

Performance Characteristics of Biodiesel Production from Karanja Oil

¹Mahesh kumar AR, ²Sakthivel M, ³Sugumar.S, ⁴Jayakumar M, ⁵Franklin M.

^{1,2,3}Assistant Professor, ^{4,5}UG Students

^{1,2,3,4,5}Department of Mechanical Engineering, IFET College of Engineering, Villupuram, TamilNadu.

Abstract: Due to the increasing demand for fossil fuels and more liberation of pollutants in environment, a number of renewable sources of energy have been studied worldwide. Non-edible oil contains several unsaponifiable and toxic components, which make them unsuitable for human consumption. An attempt is made to evaluate the suitability of vegetable oil for diesel engine operation, without any modifications in its existing construction. Biodiesel is a clean and renewable fuel which is considered to be the best substitution for diesel fuels. In order to succeed this, Biodiesel is prepared from the Karanja by transesterification of the crude oil with methanol in the presence of NaOH as catalyst. The important fuel properties of methyl esters of biodiesel produced from karanja oil, like cc etc., should be found out and to compare with the properties of Indian standard biodiesel for its use.

Keywords: fossil fuels, energy, vegetable oil, diesel engine, renewable fuel, transesterification, crude oil, methanol, viscosity, flash point, fire point, calorific value.

I. Introduction:

Biodiesel is simply a liquid fuel derived from vegetable oils and fats, which has combustion properties as regular petroleum diesel fuel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, and tallow of waste cooking oil. Biodiesel is nontoxic, biodegradable, and has significantly fewer emissions. Biodiesel is an alternative fuel similar to conventional fossil or petroleum diesel. The process used to convert these oils to biodiesel is called transesterification. The largest possible source of suitable oil comes from oil crops such as soya bean, rapeseed, corn, and sunflower. At present, oil straight from the agricultural industry represents the greatest potential source, but it is not being used for commercial production of biodiesel simply because the raw oil is too expensive. After converting it to biodiesel the price is too high to compete with petroleum diesel. Vegetable oil can often be obtained free or treated. One disadvantage of using waste oil is it must be treated to remove impurities like free fatty acids before conversion to biodiesels. Biodiesel produced from waste vegetable oil and fats can compete with the prices of petroleum diesel without subsidies.

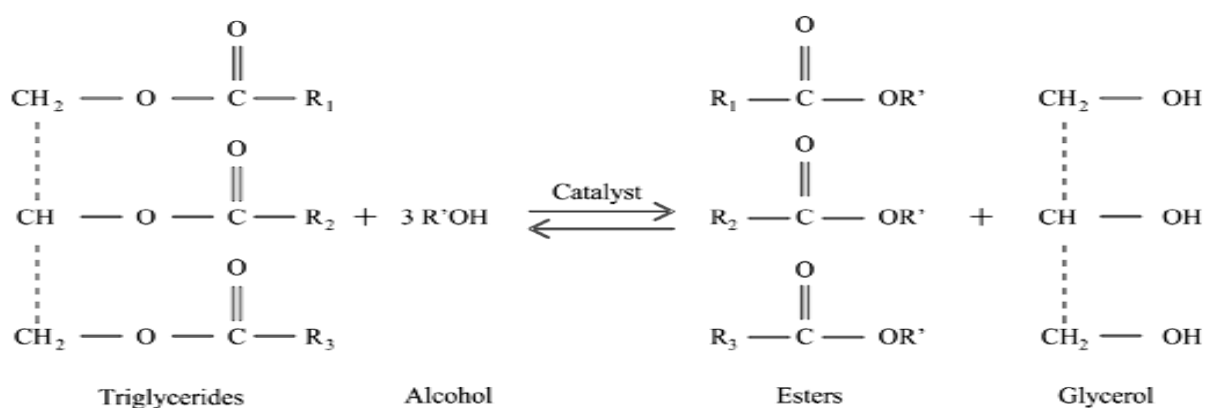
1.1 Biodiesel as a Fuel for Diesel Engine

Energy demand will still increase considerably in the upcoming years due to population growth and gradual rise in living standards, especially in developing countries. To satisfy this demand, the energy sources will become more complementary than competitive. Bio-diesel is an alternative fuel similar to fossil fuel for diesel engines is possible alone in blends with fossil diesel. Biodiesel is nontoxic, biodegradable and environment friendly. Biodiesel contains almost no sulphur and does not contribute to greenhouse gases due to its closed carbon cycle. Biodiesel is constituted by a mixture of fatty acid alkyl esters. The ester composition varies according to the fatty acids present in the triglyceride used as raw material. Vegetable oils are the most used raw-materials, but new raw-materials are need to be developed at low cost. Animal fat wastes can reduce biodiesel production costs, at the same time allowing significant value to the wastes. Poultry fat is currently considered potentially a low cost raw-material for biodiesel production. It is possible to obtain biodiesel through transesterification reaction of poultry fat wastes at low temperatures as poultry fat wastes is extremely appealing as raw-material.

