewer pesticides and other agricultural inputs than canola. Therefore, it can potentially be grown more cheaply. Mustard yields about 48 gallons of biodiesel per acre. Mustard oil biodiesel performed very well in vehicles. Fuel consumption increased compared to fossil diesel because biodiesel has slightly less energy per gallon than diesel fuel. The fuel filter had to be changed more often compared to what would normally be experienced with petroleum diesel. This may have been because the fuel filter material did not hold up well with biodiesel. Mustard oil is available plenty and it will be generate less emission compared to diesel as shown in figures 2 and 3.


Fig 2: Mustard flowers


Fig 3: Mustard seeds

2) Honge oil: Pongamia oil is derived from the seeds of the Millettia pinnata tree, which is native to tropical and temperate Asia. Millettia pinnata, also known as Pongamia pinnata or Pongamia glabra, is common throughout Asia and thus has many different names in different languages, many of which have come to be used in English to describe the seed oil derived from M. pinnata; Pongamia is often used as the generic name for the tree and is derived from the genus the tree was originally placed in. Other names for this oil include Pungai oil (in Tamil language), Honge oil (in Kannada language), Kanuga oil (in Telugu language) and Karanja oil (in Hindi language) as shown in figure 4.


Fig 4: Honge seeds and Tree

India is focusing on Pongamia pinnata, which can grow in arid and wastelands. Oil content in the Pongamia seed is around 30-40%. India has about 80-100 million hectares of wasteland, which can be used for Pongamia and other non-edible plants. Implementation of bio diesel in India will lead to many advantages like green cover to wasteland, support to agriculture and rural economy and reduction in dependence on imported crude oil and reduction in air pollution.

3) Titration: As we select Honge and Mustard oil for Biodiesel which was very thick (highly viscous), so we did titration to know the amount of catalyst to be added and we did Transesterification.

4) Titration test: Titration is an analytic technique used to determine a quantity of substance dissolved in a sample. It is determined on the basis of complete chemical reaction between the substance and the reagent of known concentration which is added to the sample.

Types of Titration tests:

1. Acid-base reaction
2. Redox reaction
3. Complex metric reaction
4. Precipitation reaction
5. Colloidal precipitation reaction

5) Acid- base titration: Acid base titration is the process or determining the concentration of an acid (or) base by exactly neutralizing the acid (or) base with an acid (or) base of unknown concentration Equipment needed for the titration:

1. Burette
2. Conical flask
3. Test tube
4. Colour indicator
5. Acid (or) Base

6) Procedure to carry out titration:

1. Preparation of 0.1N KOH: 1liter of distilled water is taken in a conical flask. 1gram of potassium is measured and added to the distilled water and mixed properly, this gives 0.1N KOH solution

2. 10ml of isopropyl alcohol is taken in a test tube.
3. 1ml of a sample oil is added to the isopropyl alcohol and mixed well
4. Colour indicator Turmeric powder is added to the solution and mixed well
5. 0.1N KOH solution is taken in burette. Initial volume is noted than it is added against titration solution till colour changes to dark red from yellow
6. The final volume of KOH solution is noted when the colour changes to red and remains same.

7) Determination of free fatty acid content in the oil: It involves with the preparation of 0.1N Sodium Hydroxide solution by mixing 4grams of NaOH crystals with 1 liter of water.Take 25 ml of 0.1N NaOH solution in a clean and dry burette and take 50 ml of Isopropyl alcohol in a clean and dry 250 ml conical flask. Add few drops of NaOH solution and shake well. Measure 10 grams of oil to the flask and shake it well and heat the mixture above 60º C. Allow the mixture to cool a little and then add few drops of phenolphthalein indicator. Titrate against 0.1N NaOH from burette till color persists for at least one minute and note down the burette reading. Free fatty acid content is obtained by using the formula. FFA Content = 28.2∗ (Normality of NaOH) ∗ (Titration value) Weight of oil

The value of FFA obtained is 3.108 When the FFA value is more than four both esterification and transesterification are done to prepare a biodiesel.

