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Performance Investigation of Single Cylinder 4-StrokeDiesel Engine Using Bio-Diesel-An Extract Of Neem Oil

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ABSTRACT
Biodiesel is a fatty acid alkyl ester which is renewable, biodegradable and non- toxic fuel which can be derived from any vegetable oil and animal fats. Vegetable oils and animal fats in their raw form have high viscosity that makes them unsuitable as fuels for diesel engines. Transesterification is one of the well-known process by which fats and oils are converted into biodiesel. The reaction often makes use of acid/base catalyst. The present study consists of the production of biodiesel from Neem- oil with the use of Potassium Hydroxide as a base catalyst s. The Transesterification results shows that the lower viscosity, lower specific gravity with higher yield. The prepared biodiesel was tested as per the ASTM biodiesel standard and was found to be within the standard limits of biodieseland also studied on performance of Neem biodiesel and compare the results with pure diesel in 4stroke single cylinder diesel engine

1. Introduction

In present energy scenario of world energy crisis, the fuels of bio-origin can provide a feasible solution. The enormous growth of world population, increased technical development, enhancement in the standard of living and industrialization has led to this intricate situation in the field of energy supply and demand. The price of crude oil keep rising and fluctuating on a daily basis. Excessive use of fossil fuels has led to global environmental degradation effects such as green house effect acid rain, ozone depletion; climate changes etc. The variation in energy prices is very heavy in the last decade. The sky rocketing oil prices exert enormous pressure on our resources and seriously affect our economy. The fact that petroleum based fuels will neither be available in sufficient quantities nor at reasonable price in future has revived interest in exploring alternative fuels for diesel engines. The presence of oxygen in biodiesel(≈10%) improves combustion and reduces CO, soot, andhydrocarbon emissions while slightly increasing the NOx emissions.

Fossil fuels are non-renewable energy resources. Although, these fuels are contributing largely to the world energy supply, their production and use have raised environmental concerns and political debates. There are limited reserves of the fossil fuels and the world has already faced the energy crisis of seventies concerning uncertainties in their supply.

1.1 Types of Alternative Fuels

Alternative fuels are fuels that aren't made from petroleum. There are different kinds of fuels that vehicles can use that aren't made from petroleum. Various types of alternative fuels that are explored, in partial usage and under extensive research are

- Solar Energy
- Alcohols – ethanol and methanol
- Compressed natural gas (CNG) – natural gas under high pressure
- Electricity stored in batteries
- Hydrogen (considered a special gas)
- Liquefied natural gas (LNG) natural gas that is very cold.
- Liquefied petroleum gas (LPG) propane, it is hydrocarbon gas under low pressure

1.2 Advantages of Biofuels

- Biofuel is Environmentally Friendly.
- No Engine Modifications Necessary.
- Biofuel prolongs Engine Life.
- Emits less CO, unburnt HC, SOx other than NOx.
- Higher flash point and hence safe to handle storage and transport.
- Supports the Indian formers.
- Biodiesel can be made at home.
- Biodiesel has economic advantages

1.3 The Disadvantages of Vegetable Oils as Diesel Fuel

The major problems of using vegetable oil as diesel fuel are higher viscosity, lower volatility and the reactivity of unsaturated hydrocarbon chains. Although short-term tests using neat vegetable oil showed promising results, problems appeared only after the engine had been operating on vegetable oil for longer periods of time. The high fuel viscosity in compression ignition causes the major problem associated with the use of pure vegetable oils as fuel for Diesel engines. All the vegetable oils are extremely viscous, with viscosities ranging 10-20 times greater than diesel fuel.

The major problem in direct use of vegetable oils as fuel into C.I engines is their higher viscosity. It interferes the fuel injection and atomization and contributes to incomplete combustion, nozzle clogging, excessive engine deposits, ring sticking, contamination of lubricating oil, etc. The problem of higher viscosity of vegetable oils can be overcome to a greater extent by various techniques, such as heating, dilution, emulsification and esterification.

1.4 Neem and Neem oil

Extraction of bio-Diesel from Neemseeds is become more advantageous in now a days because the only reason is found abundantly in all types of whether conditions in all over India and Indian sub-continents. Neemseeds contains nearly 25-40% fat.