1.2 Making of Bio Diesel

The most common way to produce biodiesel is through transesterification reaction, also called alcoholysis. The transesterification is a three-step reversible reaction that converts the initial triglycerides into a mixture of esters (biodiesel) and glycerol, in the presence of a catalyst. The process of transesterification reaction, the triglycerides are converted into diglycerides, monoglycerides and glycerol; at each step, one molecule of ester is produced. Usually a homogeneous base such as NaOH or KOH or their methyl oxides can be used as catalysts. The use of methoxides, such as sodium meth oxide, has been demonstrated to be a better option instead of using NaOH or KOH, because they are water free. When NaOH is added with the alcohol, instead of using meth-oxide, their reaction might lead to water formation and consequently decreases the

reaction yield. Therefore, the use of meth -oxides usually leads to higher quality products with better yields. The transesterification of triglycerides produce methyl esters with free glycerol. The most widely used alcohol is methanol. Besides being cheaper, one of the major advantages of using methanol is fatty acid methyl esters (FAME) and glycerol can be very easily separated. Non-catalytic transesterification is one alternative technology for biodiesel production using methanol under supercritical conditions. The reaction is fast, and yielding the conversion in short time (50-95% after 10 min reaction). From all the technologies applied, the transesterification has been demonstrated to be the more efficient and reduce the triglyceride viscosity with properties similar to those of fossil diesel. Many parameters affect the transesterification reaction to produce biodiesel, such as temperature, methanol/oil molar ratio, mixing rate, catalyst type and amount of catalyst. The optimization of the reaction usually considers the parameters previously referred and the type of feedstock. Considering the homogeneous alkali catalytic systems, the optimum temperature tends to be the one closest to the boiling point of the alcohol used. An excess of alcohol is necessary to promote a good conversion. The mixing rate should be as high as possible to promote the mixture between reactants, which is particularly important because reactants and catalysts constitute two phases.



1.3 Classification of bio fuels

Bio fuels are classified as primary and secondary bio fuels. The primary bio fuels are used in an unprocessed form primarily for heating, cooking or electricity production such as fuel wood, wood chips and pellets, etc. The secondary bio fuels are produced by processing of biomass e.g. ethanol, biodiesel, DME, etc. that can be used in vehicles and various industrial processes. The secondary bio fuels are further divided into first, second and third generation bio fuels on the basis of raw material and technology used for their production. Bio fuels are also classified according to their source and type. They may be derived from forest, agricultural or fishery products or municipal wastes, including by-products and wastes originated from agro-industry and food industry. Bio fuels can be solid, such as fuel wood, charcoal, and wood pellets; or liquid, such as ethanol, biodiesel and pyrolysis oils or gases, such as biogas (methane).

1.3.1. Primary bio fuels Vs secondary bio fuels

Primary bio fuels are natural and unprocessed biomass such as fire wood, wood chips and pellets, and are mainly those where the organic material is utilized essentially in its natural and non modified form. Primary fuels are directly heating or electricity production in small and large-scale industrial applications. Secondary fuels are modified primary fuels, which have been processed and produced in the form of solids (e.g. charcoal), or liquids (e.g. ethanol, biodiesel and bio-oil), or gases (e.g. biogas, synthesis gas and hydrogen). Secondary fuels can be used for multiple ranges of applications, including transport and high temperature industrial processes. Now more advanced and efficient conversion technologies exist for the extraction of bio fuels in solid, liquid and gaseous forms - from materials such as wood crops and waste material.

1.3.2. Advantages and challenges of bio fuels

Bio fuels offer the promise of numerous benefits related to energy security, economics, and the environment. At the same time, several challenges must be overcome to realize these benefits. The key advantage of the utilization of renewable sources for the Production of biofuels is the utilization of natural bio resources (that are geographically more evenly distributed than fossil fuels) to produce bio energy. Utilizing agricultural residual and waste substrates as raw materials will minimize the potential conflict between food and fuel.

II. Biodiesel Preparation

2.1 Biodiesel

Various researchers have discussed fairly extensively, the advantages of using vegetable oils as diesel. Such properties include liquid nature for transport, heat content, and that they are Renewable and readily available. Though there are some disadvantages such as higher viscosity, lower volatility and the reactivity of unsaturated hydrocarbon chains. Vegetable oils cannot often be used directly as an energy source in an engine due to the higher level of viscosity, the lower volatility and the reactivity of the unsaturated hydrocarbon chains within oils. Direct use of vegetable oils has been deemed unsatisfactory as due to the high viscosity, Free Fatty Acid (FFA) content and the matter of carbon deposits, their use has been limited to a considerable extent. Many technologies and methods have been employed to try and reduce the viscosity of the oil; these include micro emulsion, pyrolysis (thermal cracking), catalytic cracking and transesterification. Biodiesel is used to replace diesel and is produced by transesterification of vegetable oil and waste fats hence, biodiesel can be defined as “mono alkyl esters of fatty acids derived from vegetable oil or animal fats”. It is the similarities in the constitution of the vegetable oils/animal fats and petroleum derived diesel that makes the vegetable oils suitable for conversion to biodiesel. The vegetable oils/animal fats are naturally insoluble in water and are hydrophobic substances. Their general make up consists of one glycerol to three fatty acids thereby they are frequently referred to as triglycerides. The characteristics of the fat are influenced by the nature of the fatty acids attached to the glycerin; the nature of the fatty acids can have a knock on effect on the characteristics of the biodiesel. The most commonly considered animal fats consist of those derived from poultry, pork and beef. While one research group reported on the conversion of animal fats for biodiesel, but then other group has argued that although animal fats are mentioned regularly, their uses are limited as some of the methods for converting vegetable fats are not applicable to animal fats due to the natural differences between the two types of fats. Used vegetable fats can be recycled for biodiesel production, but the quality of the oil will have a knock on effect on the quality of the Bio diesel produced.

