PERFORMANCE AND EMISSION CHARACTRICTICS MEASUREMENT OF BIODIESEL FUELLED DIESEL ENGINE

Abhishek Pratap Shahi[1], Sanjay Kumbhare[2], K.K Thakur[3]

[1] *Patel College of Science & Technology, Research Scholar, RGPV Bhopal, M.P,(India)*

[2, 3] *Patel College of Science & Technology, Professor, RGPV Bhopal, M.P, (India)*

ABSTRACT

The depleting reserves of petroleum and environmental issues have led to the Search for more Environmental-friendly and renewable Fuels. Biodiesel obtained from various renewable Sources has been recognized as one of the alternatives Fuel due to its biodegradability, high Cetane no, no sulphur emissions and low volatility. Biodiesel derived from non-edible feed stock Such as Jatropha oil are reported to be feasible choices for developing countries including India Where consumption and cost of edible oil is very high .the aim of present work is to compare The emission of diesel to the biodiesel production of Jatropha oil through Trans esterification Process of different biodiesel blend(10%,20%,30%).the various performance and emission Parameters like brake power(BP), brake specific fuel consumption(BSFC), brake thermal Efficiency, CO emission, CO2 emission, HC emission, NOx Emission were evaluated at different Loads in a four stroke, Single cylinder Compressed ignition engine. These Performance and Emission Parameters of diesel fuels is compared with that of B10, B20, and B30. It is founded That CO2, HC and CO emissions decreases as the blend content increases whereas the NOx Emissions Increases as the blend content increases. Biodiesel production from Jatropha oil using Transesterification process. The performance and emissions parameter for diesel fuel were compared with B10, B20, B30. The following conclusions can be drawn from the present study: Maximum biodiesel production was obtained at molar ratio of 5:1, reaction time 60 minutes, 0.5% NAOH concentration. The fuel properties of biodiesel were found to be comparable to diesel were conforming to the latest biodiesel Calorific value of Jatropha biodiesel is 42663 kJ/kg which is nearer to diesel Performance parameters such as BP, BSFC, and brake thermal efficiency with B20 were observed to be nearly similar to the diesel fuel at all loads. B20have better performance parameter than other blends. The BSFC is lowest among the blend. The emission parameter B10 blend such as CO, CO_2 and HC were nearly similar to diesel fuel. With increase in blend content these emissions were observed to be decreased. Among all blends, these emissions from B20 blend were observed to be lowest. The NOx emissions were observed to be lowest.

Keyword: Biodiesel, Brake Power. Brake Specific Fuel Consumption, Brake Thermal Efficiency, Jatropha, Environmental-Friendly, Emission.

I INTRODUCTION

1.1 Concept of Biodiesel

Due to scarcity and increasing costs of conventional fossil fuels, biodiesel as a Fuel has become more attractive fuel. Experts suggest that current oil and gas reserves would tends to cost only for few decades. To fulfill the rising energy demand and replace reducing oil reserve renewable fuels like biodiesel within the forefront of other technologies. Biodiesel has proved to be possible to the alternative for diesel in compression ignition engine. Biodiesel burn like petroleum diesel as it's involves regulated pollutant. Diesel can be replaced by biodiesel made from vegetable oil. Biodiesel is now mainly being produced from soybean, rapeseed and palm oils. In developed countries, there is a growing trend toward using modern technology and efficient bio energy conversion using a range of bio fuels, which are become a cost wise competitive with fossil fuels. India enjoys some special advantages in taking up plantation of tree borne oil seeds for production of biodiesel due to unutilized land. The use of biodiesel results in substantial reduction of un-burnt carbon monoxide and particulate matters. It has almost no sulphur, no aromatic and more oxygen content, which help It's to burn fully. Its higher Cetane number improves the combustion. Sunflower and rapeseed are the raw material used in Europe whereas soybean is used in USA. Thailand uses palm oil, Ireland uses frying oil and animal fats. In India vast research has been done on biodiesel from Jatropha oil. It proposed to use non-edible oil for making biodiesel, as consumption of edible oil is very high in India.