Fig.1Neem seed

1.5 Scope of the Present biofuel extraction Work

.In the present work production and instigates the performance of neem biodiesel. The properties of the methyl ester and its blends were found out. Experimental investigations were carried out with the biodiesel with diesel and in a single cylinder 4 stroke direct injection engine.

1. To prepare biodiesel from neem oil by transesterification process. Since chemically modifying the structure of vegetable oils by esterification reduces the viscosity.

2. To run a single cylinder four stroke diesel engine with biodiesel in order to evaluate their performance in regard to brake power, brake thermal efficiency, brake specific fuel consumption are calculated. For comparison, the same parameters were to be determined for engine operation with conventional diesel.

2. Biodiesel Processes

This process has two separate starting points. If vegetable oils can be obtained that are below 2.5% FFA, the esterification step is not necessary as shown in Fig.2.

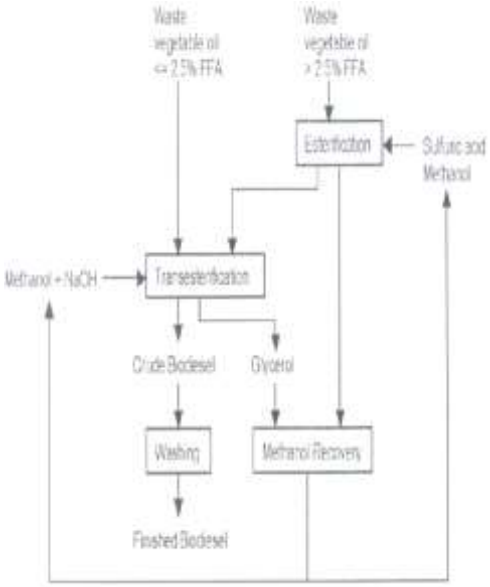


Fig. 2 Process Flow for Biodiesel Production.

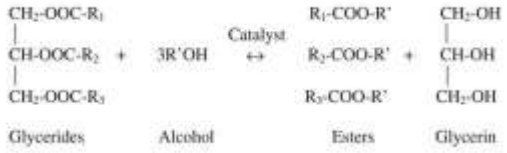
2.1 Calculation of amount of free fatty acid in oil

Before calculating the amount of FFA in the oil, we should write down the equation ofthe reaction. You should also know that the general formulae for a fatty acid chain arerepresented as RCOOH. Where R is an alkyl group. Hence,RCOOH (aq) + KOH(aq) → RCOOK (aq) + H2O(L)Formula for FFA calculation% FFA (as oleic) = Titre x N x 28.2/ (Weight of sample)Where N = molarities of base

2.2 Transesterification of vegetable oils

Transesterification is the reaction of a fat or oil with an alcohol to form esters andglycerol. Alcohol combines with the triglycerides to form glycerol and esters. Acatalyst is usually used to improve the reaction rate and yield. Since the reaction isreversible, excess alcohol is required to shift the equilibrium to the product side.Among the alcohols that can be used in the transesterification process are methanol,ethanol, propanol, butanol and amyl alcohol. Alkali-catalyzed transesterification muchfaster than acid-catalyzed transesterification and is most often used commercially.R1, R2, R3 and R' represent various alkyl groups. The process of

Transesterification brings about drastic change in viscosity of vegetable oil. The biodiesel thus produced by this process is totally miscible with mineral diesel in anyproportion.



2.3 Procedure of Transesterification

- Measure 1L of neem crude oil using measuring cylinder and pour it in three mouth flask.
- Three mouth flask should be provided with cooling system to circulate methanol.
- Heat crude oil using electric heater it up 75° and stir it continuously using magnetic stirrer.
- Prepare a solution of 300ml of methanol and NaOH crystals.
- When temperature of three mouth flask reaches 75°, slowly add above prepared solution to the flask.
- Continue heating till one and half hour make sure that temperature remains constant.
- Pour the content of flask into separation funnel and keep it for at least 6 hours which permits glycerin to settle down hence it being denser then biodiesel

2.4 Process Variables

The most important variables that influence the transesterification reaction are:

1. Reaction temperature.
2. Ratio of alcohol to vegetable oil.(Molar ratio).
3. Catalyst concentration.
4. Reaction time

3. Experimental set up

3.1 Introduction

The detailed explanation of experimental set up and measurement systems and procedure carried out in the present work. The experiment aims at determining appropriate proportions of biodiesel & diesel for which higher efficiency is obtainable. Hence experiments are carried out at constant speed, comparing the performance of a compression ignition engine operated at different blends.