2.2 Collection of Karanja Seeds

Initially the seeds of the plants are collected from the grown tree, they are selected in such a way that they exist homogenous in size. Seed collection is done during the ideal period that the maximum oil content is obtained for extraction.



Fig 2.1 Karanja seed

2.3 Drying Process

The collected seeds of the plants are dried in sun for about two days, seeds are maintained within particular periods of the day in exterior because it is undesirable to keep them in cold environment.



Fig 2.2 Dried karanja seed

2.4 Preparatory Process

After the seeds are sufficiently dried, the water content in them is completely removed, they are subjected to preliminary preparatory phase. In this phase, the dried seeds are broken and the interior part is taken for further processing. The shell is removed since it is not desirable for the overall process.



Fig 2.3 (a) karanja seed coat



Fig 2.3 (b) Karanja seed endosperm

2.5 Extraction Process

After the seeds are dried sufficiently, we had the oil by using the karanja seeds. We used chekku to get the oil from the seed. Normally if we use 1kg we can get 0.8 liters of oil. Then the remaining filtered byproducts can be used as medicinal purposes.



Fig 2.4 Extracted karanja oil

2.6 Procedure for Production of Biodiesel

2.6.1. Raw materials required:

1. Karanja oil
2. Lye (Catalyst)
3. Methanol
4. Isopropyl Alcohol (for tests. Use 99% IPA)

2.6.2 Titration Process to Determine Lye Quantity

Free fatty acids will increase with the temperature and vegetable oil has been heated. Oil which has been used for cooking will require more of the reactive agents (lye and methanol) than fresh oil. The presence of too many free fatty acids will retard or stop the reaction which produces biodiesel, so it is necessary to detect the exact amount of LYE (Sodium Hydroxide or NaOH) needed to neutralize. Adding too much or too little NaOH will just make excessive amounts of bi-products (soap).

2.6.3 To Determine Reaction Proportion

To find the total amount of NaOH to be added we add the number of drops of NaOH needed for the wasted vegetable oil solution to reach a pH of 8-9 and 3.5 grams NaOH to catalyze the oil (stoichiometric). An example formula is used with one particular batch of wasted vegetable oil 1ml of oil is titrated with a 1gm NaOH and 1litre H₂O solution. It required 6 ml to raise the pH level to 8. Hence 6.0gm/1000ml to neutralize the free fatty acids plus 3.5g NaOH as catalyst = 9.5g per 1000ml oil.

2.6.4 Vegetable Oil

Diesel has a chain of 11-13 carbons and new vegetable oil has a chain of about 18, but waste vegetable oil, which has been heated, has a chain of up to 32 carbons. To burn in an engine the chain needs to be broken down to be similar in length to diesel.

2.6.5 Lye (Catalyst)

Lye is the catalyst used for transesterification. It works by "cracking" the vegetable oil molecules, splitting the triglycerides from the hydrocarbons and shortening the carbon chain of 3.5gm or 0.35% is the standard amount of lye necessary to create a reaction, when using fresh vegetable oil. Due to the presence of a very small quantity of FFA we add an additional 0.3 to 0.4 grams in order to neutralize completely.

2.6.6 Methanol

The amount of methanol needed will also vary, but the ideal is to use the least amount of methanol necessary in order to get the highest yield. The yield is related to completion so if you get 90% yield that means that 90% of the fatty acids have been eliminated from the vegetable oil. We have found that the best is to use 15% to 20% methanol, based upon the total weight of batch of oil. A hydrometer can also be used to check the amount of completion according to density.

III. Methodology

3.1 Types of Methodology

Different methodologies used for production of biodiesel are:

- i. Direct use/blending,
- ii. Micro-emulsion,
- iii. Pyrolysis and
- iv. Transesterification.

3.1.1 Direct Use/Blending

Vegetable oil can be directly used as diesel fuel without any changes to engine. The very first engine (by Rudolf Diesel) was tested using vegetable oil as fuel. The primary concern with vegetable oil as fuel is its high viscosity (atomization of vegetable oil is difficult), which leads to problems in the long run: Advantages of vegetable oil as diesel fuel are

- i. Liquid nature and portability
- ii. High heat content (80 per cent of diesel fuel)
- iii. Ready availability and
- iv. Renewability

3.1.2 Micro-emulsions:

Micro emulsion is defined as colloidal dispersion of fluid microstructures (1-150 nm) in solvent forming two immiscible phases. The common solvents used are methanol and ethanol. Micro-emulsions is the probable solution to high viscosity of vegetable oil. Their atomization is relatively easy because of lower viscosity.

