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PERFORMANCE AND EMISSION ANALYSIS OF BIODIESEL (JATROPHA+CHICKEN FAT) ON DIESEL ENGINE

JAYANT ARBUNE, SHYAM MANATKAR, NEHA KOPARDE, MANJIREE HINGANE & ABHIJEET GHADGE

Student, Department of Mechanical Engineering, A.D.C.E.T., Ashta, Maharashtra, India

ABSTRACT

Bio fuel has been regarded as potential alternative fuel for partial substitution of petrodiesel. Jatrophacurcas which is one of the sources of bio-diesel, are easily available in tropical and sub-tropical areas. A number of plantation practices and engine test runs have been conducted across the world, which has been successful to demonstrate it as alternative source of fuel. The article here thus tries to compile some of the important aspects of Jatropha, and chicken fat oil, which is hoped to be an aided tools for researchers and to internalize in their respective areas for the promotion of jatrophacurcas and chicken fat oil to provide complimentary support in substituting petro-diesel in future, especially in developing countries.

KEYWORDS: Diesel Engine Performance, Biodiesel Blends, Performance Analysis

INTRODUCTION

HISTORY

Vegetable oil used as a diesel fuel in early as in 1900, when Rudalf Diesel demonstrated that the diesel engine could be run on the peanut oil, however it is used as a fuel attracted little attention towards accepting times of crisis such as world war II and the energy storage of 1970s. The name Biodiesel was introduced in U. S. in 1992 by National Biodiesel board, which has pioneered the commercialization of the Bio diesel in U. S., chemically Biodiesel is referred to as the 'Monoalkyl Esters of long chain fatty acids derived from liquid sources'

OBJECTIVE

The increased demand of petroleum derived fuel as well as their resulting environmental concerns provides the incentives for the development of alternate fuels from renewable resources. Biodiesel derived from animal fat and vegetable oils can be used as diesel fuel substitute. The conventional method for the preparation of Biodiesel consists of alkali catalysed transesterification of the low free fatty acid (FFA) oil with methanol. Karanja is a non-edible oil seed grown throughout India is presently being underutilised. The by-products exhibit interesting biological activity. These can be used as insecticides & for various therapeutic uses.

Keeping the above facts in mind, the present work has been undertaken with the following

Objectives

- The main aim of our project was to extract oil from karanja seeds,
- To find the constituents of the oil,

- To explore the preparation of biodiesel
- To find any other uses.

BIODIESEL

Biodiesel is domestically product, renewable fuel that can be manufactured from vegetable, and reduces serious air pollutants such as particulates, carbon monoxide, hydrocarbon, and air toxics. Blends of 20% biodiesel with 80% petroleum diesel (B20) can generally be used in unmodified diesel engine; however user should consult their OEM and engine Warranty statement. Biodiesel can also be used in its pure form (B100), but it to may require certain engine modification to avoid maintenance and performance problem. User should consult there engine warranty statement.

TECHNICAL DEFINITION

Biodiesel, a fuel composed of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animals fats, designated B100, and meeting the requirement of ASTM (American Society for Testing & Materials) D6751. Animal fat & virgin & recycled vegetable oil derived from crop such soybeans, canola, sunflower & corn can be used in production of Biodiesel fuel. Tall oil produced from wood pulp, waste is another feed stock. Biodiesel fuel derived from petroleum crude oil. Vegetable oil as a biomass-based energy can be considered as possible alternative fuels. Neat vegetable oil is too viscous, has poor volatility, comparatively lower certain no& having different chemical structure than diesel fuels.

Biodiesel is the name of variety of ester based oxygenated fuels from renewable biological sources. Biodiesel is a methyl or ethyl ester of mainly vegetable oils. Biodiesel readily with diesel fuels in any % The blend level is the function of economics the desired emission profile, material compatibility, & combustion characteristics. Methyl or ethyl ester can be produced from vegetable & tree oils, animal's fats are used oils & fats. For vegetable oils to be used as fuels as fuels for conventional diesel engine the oil must be further processed primarily because of its high viscosity. Transesterification of vegetable oil or animal fats, using alcohol in the presence of catalyst, is the more popular process. However, for every 100 units of glycerine by-product, Glycerine is used in such product as hand creams, toothpaste and lubricants.

BIODIESEL IN INDIA

Table 1: Vegetable Oil Production and Demand in India

Financial Year	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Production	6.46	6.89	7.32	6.75	7.21	7.69
Demand	11.74	12.96	13.85	12.79	15.46	15.93
Import	5.40	6.19	6.35	5.97	6.73	7.44

HOW BIODIESEL IS MADE?