3.2 Engine setup

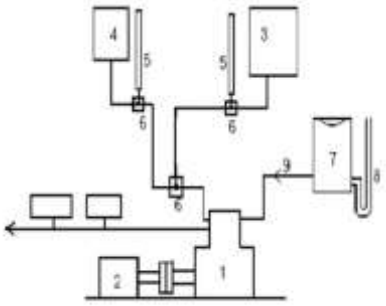


Fig.3 Experimental Setup

(1) Engine , 2)Alternator , 3) Fuel Tank(Bio-diesel) , 4) Diesel Tank , 5) Burettes 6) Three way valve , 7) Air box , 8) Manometer , 9) Air flow direction

Schematic diagram of the engine test rig is shown in Fig 3.1. The engine test was conducted on four-stroke single cylinder direct injection water cooled compression ignition engine connected to weight loading. The engine was always operated at a rated speed of 1500 rpm. The engine was having a conventional fuel injection system.

3.3 Methodology and Experimental Procedure

1. Switch on the mains of the control panel and set the supply voltage from servo stabilizer to 220 volts.
2. The main gate valve is opened and the pump is switched ON and the water flow rate to the engine cylinder jacket (200 liters/hour).

Engine is started and allowed to run for a 20 minutes to reach steady state conditions

The engine has a compression ratio of 17.5 and a normal speed of 1500 rpm controlled by the governor. An injection pressure of 200 bars is used for the best performance as specified by the manufacturer. At each loading conditions, performance parameters namely speed, brake power are measured under steady state conditions

4. Results and Discussions

This section contains the fuel properties of diesel and bio-diesel an extract of neem oil. The experiments were conducted on a direct injection compression ignition engine for various loads with an intention of studying the behaviour of the engine in regard to performance characteristics when it was run on diesel and biodiesel blend.

4.1 Fuel Properties

The fuel properties are Calorific value,Viscosity, Density, Specific Gravity, Flash point and Fire point of the biodiesel an extract of neem oil were determined. The fuel properties of each biodiesel compared with the diesel.

Table 1Performance Test on Diesel Engine

Property	Neem oil	NBD
Viscosity	28.2	6.1
Density(Kg/m^3)	926	890
Flash point(^0C)	212	138
Fire point(^0C)	220	144
Calorific value(kj/kg-k)	34000	38900

The performance tests were conducted on single cylinder four stroke diesel engine with neat diesel