3.1.3 Pyrolysis

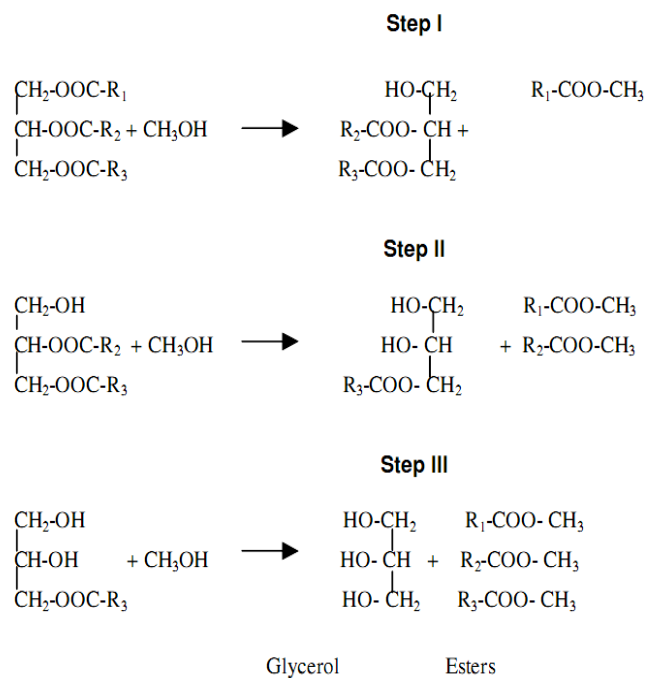
Pyrolysis means conversion of one substance to another by application of heat. Catalysts are used to speed up the process. Different products can be obtained from the same material depending on different path of reaction and this makes pyrolytic chemistry difficult. Pyrolysis of vegetable oil gives different lower hydrocarbons that can be used as fuel.

3.1.4 Transesterification

Transesterification is a kind of organic reaction where alcohol group in ester is switched. It can also be reaction of vegetable oil/fat with alcohol to give ester and glycerol. The applicability of transesterification is not restricted to laboratory. Several relevant industrial processes use this reaction to produce different types of compounds. An example is the production of PET (polyethylene terephthalate), which involves a step where dimethyl terephthalate is transesterified with ethylene glycol in the presence of zinc acetate as catalyst. Furthermore, a large number of acrylic acid derivatives are produced by transesterification of methyl acrylate with different alcohols, in the presence of acid catalysts.

3.1.5 Transesterification of Vegetable Oils

In transesterification of vegetable oils, a triglyceride reacts with three molecules of alcohol in the presence of catalyst, producing a mixture of fatty acids alkyl esters and glycerol. The overall process is a sequence of three consecutive reactions, in which monoglycerides are formed as intermediates. Transesterification is a reversible reaction, thus excess alcohol is used to increase the yields of the alkyl esters and to allow its phase separation from the glycerol formed.



3.2 Free Fatty Acid Test (Ffa)

Fatty acids are the building blocks of fat source in living organisms. Fat or lipids are made up of 3 fatty acids attached to a glycerol backbone to make up a triglyceride. Since fatty acids are necessary to create essential building blocks such as triglycerides, they are rarely found floating alone within cells. When these acids are floating alone, they are referred to as free fatty acids. Free fatty acids appear as lipids breakdown products and are therefore good indicators of degradation. There are many types of free fatty acids. They can be differentiated by the length of the carbon chain, the presence and number of double bonds and the alignment of the carbons at the double bonds. The procedure for FFA test is given below.

- i. The 5gm of fat is to be taken and add with 50 ml of ethanol.
- ii. The solution is heated till the bubbles come.
- iii. 50 ml of NaOH (0.1N) poured in the burette.
- iv. Next Phenolphthalein indicator of 2 drops is to be added in the conical flask.
- v. Now the titration is to be started.
- vi. When colour change occurs in the solution the titration is to be stopped as shown in Fig(4.1)
- vii. The burette readings are noted.



Fig 3.1 FFA test

3.2.1 Formula

The formula to determine the fatty acid is given below

$$\text{FFA} = \frac{\text{ml of NaOH} * \text{Mol.Wt. of NaOH} * \text{Normality of NaOH}}{\text{Wt. of fat per lit}}$$

$$= \frac{2.2 * 40 * 0.1}{5}$$

$$\text{FFA} = 1.76.$$

The obtained answer is less than 2. So, the trans-esterification process is to be conducted.

3.3 TRANS-ESTERIFICATION

Transesterification is a process in which viscosity & density of oil can be reduced. In the transesterification of animal fat, a triglyceride reacts with alcohol in the presence of either acid or base catalyst to produce a mixture of fatty acid alkyl ester and glycerol. In this process karanja oil is made to react with methanol in the presence of base catalyst (NaOH). The steps for trans-esterification process are given below.

3.3.1 PRE-HEATING

- i. 1 litre of karanja oil is taken.
- ii. Heat the oil up to 60°C to remove the water content present in it.
- iii. Then cool down the temperature of the karanja oil.

3.3.2 PREPERATION OF METH OXIDE SOLUTION

- i. 300 ml of Methanol is to be filled in a beaker.
- ii. 4.5 gm of NaOH pallets is to be dissolved in the methanol solution; it will act as catalyst for trans-esterification process.
- iii. The Methoxide solution preparation is shown in Fig(3.4)
- iv. In this process karanja oil is made to react with methanol in the presence of base catalyst (NaOH).