1.2 Production of Biodiesel

Many developing countries have active biodiesel programmers. Currently Biodiesel is produced mainly from field crops oils like soybean, sunflower etc., in Europe and rapeseed in US. Malaysia utilities palm oil for the biodiesel production. Total production of vegetable oil in 2012-2013 is around 7.45 MT.

Vegetable oil	Production in MT
Ground nut	0.12
Soya	1.76
Rape/ Mustard	2.01
Sunflower	0.21
Palm oil	0.08
Cotton seed oil	1.13
Other oils and fats	2.14
TOTAL	7.45

Table1- List of vegetable oil production in India (2012-2013)

1.3 Methods of Production of Biodiesel

Thermal Cracking (Pyrolysis)

Pyrolysis, define as the Conversion of one substance to another by means of heat or by heat with the aids of a catalyst. It Involve the heating in absence of air or oxygen and cleavage of chemical bond to yield small molecules. The chemistry of molecules is difficult to characterize because of different rate of reaction and different products at the end of reaction. Pyrolyzed materials can be vegetable oil, animal fats, natural fatty acids and methyl esters of fatty acids. The equipment of thermal cracking and Pyrolysis is expensive. The Product obtained from this process are chemically similar to petroleum-derived gasoline and diesel fuels. This Process Lower the viscosity, flash point and pour point of product obtained. It also Lower the Cetane number. The disadvantage of this process is that oxygen is removed at the end of the reaction which removes the environmental benefits of using oxygenated fuels.

Microemulsification

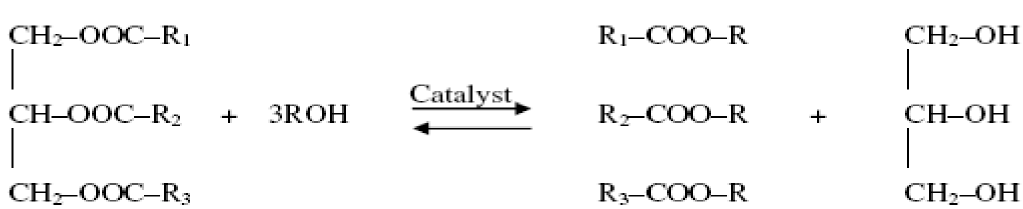
A micro emulsion is defined as a colloidal Equilibrium dispersion of optically isotropic fluid microstructure with dimensions generally in the 1±150 nm range formed spontaneously from two normally immiscible liquid. This process reduces the higher viscosity of vegetable oils. Micro emulsion of vegetable oil can be prepared with solvent such as methanol, Ethanol, butanol etc. spray characteristics of oil are improved after this process.

Dilusion

Direct use of vegetable oil or the use of blends of the oil has to be considered is not satisfactory and impractical for use direct and indirect diesel engine. The high viscosity, high composition, high fatty acid content, as well as gum formation due to oxidation and polymerization storage and combustion, carbon deposit and lubricating oil thickening of some problem which are encountered by direct use of vegetable oils or the use of blends in diesel engine.

Transesterification

Transesterification (also called alcoholysis) is the reaction of fat or oil with an alcohol to form ester and glycerol. A catalyst is usually used to improve the reaction rate and yield. Because the reaction of reversible, excess alcohol is used to shift the equilibrium to product side.Fig1.1shows the transesterification reaction with alcohol.



Triglyceride methanol methyl ester glycerol

Fig.1. Transesterification Process

The Alcohol which is used in this process is methanol, ethanol, Propanol, Butanol Amyl alcohol. Methanol and ethanol are used most frequently, especially methanol Because of its low cost and its physical and chemical advantages. Methanol can quickly react with triglyceride and the catalyst like NAOH is easily dissolved in it. Generally to complete a transesterification stiochometrically, a 3:1 molar ratio of triglyceride to alcohol is needed. In practice, the ratio needs to higher to drive the equilibrium a maximum ester yield. The Reaction can be catalyzed by alkalis, acids, or enzymes. The alkalis include NAOH, KOH, carbonates and corresponding potassium, and sodium alkoxide as a sodium methoxide, sodium propoxide, and sodium ethaxide and sodium butoxide. Sulfuric acid, Sulfonic acid and hydrochloric acid are used as a acid catalyst.