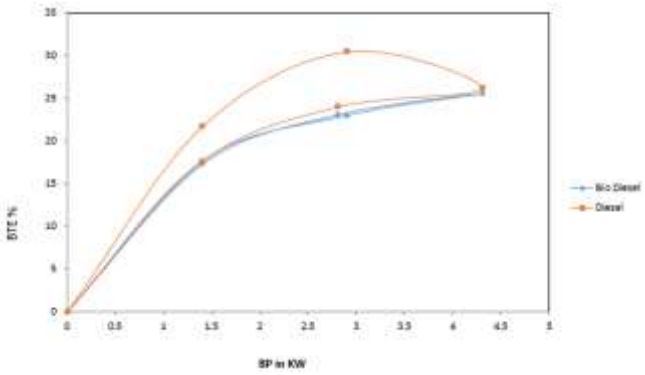


Fig 3 Brake thermal efficiency v/s BP

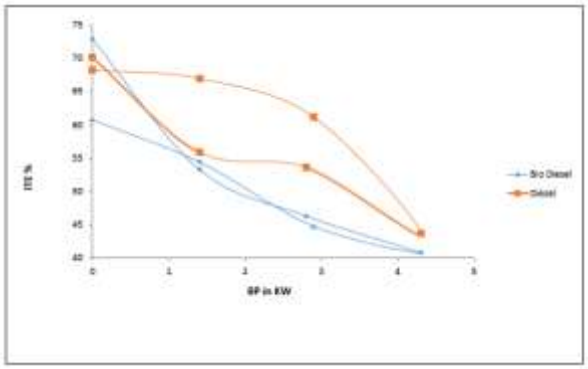


Fig 4 Indicated thermal efficiency v/s BP

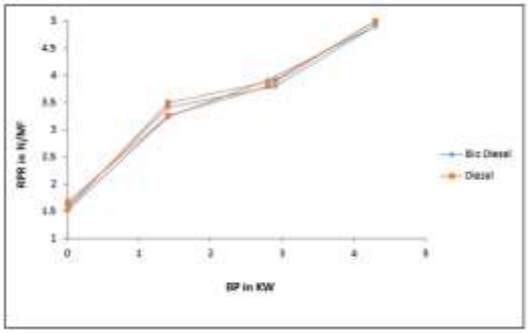


Fig 7 Rate of pressure rise v/s BP

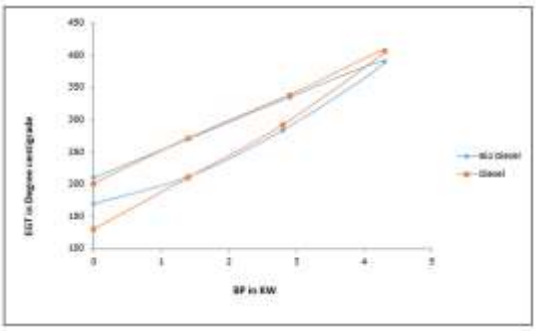


Fig 5 Exhaust gas Temperature v/s BP

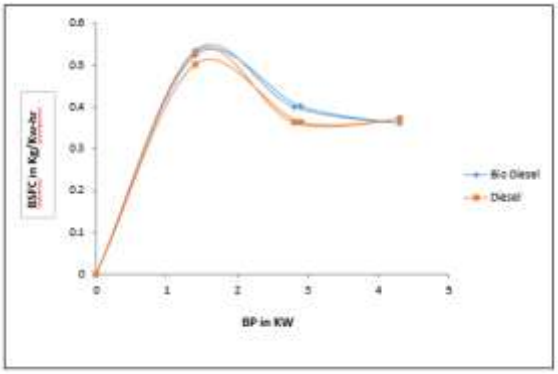


Fig 8 BSFC v/s BP

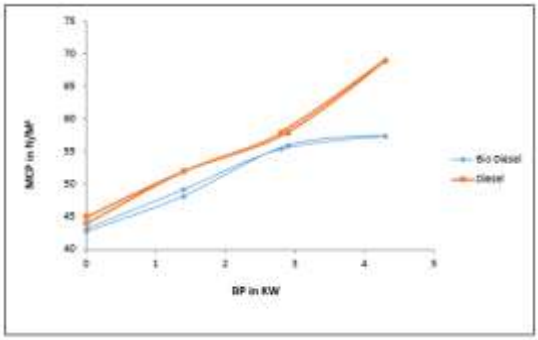


Fig 6 Maximum cylinder pressure v/s BP

5. Conclusions

The present work evaluates production of NBD using Potassium hydroxide (KOH) as a catalyst and performance evaluation of single cylinder four stroke DI diesel engine using diesel and biodiesel are carried out.

The thermal efficiency are observed to be identical at lower load conditions but at higher load (above half load) the thermal efficiency for the blend is higher compared to neat biodiesel. It is observed that the thermal efficiency of diesel fuel is increased. Above figure4.3.6 shows the variation of BSFC with brake power for diesel, biodiesel. It can be observed that the specific fuel consumption of biodiesel at all loads is higher than diesel fuel. This may be attributed to the lower heating value and higher density of biodiesel fuels.

- Filtered neem oil (biodiesel) can be substitute of diesel because the propertieslike calorific value, density and viscosity are very much comparable withdiesel.
- Biodiesel has become more alternative because of its environmental benefits and the fact that it is made from renewable resources.

Scope for Future Work

The present work is an experimental study on production of biodiesel and performance characteristics of direct injection compression ignition engine using the NBD as fuel with injection pressure of 200 bar and compression ratios like 17.5 under various loads. Further work can be done in the following areas.

1. A study of performance and emission of the engine with the NBD can be carried out by varying the injection Pressure.
2. The performance and emission characteristics of the engine with variation of compression ratio of the engine can be studied for all blends.
    - Test results with multi-cylinder engine fueled by NBD and its blends can be carried out and compared with that of single cylinder engine performance,

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