Biodiesel fuel can be made from new or used vegetables, oils and animal fats, which are nontoxic, biodegradable, renewable resources, fats and oils are chemically reacted with an alcohol (methanol is usual choice) to produce chemical compounds known as fatty acids, methyl ester. Biodiesel is name given to this ester when they are intended for use as fuel. Glycerol (used as pharmaceutical and cosmetics among the other market) is produced as co product.

Biodiesel can be produced by a variety of etherification technologies. The oils and fats are filtered and preprocessed to remove water and contaminants. If free fatty acids are present, they can be removed or transformed into

Biodiesel using special pretreatment technologies. The pretreated oils and fats then mixed with alcohol (usually methanol) and a catalyst (usually sodium or potassium hydro oxide). The oil molecules are broken apart and they form into esters and glycerol, which are then separated from each other and purified. Approximately 55% of Biodiesel industry can use any fat or oil feed stock, including recycled cooking grease, the other half of industry is limited to vegetable oils, the least expensive of which is soy oil.

Based on combined sources of both industries, there are enough of feed stocks to supply 1.9 billion gallons of Biodiesel (under policies designed to encourage Biodiesel use). For vegetable oils to be used as fuel for conventional diesel engine the oil must be further processed primarily because of its high viscosity. Tranestererification of vegetable oil or animal fat using alcohol in presence of catalyst is most popular process. Glycerin is obtained as a byproduct. Glycerin is used in such product as hand crams, toothpaste and lubricants. Another production process in limited use is cold press rapeseed oil, which does not produce any glycerin, by product alternatively, unprocessed vegetable oil can be used in modified diesel engine. Such engine is in limited production and is therefore more expensive.

- **Biodiesel from Vegetable Oil**

The waste vegetable oil used fryer grease, animal fats, lards is often free for the taking. All you need is a few common chemicals and same equipment you can easily buy or make yourself. The result is cheap, clean burning, nontoxic, renewable, high quality motor fuel you can use in your car without modifications.

- **Cautions**

Wear proper protective gloves, apron and eye protection and do not inhale any vapors. Methanol can cause blindness and death, and you don't even have to drink it, it absorb through the skin. Sodium meth oxide can cause severe burns and death. Together these two chemicals form sodium meth oxide. This is an extremely caustic chemical. These are dangerous chemicals always have to hose running when working with them. The work space must be thoroughly ventilated.

PROCEDURE

- Filter oil to remove any food scraps or solid particles.
- Heat vegetable oil to remove any water particles.
- Prepare sodium hydroxide.
- Mix in the sodium meth oxide in the Karanji oil with stirring.
- Allow settling the mixture, removing the glycerin.
- Now wash and dry.
- Check the quality of the oil.

This procedure is called transesterifiaction, similar to saponification. Also called as alcoholysis, this process includes displacement of alcohol from an ester by another alcohol in a process has been widely used to reduce the viscosity of triglycerides.

The general equation is: -RCOOR'+R"=RCOOR"+R'OH

If methanol is used in used in the above reaction, it is termed methanolysis, Triglycerides are readily transesterified in the presence of alkaline catalyst at atmospheric pressure and at a temperature of approximately 60 to 70 degree C with an excess of methanol. This mixture then allowed settling. The "R" groups are the fatty acids, which are usually 12 to 22 carbons in length.

TRANS-ESTERIFICATION PROCESS

The use of bio diesel is effective way of substituting diesel fuel in the long run. One important conclusion that can be drawn from the work done earlier is that the vegetable/plant oils can't be used directly in the diesel engine. Several problems crop up if unmodified fuel is used and viscosity is the major factor. It has been found that this process is the most effective way to reduce the viscosity of these oils and make them fit for their use in the present diesel engines without any modification.

Vegetable oil + Methanol Catalyst Methyl + GlycerinTrans fatty acids ⟶ Sodium Ester & SoapHydroxide

PROCEDURE

- **Filtering**

Filter the oil to remove food particles and warm it up a bit first to get it to run freely (up to 35 degrees). Use a double layer of cheesecloth in a funnel, or a restaurant or canteen type coffee filter.

- **Removing the Water**

Heat the oil first to remove water content. Water tends to slow down the reaction a may cause saponification. For good performance lesser the water in oil, better is the reaction process. Temperature should be 60-80 deg C, hold it till the water boils off.

- **Preparing the Sodium Methoxide**

Generally the amount of methanol needed us 20% of the oil by mass. The densities of these two liquids are fairly close so measuring 20% of methanol by volume should be about right. This is exothermic reaction. Keep all utensils as dry as possible.