B. Transesterification

1) Fabrication of transesterification reactor oil: .Components of the biodiesel reactor is as shown in figure 5

1. Reactor tan 2. Water wash tank 3. Collector tank 4. Pump 5. Frame

1. Reactor tank:

Reactor tank is a tank where transesterification of oil is carried out. It is made up of 3mm thick Mild Steel. Upper portion of the tank is cylindrical and lower portion is conical in shape. Dimension of cylindrical part: Height is 100mm and Radius is 100mm as shown in figure 6.

Dimensions of Conical part: Height of this part is 100mm and cone angle is 45^0. Reactor tank consist of two heaters of 35W capacity. The conical part consists of a slot of length 90mm and 8mm wide covered with glass to indicate the level of the glycerol in the reactor tank. Capacity of the reactor tank is 5 liters.

Figure 5: Transesterification Reactor set up

Figure 6: Reactor tank

2. Water wash tank:

It is a tank of 5 liters capacity and made up of plastic. And it is used wash the biodiesel to remove impurities present in the biodiesel. A pipe is connected from reactor through pump to water wash tank as shown in figure 7.

3. Collector tank:

It is a tank of 5liters capacity made up of plastic. A pipe from water tank is connected to collector tank. It is kept bellow the water wash tank to collect the pure biodiesel as shown in figure 8.

Figure 7: Water wash Tank

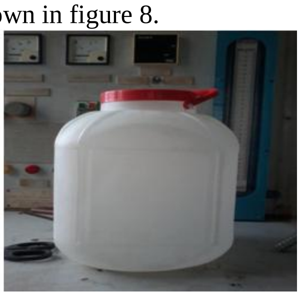

Figure 8: Collector Tank

4. Pump:

Pump used is having 0.5HP. It will connect both the rector tank and water wash tank through pipe. It will pump oil from reactor tank to the water wash tank as shown in figure 9.

5. Frame:

Frame is made up of wood and supports all components of the biodiesel reactor. It has two slots, one for holding the reactor tank and other is for supporting water wash tank and also contain spike buster (junction box) to supply the power to the heaters and pump as shown in figure 10.


Figure 9: 0.5HP Pump Figure 10: Transesterification reactor Frame

2) Factors affecting the transesterification process: The most important variables which influence the transesterification reaction are reaction temperature, ratio of alcohol to oil, catalysts, mixing intensity, purity of reactants, effect of moisture and water content on the yield of biodiesel, effect of free fatty acids, effect of stirring and effect of specific gravity.

C. Blending

This section focuses on blending B100 with petroleum diesel to make B10, but the approach is similar for other blend levels, such as B20 or B30. As discussed in the previous sections, the performance properties of B100 can be significantly different from those of conventional diesel. Blending biodiesel into petroleum diesel can minimize these property differences and retain some of the benefits of B100. B20 is popular because it represents a good balance of cost, emissions, cold weather performance, materials compatibility, and ability to act as a solvent. B10 is also the minimum blend level that can be used for Epact compliance for covered fleets.

1) Blends

Figure 11: Different Blends of Biodiesel i.e. B-10, B-20 and B30.

B-0: it refers to 100% Diesel

B10E2: it means that it contains 10% Biodiesel with 2%Ethanol and 88% Biodiesel.

I.e. for 1 Litre, 100ml of mustard and Honge blends and 20ml of ethanol and 880 ml of diesel similarly for 20% and 30% blends.

B20E2: it means that it contains 20% Biodiesel with 2% of Ethanol and 78% of Biodiesel.

B30E2: it means that it contains 30% Biodiesel with 2% of Ethanol and 68% of Biodiesel. All the properties of Blends are shown bellow.

Different Blends of Biodiesel i.e. B-10, B-20 and B30. From the above figure we absorbed that B-10 is lighter in color compared to B-20 and B-30 but B-30 is darker in colour than B-20 and B-10, because Biodiesel content is more in B-20 and B-30.