Lipases are also used as acid catalyst. Alkali-catalyst transesterification is much faster than acid catalyst transesterification and is most often used commercially. This process raised the cloud point and pour point. This process is use with oils having less fatty acid content. This process is generally preferred over all other process for the biodiesel production.

Factor Affecting the Production of Biodiesel

Increase in the molar ratio of alcohol to vegetable oil increases the yield of methyl ester of vegetable oil up to a particular limit. After a higher molar ratio than particular limit the glycerol become difficult to separate.

Amount and type of catalyst also affects the conversion rate of vegetable oil to methyl ester. For oil having content less fatty acid alkaline transesterification is used and for oils having higher fatty acid content acid transesterification is us

Stirring helps in higher conversion rate of methyl ester to vegetable oil.

Impurities present in vegetable decreases the conversion rate of methyl ester.

1.4 Properties of Biodiesel

Biodiesel are characterized by their viscosity, density, Cetane number, cloud and Distillation range, pour point, flash point, sulphur content, ash content, carbon residue, Copper content, acid value, and higher heating value (HHV). The most important variable affecting the ester yield during the transesterification process are the molar ratio of ester to vegetable oil and reaction temperature. Some of the properties of biodiesel are discussed below:

Viscosity

Viscosity is the most important property of biodiesel since its affects the operation of fuel injection equipment and particularly at low temperature when an increase the viscosity affects the fluidity of fuel. High viscosity leads to poorer atomization of the fuel spray and less accurate Operation of fuel injector. The conversion of triglyceride to methyl Esters through the transesterification process reduces the Molecular weight. Biodiesel have viscosity closes to diesel fuels. As the oil temperature increases is viscosity decreases. The major problems associated with the use of pure vegetable oil as the fuels of diesel engines are high viscosity in compression ignition. Therefore vegetable oils are converted into their methyl ester(biodiesel) by Transesterification.

Density

Density of biodiesel is more than diesel therefore biodiesel should be put at the top of diesel while using in the engine as a blend Otherwise it will be not used properly.

Cetane Number (CN)

Higher the Cetane number better are the ignition Property of the fuel. The Cetane no of biodiesel should be higher. The CN is measure the ignition quality of diesel fuel, and high CN implies short ignition delay. The CN of biodiesel are generally higher than conventional diesel. The CN of biodiesel is higher because of its long fatty acid chain and more saturation content. The CN of biodiesel is generally higher than conventional diesel. CN no affects performance parameters like combustion, stability, white smoke, noise and emissions of CO and HC. Due to higher CN, combustion efficiency of biodiesel is higher

Cloud Point

The CP is the temperature at which wax first becomes visible when the fuel is cooled. Biodiesel has higher CP than conventional diesel fuel. The specifications for the cloud point are not provided by the ASTM D 6751 but care should be taken while using fuel in cold climates.

Pour Point

It is the lowest temperature at which the fuel can flow. Biodiesel has a higher PP compared to conventional diesel.

Cold Filter Plugging Point (CFPP)

At low temperatures the fuel may start to thicken which affects the performance of fuel lines, fuel pumps and injectors. It reflects the cold weather properties of fuel therefore additives should be used to improve the CFPP.

Flash Point

The temperature at which fuel started to ignited when exposed to flame or spark .The flash point of biodiesel is higher than the conventional diesel fuel. It is around 160^0C for biodiesel. Flash point affects the combustion quality and low flash point is harmful to fuel pumps, seals. ASTM D 6751 specified a flash point of 130^0C.

Water Content

Water content has a negative effect on the yield of methyl esters. But it has positive effect on the formation of methyl ester using supercritical methanol method.

II EXPERIMENTAL SETUP AND METHODOLOGY

This experiment deals with the steps and procedure estimate for the preparation of biodiesel obtained from Jatropha oil. Take three blends which is fuelled in a compression ignition (C.I.) engine. The performance parameters such as brake power (BP), Brake Thermal Efficiency, Brake Specific Fuel Consumption (BSFC) are measured.

Emission parameters such as Carbon Monoxide (CO), Carbon Dioxide (CO2), Un-burnt Hydro carbon (UHC), Nitrogen Oxides (NOx) are analyzed and evaluated. These performance and emission parameters of Jatropha biodiesel with different blends are compared to those of pure diesel.