3.3.3 PREPARATION OF BIO FUEL

- i. The Pre-Heated karanja oil is to be placed on hot plate.
- ii. Maintain the temperature of 60⁰-70⁰C
- iii. Stir the solution as shown in the Fig(3.2)
- iv. 300 rpm is to be maintained for stirring.
- v. Add the Methoxide solution to the beaker.
- vi. This process is to be continued for about 2 hrs.
- vii. After the process is completed, glycerol and bio-fuel will be obtained.
- viii. After 24 hrs glycerol will ettle at the bottom of the beaker and the bio-fuel float at the top layer as shown in Fig(3.3)
- ix. Then separate the glycerol from bio-fuel.



Fig 3.2 stirring process

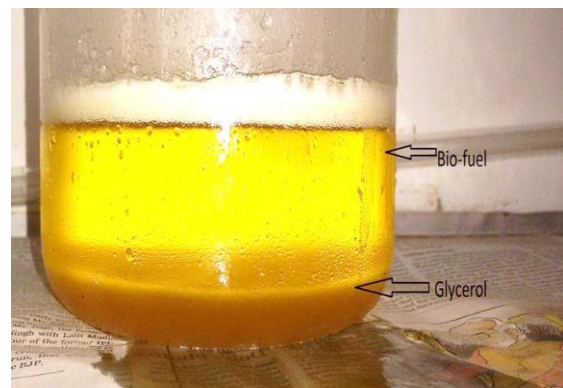


Fig 3.3 Sediment solution

3.4 PROPERTIES OF BIO-FUEL

- Kinematic Viscosity.
- Flash Point.
- Fire Point.
- Density.
- Calorific Value.

3.4.1 Kinematic Viscosity

The viscosity of a fluid is a measure of its resistance to gradual deformation by shear stress or tensile stress. For liquids, it corresponds to the informal concept of "thickness". For example, honey has a much higher viscosity than water. A fluid that has no resistance to shear stress is known as an ideal or viscous fluid. Zero viscosity is observed only at very low temperatures in super fluids. Otherwise, all fluids have positive viscosity, and are technically said to be viscous.

3.4.2 Flash Point

The flash point of a volatile material is the lowest temperature at which vapours of a fluid will ignite. Measuring a flash point requires an ignition source. At the flash point, the vapour may cease to burn when the ignition source is removed.

3.4.3 Fire Point

The fire point of a fuel is the temperature at which the vapour produced by the given fuel which will continue to burn for at least 5 seconds after ignition by an open flame. At the flash point in lower temperature, a substance will ignite briefly, but vapour might not be produced at a rate to sustain the fire. Most tables of material properties will only list material flash points, but in general the fire points can be assumed to be about 10°C higher than the flash points. However, this is no substitute for testing whether the fire point is safe or critical. For our Bio-diesel, Flash Point is found out by heating the oil at maximum temperature and ignite the oil. Fire will appear on the surface of the oil. By using thermometer temperature is noted and the results are shown in the table.

3.4.4 Density

For a pure substance the density has the same numerical value as its mass concentration. Different materials usually have different densities, and density may be relevant to buoyancy, purity and packaging. Osmium and iridium are the densest known elements at standard conditions for temperature and pressure but certain chemical compounds may be denser.

3.4.5 Calorific Value

Calorific Value is a measure of heating power and is dependent upon the composition of the gas. The Calorific Value refers to the amount of energy released when a known volume of gas is completely combusted under specified conditions. By using Bomb calorimeter our bio-fuel is tested and the readings are shown in table (3.1)

| Properties | Bio-Diesel | ASTM Standard |
|---------------------|-------------|---------------|
| Kinematic Viscosity | 5.431 | ASTMD614 |
| Flash Point | 47 | ASTM Standard |
| Cetane number | 42 | ASTMD613 |
| Density | 889 | >120 |
| Calorific Value | 39656 kJ/kg | ASTM Standard |

Table (3.1) Properties of biodiesel

3.5 Phase separation study

Biodiesel and diesel are mixed in various ratios on volume basis. The various blends and their composition are given in Table (3.2)

| S.No | Diesel | Bio-Diesel |
|------|--------|------------|
| 1. | 90% | 10% |
| 2. | 80% | 20% |
| 3. | 75% | 25% |

Table (3.2) Composition of blend

3.6 Determination of properties of fuel blends

Viscosity is a measure of resistance offered and important fuel property related to diesel engine performance. The viscosities of blends are measured using Redwood viscometer. Flash point of a liquid is the lowest temperature at which it can vaporize to form an ignitable mixture in air. Cleveland apparatus was used to determine the flash point.

IV. Experimental Setup and Experimentation

4.1 IC Engine

An IC engine is a heat engine, the combustion of a fuel occurs with an oxidizer in a combustion chamber. In an internal combustion engine the expansion of the high temperature and pressure gases produced by combustion apply direct force to some component of the engine. The force is applied typically to pistons. This force changes the component over a distance, transforming chemical energy into mechanical energy. The term internal combustion engine usually refers to an engine in which combustion is intermittent, such as the more familiar 4 stroke and 2 stroke piston engines, along with variants, such as the 6 stroke piston engine. Typically an internal combustion engine is fed with fossil fuels like petroleum products such as gasoline, diesel fuel or fuel oil. There is a growing usage of fuels like biodiesel for compression ignition engines and bio-ethanol or methanol for spark ignition engines.