D. Experimental Set up of Engine Test

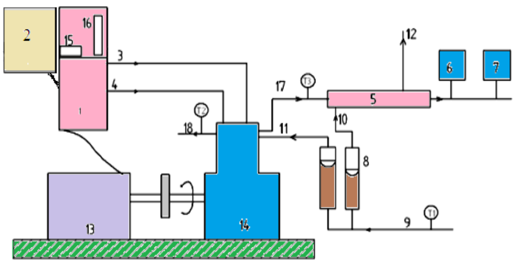

Fig 12: Schematic diagram of the experimental set up.

1 = Control Panel 2 = Readings board 3 = Diesel flow line 4 = Air flow line 5 = Calorimeter 6 = Exhaust gas analyzer 7 = Smoke meter 8 = Rota meter 9= Inlet water temperature 10= Calorimeter inlet water temp. 11= Inlet water temperature 12 =Calorimeter outlet water temp 13 = Dynamometer 14 = CI Engine 15 = Speed measurement

16 = Burette for fuel measurement 17 = Exhaust gas outlet 18 = Outlet water temperature T1= Inlet water temperature T2 = Outlet water temperature T3 = Exhaust gas temperature.

E. Experimental Measurement System

The test bed is fully instrumented to measure the various parameters such as engine speed measurement, air flow measurement, load measurement, pressure measurement, temperature measurement, exhaust gas emission measurement during the experiments on the engine.

Engine speed measurement:

Inductive pickup sensor is used to measure the engine speed with digital RPM indicator, the dynamometer shaft rotating close to inductive pickup serves as an arrangement to send voltage pulse whose frequency is converted in to RPM and displayed by digital indicator in the control panel. The speed is directly indicated in number of revolution per minute using rotary encoder.

Air flow measurement:

Conventional method U tube manometer as well as air intake differential pressure unit present in the control panel. Two air suction, one for U tube manometer having range of 100-0-100 mm and another for pressure differential unit, which sense the difference in pressure between suction and atmosphere. This difference in pressure will be sent to transducer which will give the DC volt analog signal as output which in turn will be converted into digital signal by analog to digital converter and fed to the engine software. For fuel flow rate measurement, the fuel tank in the control panel is connected to the burette for manual measurement and to a fuel flow differential pressure unit for measurement through computer. Cooling water flow to the engine and calorimeter is measured by means of a calibrated Rotameter with stainless steel float.

Load measurement:

The eddy current dynamometer is provided to test the engine at different loading conditions. A strain gauge type load cell mounted beneath the dynamometer measures the load.

Pressure measurement:

Water cooled piezoelectric transducer mounted on the cylinder head surface measures the cylinder dynamic pressure and a piezo sensor mounted on the fuel line near injector, measures injector pressure. We have chosen three injection pressure namely 180, 200bar and

Temperature measurement:

Thermocouples connected to digital panel meter are positioned at different locations to measure the following temperatures.

1. Jacket water inlet temperatures (T1)
2. Jacket water outlet temperatures (T2)
3. Calorimeter inlet water temperature (T3)

III. TEST TO BE PERFORMED

A. Fuel properties

Flash and Fire point test:

Instrument description: Cleave land open cup tester is used to measure the lower temperature at which the application of the test flame causes the vapour above the biodiesel sample to ignite. It is used to assess the overall flammability hazard of the biodiesel. Specifically the flash point is used in safety regulations to define the flammable and combustible materials that are less likely to ignite accidently. As shown in figure 13, measured biodiesel is poured up to the mark indicated in the flash point apparatus. Then the oil is heated and stirred at regular interval. The external fire is introduced at the regular period till the flash is observed. Once the flash is observed the temperature is noted. Noted temperature at the time of the flash is the flash point of the biodiesel.

Cetane number:

Cetane number (CN) is a dimensionless indicator that characterizes ignition quality of fuels for compression ignition engines (CIE). Theoretically, the cetane number is defined in the range of 15-100; the limits are given by the two reference fuels used in the experimental determination of the cetane number.