2.1 Production of Biodiesel

Jatropha is taken:

Various steps and procedure used in preparation of biodiesel from Jatropha oil are described as below:

1. Firstly 400ml of Jatropha oil is taken in a separate flask and preheated to 70^0C.
2. Then 10ml sulfuric acid (by volume) and .5% NAOH (by weight) was mixed and stirred in separate flask
3. After that the stirred and mixed mixture was added in the preheated Jatropha oil and again mixed properly by stirring
4. This mixture was then constantly stirred for reaction time 90min at a constant temperature of 70^0C.
5. After this the stirred and mixed sample was taken out and was poured in a separating funnel to separate the glycerol.
6. After 24 hours the glycerol was removed and again 100ml methanol (by volume) and .5% NAOH (by weight) was mixed and stirred in a separate flask.
7. After that the stirred mixture was added in the preheated Jatropha oil and again mixed properly by stirring.
8. This mixture was then constantly stirred for reaction time 90min at a constant temperature of 70^0C.
9. After this the stirred sample was taken out and was poured in a separating funnel to separate the glycerol from the methyl ester.
10. After 24 hours the glycerol was removed and separated to obtain the methyl ester.
11. For the purification purpose methyl ester was washed and dried to remove the excess methanol, NAOH, and other impurities.

Fig. 2 shows separation of glycerol from Jatropha methyl ester in a separating funnel.

2.2 Equipments Used For Evaluation of the Engine Performance

The experiment is performed in compression ignition engine in heat engine laboratory, and measurement of performance and emission is evaluated in diesel engine. Following equipment used during the experiment discuss below.

2.2.1 Compression ignition engine: A single cylinder direct injection, water cooled diesel engine used for the experiment and following performance is evaluated:

1. Brake power (BP)
2. Brake thermal efficiency
3. Brake specific fuel consumption (BSFC)

Fig. 3 Compression Ignition Engine

MODEL	TV1(KIRLOSKAR)
Type	Direct injection diesel engine
Compression ratio	17.5
Rated power	5.2 KW@1500 RPM
Bore	87.5mm
Stroke	110mm
Speed	1500rpm
Connecting rod length	217mm
Orifice diameter	16mm
Dynamometer	Eddy current type
Dynamometer arm length	185mm
Load indicator	Digital, range 0-50 kg, supply 250V AC

Table 2 The Specifications of Engines Used in the Present Study

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2.2.2 Eddy Current Dynamometer

The single cylinder diesel engine is connecting with eddy current dynamometer which evaluates the brake power and torque. With help of load cell connect with dynamometer to measure the different load 0 -20 Kg which one is applied on the engine. Load sensor is connecting to engine which is indicating the load by load indicator. And by dynamometer load is change in each experiment to evaluate the power. The construction of dynamometer which is ring(rotor) is rotate in ccw direction which is driven by diesel engine and in dynamometer stator is locate between air gap. The coil is excited in direction of stator which is wounded in circumferential direction. When current is going to exciting coil, a magnetic pole is excited in stator and rotor in dynamometer. The rotation of rotor and stator used for density difference, and the current make in stator. The EMF is produced in direction of current flow and. Fig 3.3 illustrates the eddy current dynamometer.

Fig 4 Eddy Current Dynamometer

2.3 Procedure of Experiment

The experiment was performed firstly is diesel and then used three blends of Jatropha B10, B20, B30 wit diesel and experiment was performed with those blends.

1. Firstly diesel is taken in fuel tank
2. After setting the water supply, water tank and calorimeter is set and open during the experiment
3. All the electric connection checked properly and then electric supply is started.
4. The engine performance software legion brother software is open during the experiment.
5. Then the valve provided at the burette is opened to supply the diesel in the engine
6. The engine is started and run for few minutes at no load condition.
7. Then AVL gas analyzer is connected to the engine and emission sensor or probe is connected to the analyzer.
8. So load is applied in the engine and reading is taken from the AVL gas analyzer
9. And performance is taken from legion brother software like cylinder pressure, heat release rate etc.