4.2 Twin Cylinder Engine

A twin cylinder four stroke diesel engine is having the provision of mechanical loading. The air box with an orifice meter and water manometer is used to measure the flow rate of air supplied to the engine. The volumetric flow of fuel is measured using burette and a stop watch. A single cylinder four stroke diesel engine is coupled with the alternator having the provision of electrical loading. The specifications of the engine and the alternator are given in the Table I and II respectively. Continuous water supply is given to the engine for the cooling. The air box with an orifice meter and water manometer is used to measure the flow rate of air supplied to the engine. The volumetric flow of fuel is measured using burette and a stop watch. In this project twin cylinder internal combustion engine is used which requires some specifications which are as follows

| | |
|-------------------------------------|-----------|
| Make | Kirloskar |
| Bore | 87.5 mm |
| Stroke | 110 mm |
| Orifice Diameter | 0.02 m |
| Rate Speed | 1500 rpm |
| Compression Ratio | 16:1 |
| Coefficient of discharge of orifice | 0.64 |
| BHP | 10 HP |
| Specific Gravity | 0.8275 |

Table 4.1 Specification of Diesel engine



Fig 4.1 Diesel engine

V. Result and Discussion

The performance characteristics of a high speed diesel engine at various loads from one fourth loads to full load with linseed - Coconut biodiesel are compared with standard diesel.

- The performance test conducted in the single cylinder diesel engine the following procedure is followed:
- The blended mixer of diesel and biodiesels is filled in the fuel tank
- The engine is started at the no load condition
- No load reading of monometer, fuel consumption, current and voltage and speed are noted.

The following methodology is used for the power outputs and efficiency. The ratios used for performance testing are

- 100% diesel
- 90% diesel and 10% bio-diesel
- 80% diesel and 20% bio-diesel
- 75% diesel and 25% bio-diesel

VI. Performance Curve

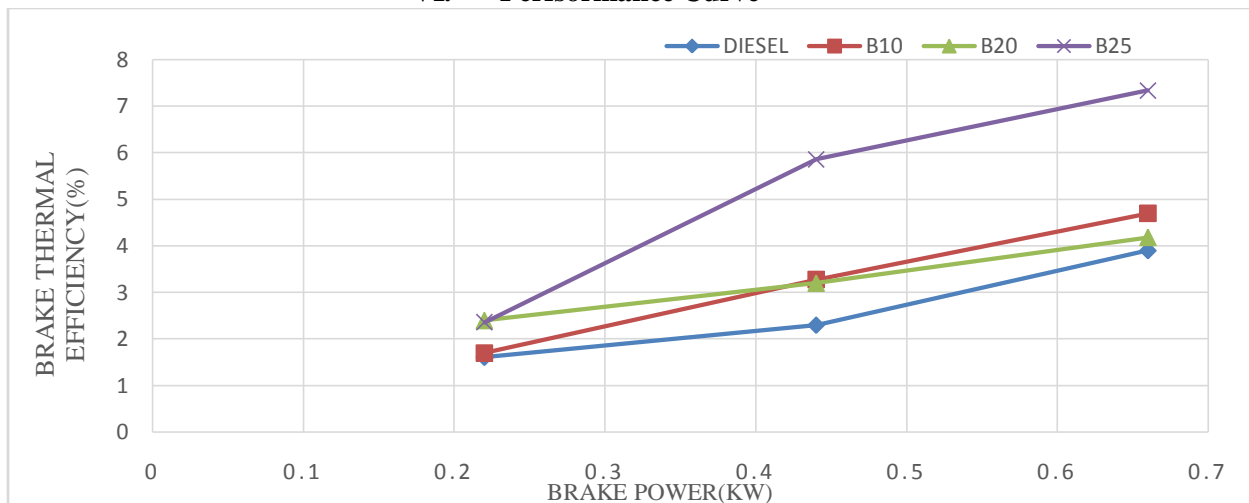


Fig 6.1 Brake Power Vs Brake Thermal Efficiency

The comparison between Brake power and Thermal Efficiency, says that at the blending of B25 thermal efficiency increases when Brake Power increases. Where in other blends the thermal efficiency is low when compared to B25.