Figure 13: cleave land Open cup Flash and fire Point Apparatus Figure 14: Red wood Viscometer Apparatus

Density of biodiesel:

Fuel density is the mass of unit volume, measured in a vacuum and is strongly influenced by temperature, quality standards state the determination of density at 15 °C. Fuel density directly affects fuel performance, as some of the engine properties, such as cetane number, heating value and viscosity are strongly connected to density. The density of the fuel also affects the quality of atomization and combustion. Modification of the density affects the fuel mass that reaches the combustion chamber, and thus the energy content of the fuel dose, altering the fuel/air ratio and the engine's power.

Viscosity of biodiesel:

Viscosity is one of the most important properties of biodiesel influences the ease of starting the engine, the spray quality, the size of the particles (drops), the penetration of the injected jet and the quality of the fuel-air mixture combustion. The fuel with a too low viscosity provides a very fine spray, the drops having a very low mass and speed. This leads to insufficient penetration and the formation of black smoke specific to combustion in the absence of oxygen. A too viscous fuel leads to formation of too big drops and penetrate the wall opposite to the injector. Viscosity of the biodiesel is measured using the Red wood viscometer shown below as shown in figure 14.

Cold flow property:

Generally, all fuels for CIE may cause starting problems at low temperatures, due to worsening of the fuel's flow properties at those temperatures. The cause of these problems is the formation of small crystals suspended in the liquid phase, which can clog fuel filters partially or totally.

Cloud point (CP):

The cloud point (CP) is the temperature at which crystals first start to form in the fuel. The cloud point is reached when the temperature of biodiesel is low enough to cause wax crystals to precipitate. Below the CP these crystals might plug filters or drop to bottom of a storage tank.

B. Mustard Biodiesel and Honge Biodiesel properties:

Table 1 Roperties of honge oil and mustard oil

Properties	**Density at 15^0C**	**Kinematic viscosity at 40^0 C**	**Flash point**	**Cetane number**	**Calorific value in MJ/Kg**
Mustard Biodiesel	940	10.3cst	145	37	32.43
Honge Biodiesel	890	5.68cst	163	42	38.43
Mustard and Honge	915kg/m	8cst	155	40	35.43

Fig 15: Mustard Biodiesel, Honge biodiesel, and Blending of mustard and Honge biodiesel

1) Biodiesel blends and its properties

Properties of various biodiesel blends are tabulated below

Table 2 Properties of various Biodiesel blends

Propertie	**Density at 15^0C**	**Kinematic viscosity at 40^0C in**	**Flash point In**	**Calorific value**
B-0	840	4.7	50	43.5
B-10	846.48	4.66	59.73	42.1409
B-20	853.98	4.68	70.13	41.167
B-30	861.48	4.72	80.53	40.08

Table 3 Engine Specifications

PARTICULARS	**SPECIFICATION**
Make	Kirloskar
Type	4Stroke Single Cylinder
Power	5.2KW
Bore	87.5mm
Stroke	110mm
Cooling	Water Cooled
Speed	1500rpm
Compression ratio	17.5
Fuel injection	Electronic Direct injection

C. Performance characteristics of Engine

Performance characteristics gives the how the engine will reacts for the various blends of Biodiesel.

1) Engine specification

The engine was first run with diesel oil, the basic fuels under steady state conditions, the fuel consumption rate, speed, voltage, current and time taken to run down the diesel were noted. The engine was next run with Biodiesel and the above procedure was repeated. Then it was run with SLO and diesel blends varying in the range of 10%, 20% and 30% in the diesel and the test was carried out exactly in the same manner. Specification of the engine is as shown in table 3.

D. Performance of engine for various blends

1) Brake Thermal Efficiency (η)

Break thermal efficiency is defined as the ratio of energy in the break power, to the input fuel energy in appropriate units.