10. And emission is carried out by AVL gas analyzer and reading is saved in computer
11. The same steps are repeated for different loads.
12. All reading were saved
13. After noted all the reading engine was brought to no load conditions and after engine and computer was turned off to stop the experiment. The fuel supply was also stopped after some time and water supply was also stopped.

III RESULTS AND DISCUSSIONS

The experiments results are divided into three categories are following:

1. Transesterification of Jatropha oil
2. Comparison of diesel and its blends on performance parameters
3. Comparison of diesel and its blends on emission parameter.

Transesterification of Jatropha oil:

Production of biodiesel from Jatropha oil from transesterification is evaluated on various parameters like molar ratio, NaOH concentration and reaction time. The reaction temperature for Jatropha oil is 70^0C. In this process molar ratio of Jatropha oil and methanol is 5:1, and .5% of NaOH by weight and 70^0C is reaction temperature. Jatropha biodiesel properties are compared with diesel and according to ASTM standard. It was founded that latest Jatropha biodiesel calorific value is 42633kJ/kg which is approximately equals to pure diesel.

Property	**ASTM standard**	**diesel**	**Jatropha biodiesel**
Density kg/m^3	------------	850	880
Kinematic Viscosity (cSt)	1.9-6.0	2.049	4.3
Flash point ^{0}C	>130	78	200
Fire point ^{0}C	>53	83	160
Cloud point ^{0}C	-3 to 12	< 10	-2
Pour point ^{0}C	-15 to 10	- 6	- 6
Calorific value KJ/kg	>33000	42000	42633
Carbon residue (%)	< 0.05	.0214	0.0179%

Ash content, (%)	0.02% max	.02	.02

Table 3 properties of diesel and Jatropha biodiesel according to ASTM standard

3.1 Engine performance and emission parameter with Jatropha biodiesel blends:

The Experiment is performed in diesel engine with diesel and Jatropha biodiesel blends B10, B20, and B30. And performance parameters like brake thermal efficiency, brake specific fuel consumption, heat release rate, cylinder pressure is evaluated.

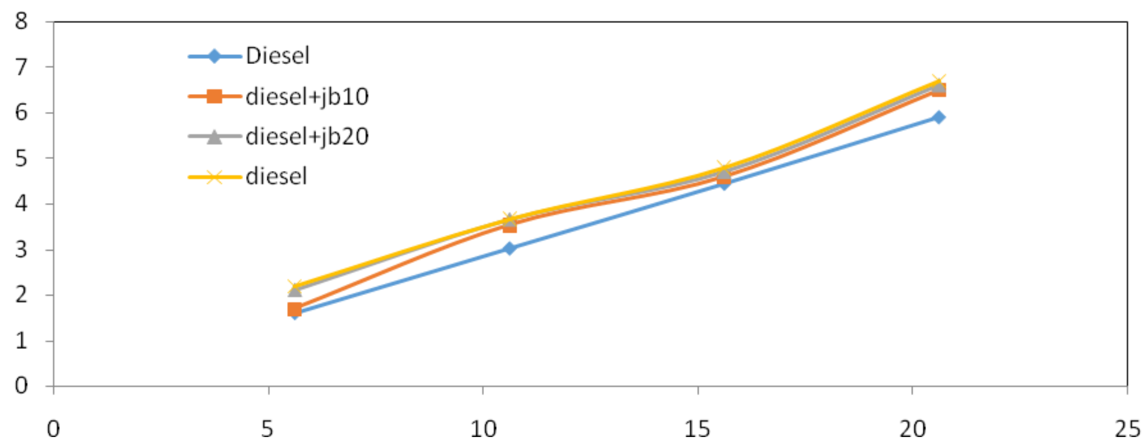

Fig.5 Variation of Brake Power (Kw) Vs. Engine Load (Kg)