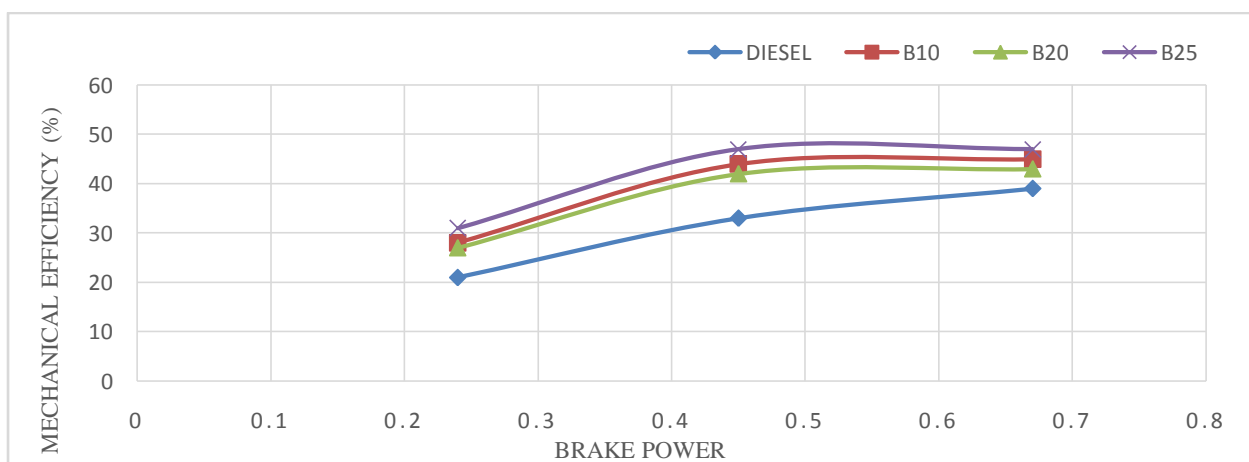


Fig 6.2 Brake Power Vs Mechanical Efficiency

The comparison between Brake power and mechanical efficiency, says that at the blending of B25 mechanical efficiency increases when Brake Power increases. Where in other blends the mechanical efficiency is low when compared to B25.

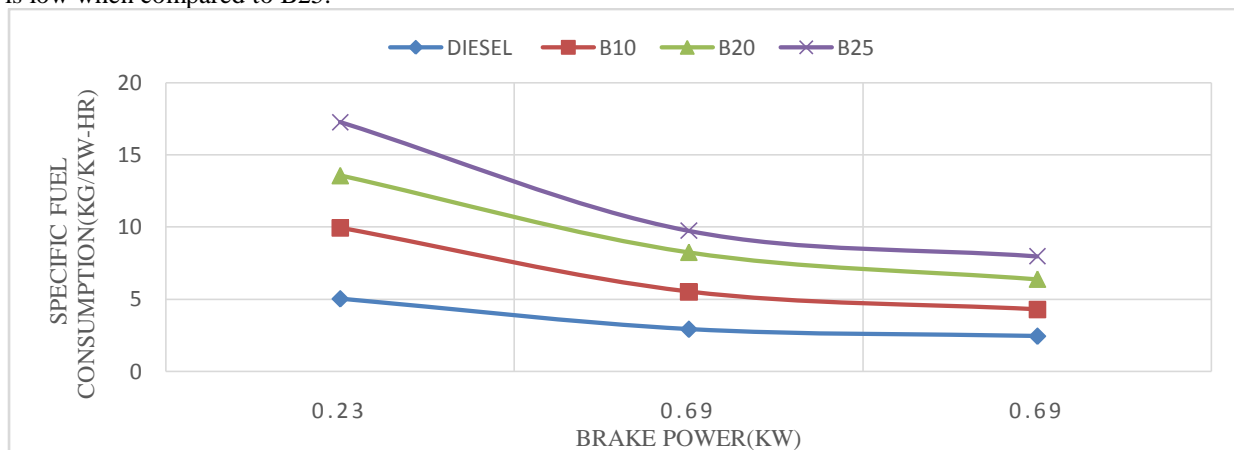


Fig 6.3 Brake Power Vs Specific Fuel consumption

The comparison between Brake power and Specific Fuel Consumption, says that at the blending of B25 Specific Fuel Consumption decreases when Brake Power decreases. Where in other blends the Specific Fuel Consumption is high when compared to B25.

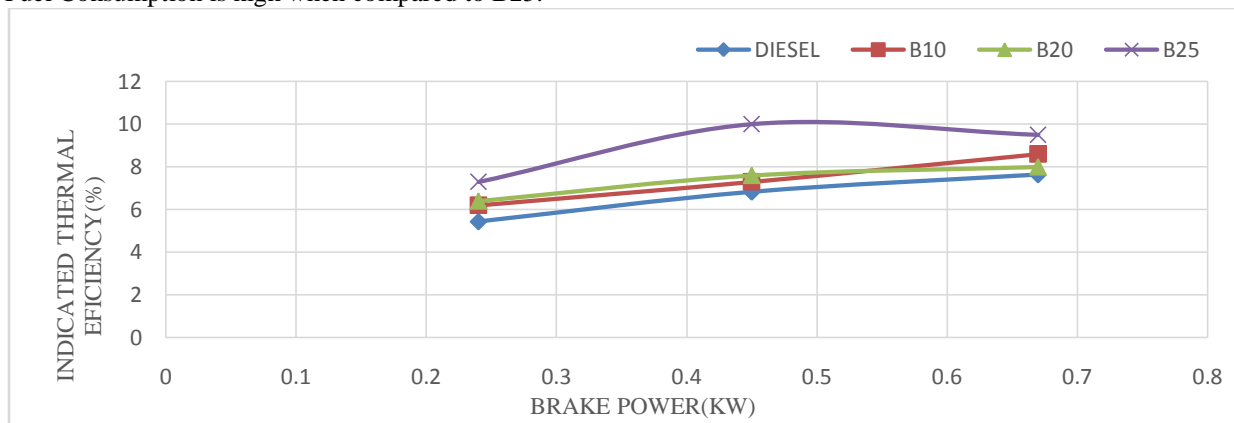


Fig 6.4 Brake Power Vs Indicated Thermal Efficiency

The comparison between Brake power and indicated thermal efficiency, says that at the blending of B25 indicated thermal efficiency increases when Brake Power increases. Where in other blends the indicated thermal efficiency is low when compared to B25.