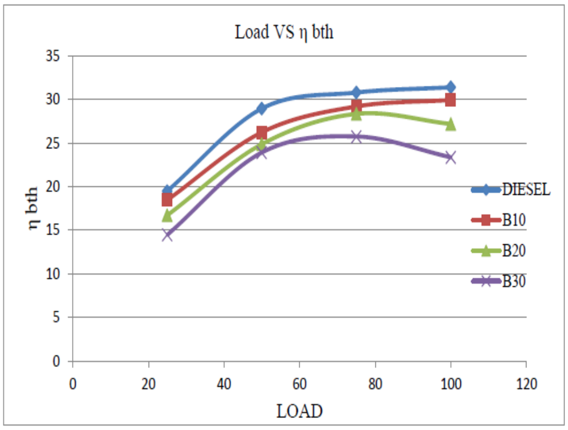

Figure1: Load vs Break thermal efficiency for IP of 180 Bar

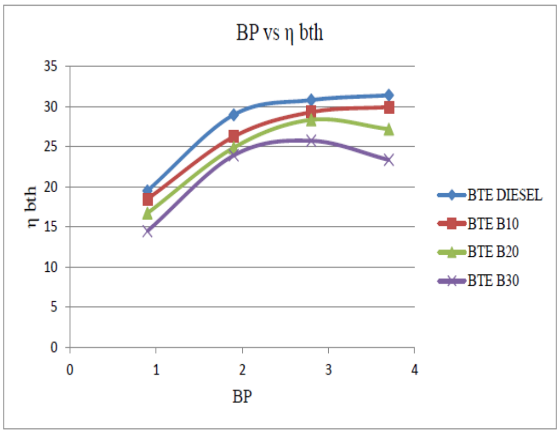

Figure 2: BP vs Break Thermal Efficiency for IP of 180 Bar

2) Break specific fuel consumption

Specific fuel consumption is defined as the amount of fuel consumed for each unit of brake power developed per hour & a clear indication of the efficiency at which engine develops power from it.

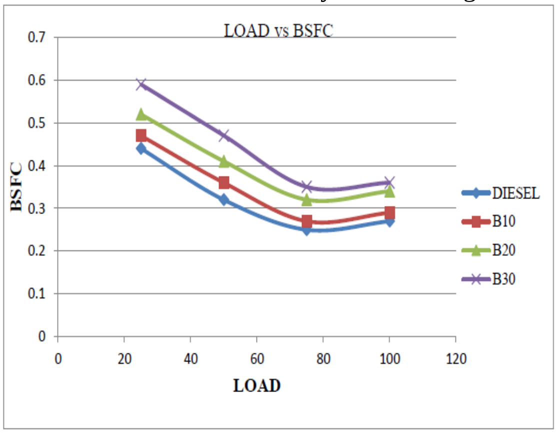

Figure 3: Load vs BSFC for IP of 180 Bar

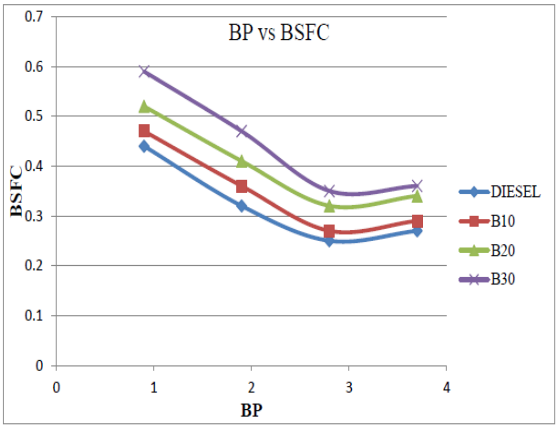

Figure 4: BP vs BSFC for IP of 180 Bar

3) Mechanical efficiency vs Break power and Exhaust gas temperature vs Brake Power