- **Heating and Mixing**

A propeller or paint stirrer coupled to a ½ -inch electric drill held securely I a jig works fine as a mixer. Too much agitation causes splashing and bubbles through vortex and reduces mix efficiency. There should be vortex just appearing on the surface so adjusting the speed, or the pitch or size of the stirrer to get the right effect. Add sodium methoxide to the oil while stirring; stir the mixture for 50 minutes to an hour. The reaction is often complete in 30 minutes, but longer is better. The transesterifiaction process separates the methyl esters from the glycerin. The CH30 of the methanol then caps off the ester chains and OH from the NaOH stabilizes the glycerin.

- **Settling and Separation**

Allow the solution to sit and cool for at least eight hours, preferably longer. The methyl esters will be floating on

top while denser glycerin will have congealed on the bottom of the container forming a hard gelatinous mass (the mixing pump must be mounted above this level).

- **Washing and Drying**

The Biodiesel obtained from the above process is unwashed Biodiesel having pH value 8. Due to this high pH value it has corroding action on the wall of the engine parts. So washing reduces the pH and hence maintains the neutrality. Then Biodiesel is washed three times with water to remove impurities like sodium, etc. It also removes excess of alcohol sodium hydroxide and soap suspended in it. Use of warm water for washing gives better results and reduces number of washings required. After each washing, water is allowed to settle for about 5 minutes. After settling, the water and impurities in the water can be drained off from the bottom of container. Each time, Biodiesel is decanted from the top. At the end of last washing, water is allowed to settle for 15 minutes. The washed Biodiesel is then heated for about 5 to 10 minutes to remove leftover traces of moisture so that it becomes almost transparent.

FATTY ACID COMPOSITION AND IMPORTANT PROPERTIES OF STRAIGHT VEGETABLE OILS

Table 2

Properties of the Oils	Jatropha	Chicken Fat	
• Fatty acid composition (%)		(C.N[a])	Wt. of chicken (%)
Palmetic acid	16.0	16:0	25.2
Stearic acid	6.50	18:0	40.5
Oleic acid	43.5	18:1	18.4
Linoleic acid	34.4	18:2	0.7
• Specific gravity	0.920		
• Viscosity (cSt)	18.20	5.4	
• Flash point (°C)	174		
• Calorific value (MJ/kg)	38.50		
• Acid value (mg KOH/gm)	3.80		
• Free fatty acid (%)	1.90		

PERFORMANCE BY USING BIODIESEL

Table 3: For Part Load

Blends	B.P (KW)	BSFC (KG/KWHR)	Efficiency (%)
Diesel	1.411	0.3424	24.73
B5	1.411	0.4103	21.15
B10	1.411	0.3572	24.58
B15	1.411	0.4120	21.41
B20	1.411	0.3998	22.50
B25	1.411	0.3585	25.65
B30	1.411	0.4189	22.50
B40	1.411	0.3654	26.18
B50	1.411	0.3138	29.64
B100	1.411	0.2995	35072

Table 4: For Full Load

Blends	B.P (KW)	BSFC(KG/KWHR)	Efficiency (%)
Diesel	1.8058	0.319	26.56
B5	1.8058	0.3473	24.98
B10	1.8058	0.322	27.28

Table 4: Contd.,

B15	1.8058	0.322	27.40
B20	1.8058	0.3373	26.67
B25	1.8058	0.3008	30.55
B30	1.8058	0.3547	26.02
B40	1.8058	0.3172	29.60
B50	1.8058	0.3066	30.35
B100	1.8058	0.2996	34.86