6.3 Brake Specific Fuel Consumption

The variation of specific fuel consumption with load is found that as load increases the brake specific fuel consumption decreases for both diesel & biodiesel. This is due to the reason that at higher loads complete combustion tends to take place, thus lesser amount of fuel is required to deliver unit power. Thus bsfc decreases with increase in load. When we compare diesel with biodiesel, the specific fuel consumption is higher for biodiesel, as it has lesser calorific value than that of diesel.

6.4 Mechanical Efficiency

There is clear that at any load the mechanical efficiency of diesel is higher than that of Chicken fat oil. At part loads the increase in mechanical efficiency but as the load increases this value decreases at full load.

6.5 Brake Thermal Efficiency

The variation of brake thermal efficiency with load is found that with increase in load the brake thermal efficiency is also increasing for both diesel & biodiesel. It is observed that at any load condition the brake thermal efficiency of diesel is greater than that of biodiesel except at full load.

6.6 Thermal Efficiency for Neat Diesel Fuel and Diesel-Biodiesel Blends

The brake thermal efficiency of the engine increases with increase of engine speed (rpm) at constant load. After reaching the maximum value of efficiency then goes to decrease. This is due to the fact that, initially with the increases of engine rpm the torque produced by the engine increase, Hence the efficiency also increases. But at higher rpm (>1000) more amount of fuel is injected into the engine cylinder per cycle and due to higher engine speed this fuel does not get sufficient time to burn completely which reduce the efficiency of the engine.

6.7 Brake Specific Fuel Consumption with Engine BMEP for Neat Diesel and Diesel-Biodiesel Blends

Brake specific fuel consumption (BSFC) decreases with the increase in brake mean effective pressure. Because of increasing brake mean effective pressure (BMEP), the time for the amount of fuel consumption decreases but with the increase in brake means effective pressure the brake power of the engine increases. As a result the brake specific fuel consumption decreases.

VII. Conclusion

- i. In this work of biodiesel production from karanja seed, which is a waste ingredient of poultry processing unit, provides us a new cheap raw material to produce biodiesel. It would be possible to optimize the characters in terms of yield and purity. However, 20 percent of Bio-diesel was blended with commercial diesel at 80 percent to meet the current needs. It will become a major fuel resource in near future.
- ii. Followings are the conclusions based on the experimental results obtained while operating twin cylinder diesel engine fuel with karanja oil as biodiesel blended in different proportion with diesel fuel. This biodiesel at lower proportion can be used in diesel engine without any modifications in its components except fuel filter that needs to be changed after some interval of time.
- iii. Brake thermal efficiency of B20 biodiesel is superior to diesel at all load conditions, B20 biodiesel gave best results so it could be considered as an optimum fuel blend in terms of performance and reduced emission. Biodiesel shows high brake specific fuel consumption than that of diesel for same power developed due to its lower calorific value.
- iv. Production of biodiesel from karanja oil by transesterification process has properties of Linseed, coconut biodiesel are comparable with conventional diesel fuels. Maximum 88% biodiesel production was found at 20% methanol, 0.5% NaOH and 55⁰C reaction temperature. The maximum biodiesel production is measured after 15 hrs (Reaction time).
- v. Thermal efficiency of biodiesel is almost similar to conventional diesel fuel. Efficiency of biodiesel (B10, B20) is 1% and 2% lower than diesel fuel due to low volatility, higher viscosity and density. The properties this fuel volumetric blends under test are higher, and calorific values are lower and are in the range of 94 to 96% that of diesel.

VIII. Reference

- [1]. Fangrui Ma & Milford A, Hanna Biodiesel production: are view, *Bio resource Technol*,70(1999) 1-15.
- [2]. Saka S & Kusdiana D, Biodiesel fuel from rape seed oil as prepared in super critical methanol, *Fuel*, 80(2001) 225-231.
- [3]. Antolin G & Tinaut FV, Optimization of biodiesel production by sunflower oil transesterification, *Bio resource Tehnol*, 83(2002) 111-114.
- [4]. SureshKumar, Gupta AK & Naik SN, Conversionofnon-edible oil into biodiesel, *J Sci IndRes*,62(2003) 124-132.
- [5]. Ayhan Demirbas, Biodiesel from vegetable oils via transesterification in super critical methanol, *Ener Conserv Manage*, 43(2002) 2349-2356.
- [6]. ShimadaYuji & Watanabe Yomi, Enzymatical cohalysis for biodiesel fuel production and application of there action to oil processing, *JMol Catal*,17(2002) 133-142.
- [7]. Siler-Marin kovic S & T omasevic A, Transesterification of sunflower oil insitu, *Fuel*, 77(1998) 1389-1391.
- [8]. Vicente G & Coteron A, Application of factorial design of experiment sand response surface methodology to optimize biodiesel production, *IndCrop Product*,8(1998) 29-35.
- [9]. Fukuda Hideki, A kihikokondo biodiesel fuel production by transesterification of oils, *JSci Bioeng*,92(2001) 405-416.
- [10]. Mohamadi.Al-widayan & TashtoushGhassan, Utilization of ethyl ester of waste vegetable oils as fuel in diesel engines, *Fuel Process Technol*,76(2002) 91-103