Mechanical efficiency is defined as the ratio of Brake power to Indicated power

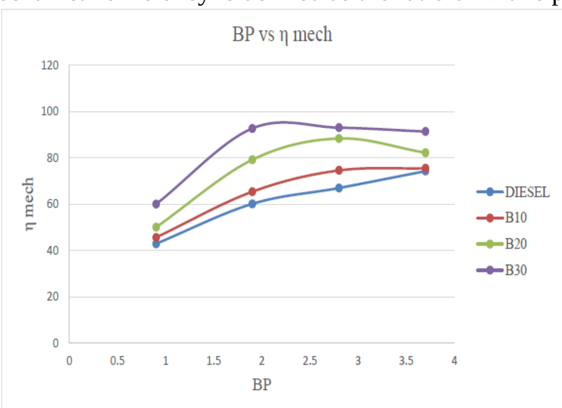

Figure 5: BP vs Mechanical Efficiency for IP of 180 Bar

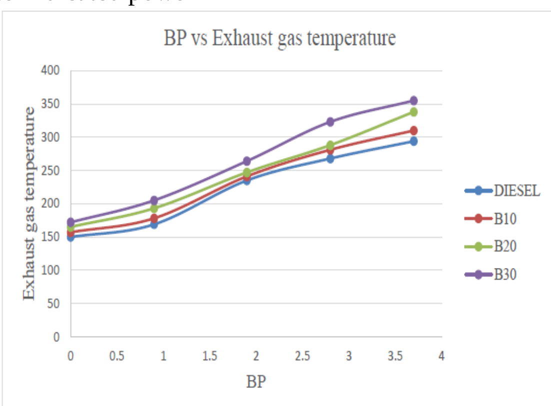

Figure 6: BP vs EGT foe IP of 180 Bar

IV. RESULTS AND OBSERVATIONS

Transesterification Reaction: It is observed from the experiment that 65^0C to 70^0C is the optimum temperature to carry out the reaction. Since the boiling temperature of Methanol is 67^0C, when heated above this temperature methanol boils and evaporates, this leads to insufficient amount of methanol for reaction and biodiesel yield is reduced. When the temperature is reduced below the mentioned limits the reaction rate reduced. Temperature less than 40^0C leads to too slow reaction.

Performance analysis: It can be observed from the graphs that with the increase in the blend quantity performance of the engine reduces. B0 (Pure diesel) has highest brake thermal efficiency and least brake specific fuel consumption and B30 has the least brake thermal efficiency and highest brake specific fuel consumption. This is due to the reason that with the increase in the blend calorific value of the fuel decreases and hence in the brake thermal efficiency and increase is BSFC. Exhaust gas temperature increases with increase in the blend.

V. CONCLUSIONS

The following conclusions have been drawn from the analysis of different blends of diesel with honge and mustard oil:

1. Optimum temperature for maximum yield of biodiesel is 65^0C to 70^0C.
2. Optimum amount of methanol is 20% of the oil taken for reaction, since further increase in the amount of methanol increases cost of production.
3. Biodiesel blends of B20 and lower typically do not result in observable power loss or reduction in fuel economy.
4. For optimum cost and performance, it is preferred to use B10, since increased blend increases the cost of the fuel and reduced performance.
5. Biodiesel blend stocks have generally been found to be nontoxic and biodegradable, which may promote their use in applications where biodegradability is desired.
6. Thus fabrication of a transesterification apparatus in turn helps us make sure the fuel prepared is up to the calculated limits and also best suited for the engine used.

Present work can be further extended to use biodiesel in various types of engines IC engines with different configurations and the usage of biodiesel fuels on heavy diesel engines like trains, racing car engines with v6, v8 configurations etc., with study of performance parameters, variations in physical properties and emission parameters.

Fabricating of an apparatus to obtain fuel automatically from the used organic oil to the Bio fuel production can be carried out, in order to make sure the quality of the fuel remains according to the permissible fuel property limits like viscosity, pH value, specific gravity, Calorific value, flash and fire points of the prepared fuels. Thus fabrication of such apparatus in turn helps us make sure the fuel prepared is up to the calculated limits and also best suited for the engine used.

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