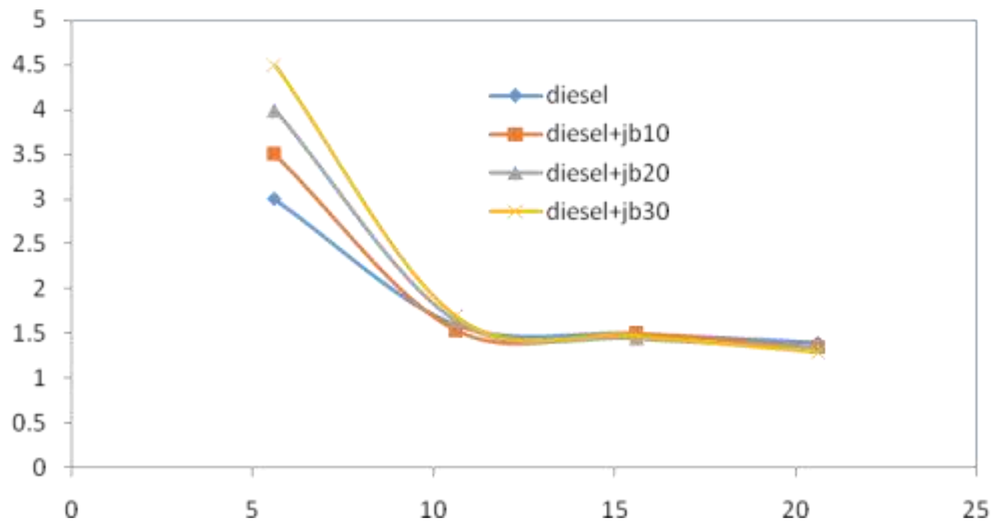

Fig. 6 Variation of bsfc (Kg/Kwh) Vs. Engine Load (Kg)

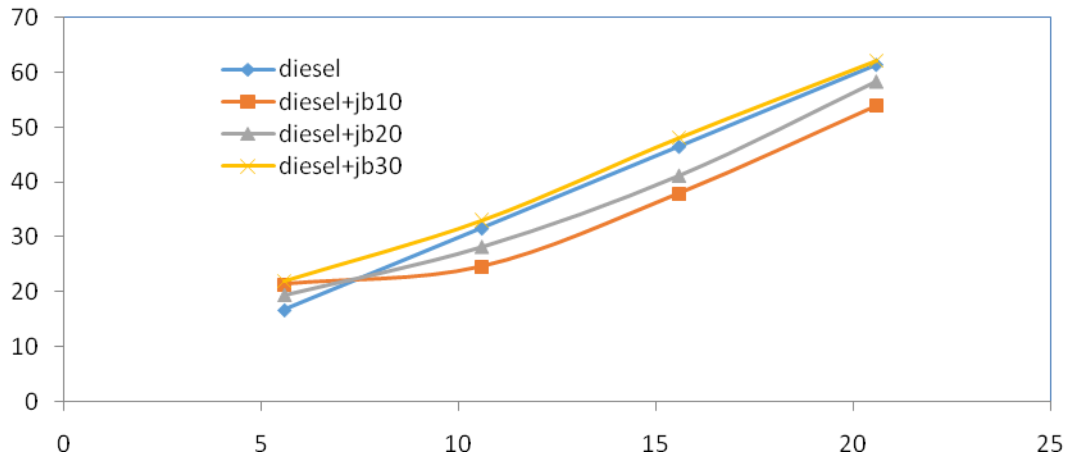

Fig. 7 Variation of Brake Thermal eff. vs. engine load (kg)

IV CONCLUSIONS

Biodiesel production from Jatropha oil using transesterification process. The performance and emissions parameter for diesel fuel were compared with B10, B20, B30. The following conclusions can be drawn from the present study:

1. Maximum biodiesel production was obtained at molar ratio of 5:1, reaction time 60 minutes, 0.5% NAOH concentration.
2. The fuel properties of biodiesel were found to be comparable to diesel were conforming to the latest biodiesel
3. Calorific value of Jatropha biodiesel is 42663 kJ/kg which is nearer to diesel
4. Performance parameters such as BP, BSFC, and brake thermal efficiency with B20 were observed to be nearly similar to the diesel fuel at all loads. B20have better performance parameter than other blends. The BSFC is lowest among the blend.
5. The emission parameter B10 blend such as CO, CO_2 and HC were nearly similar to diesel fuel. With increase in blend content these emissions were observed to be decreased. Among all blends, these emissions from B20 blend were observed to be lowest. The NOx emissions were observed to be lowest.

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