GRAPH FOR COMPARISON OF EMISSION THROUGH DIESEL AND VARIOUS BLENDS OF BIODIESEL

- **CO2%**

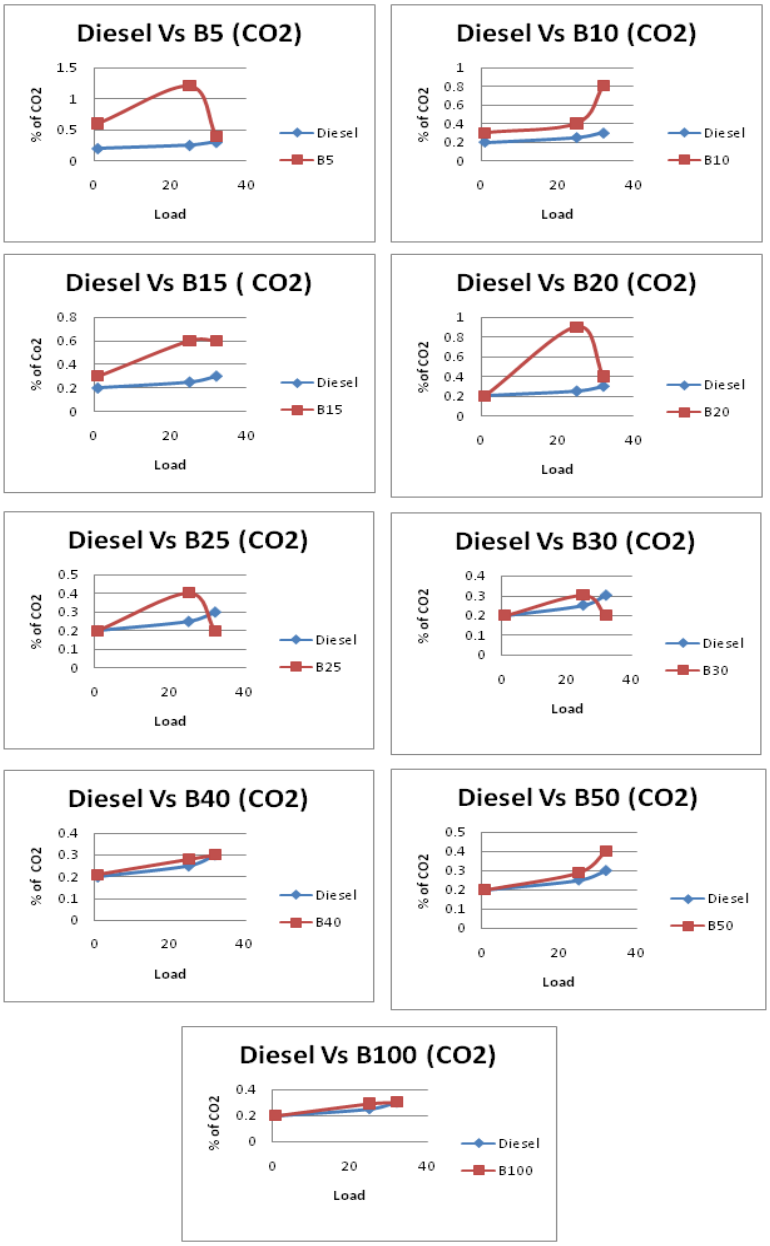

Figure 1

- **CO %**

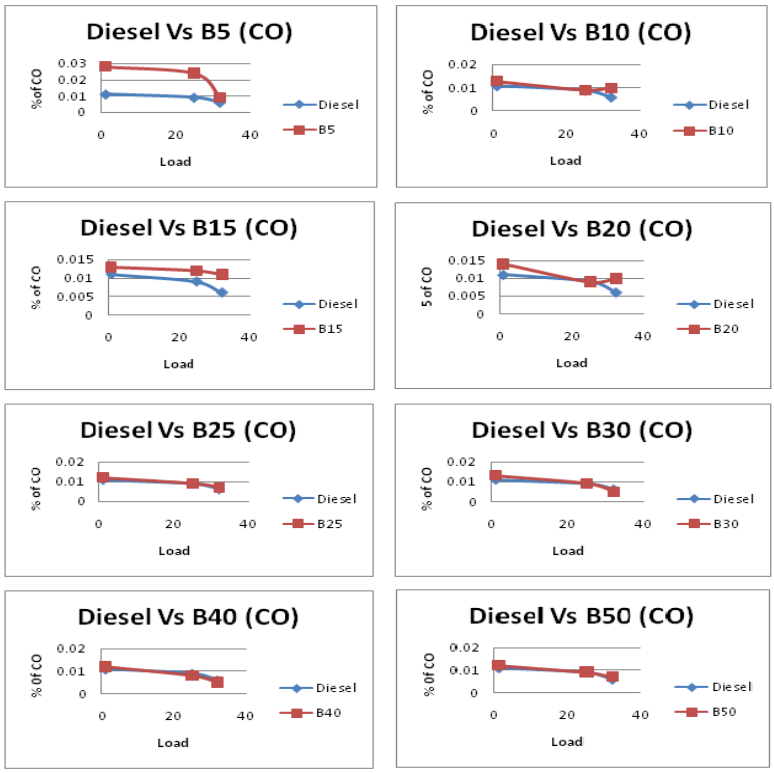

Figure 2

- **O2 %**

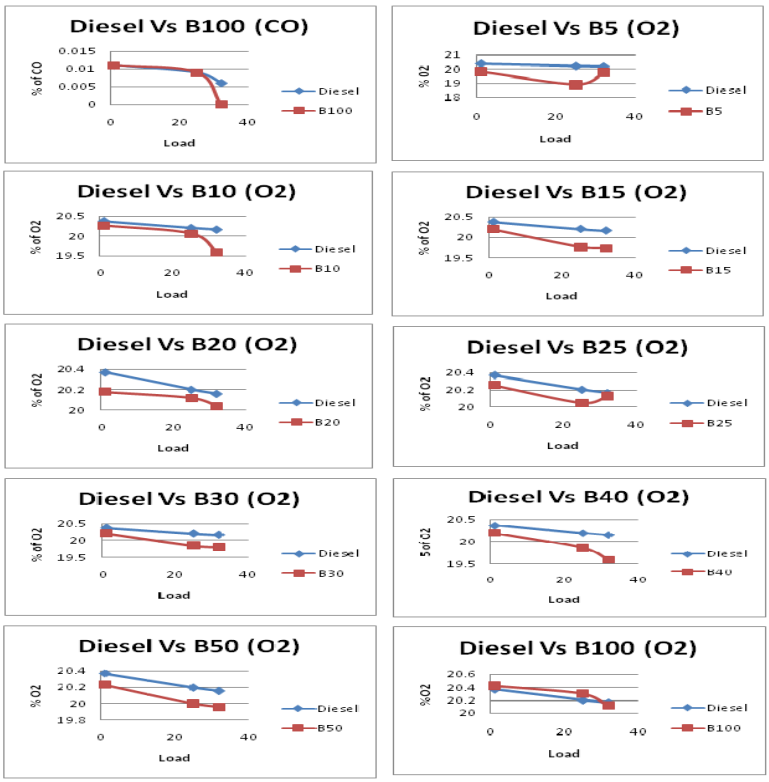

Figure 3

GRAPH FOR BSFC AND THERMAL EFFICIENCY OF VARIOUS BLENDS OF BIODIESEL

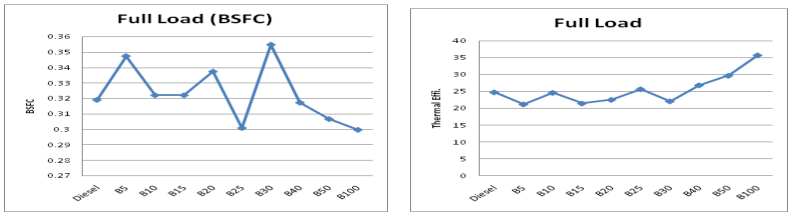

Figure 4

COST COMPARISON, ADVANTAGES & LIMITATIONS OF BIODIESEL

- **Biodiesel Beats Other Alternative Fuels on Cost**

Recent Studies have found that buses & other fleets fueled with 20% Biodiesel blends (20% Biodiesel, 80%Petrolium Diesel), can be operated competitively with vehicles using other alternative fuels. A Recent study also found that, while Biodiesel Blends are slightly more expensive per gallon than petroleum diesel fuel, they cost significantly less on a mile per mile driven basis than methanol and Compressed Natural Gas (CNG).

- **Cost and Performance**

Biodiesel's cost could decrease if more land is allocated for growing its ingredients. The cost of Biodiesel depends on the market price for oils. However, given the other advantages of biodiesel, it is a still an option to diesel, especially in certain niche markets that require a cleaner-burning, biodegradable fuel. Costs could decrease if, for example, more agriculture land was used to grow and use crops for biodiesel ingredients. Tests show biodiesel blends perform as well as petroleum diesel. More than 100 biodiesel demonstrations, including 10,00,000 mile tests and more than 50,000 mile tests, have logged more than 30 million road miles with biodiesel blends. In these tests, performance, fuel mileage, drivability, start-up, power, range, and cold weather performance characteristics of blends were similar to petroleum diesel.

- **Advantages of Biodiesel Fuel**

Biodiesel has an advantage when compared with both petroleum and other alternative fuels. It needs to be emphasized however that the goal of the Biodiesel industry is not to replace petro diesel or to supplant the invaluable role of other alternative fuels. Each of these fuels has a phase in the development of a balanced energy industry. The compression ignition has a certain advantage over spark ignition engine & role of biodiesel is to contribute to the long levity & cleanliness of diesel engine. Market are being developed on end users desire to purchase a more costly, petroleum fuel in ether nest, 100% form or blended with diesel. Consumers have shown that they are willing to purchase Biodiesel based upon several factors. These are listed below,

- Biodiesel is produced domestically, which helps to reduce the dependence on imported petroleum.
- It is a renewable fuel that can be made from agricultural crops & other feed stocks that are considered waste, such as cooking oil & trap grease. This helps conserve resources & makes the best possible use of material which may be perceived as having little or negative value.
- Biodiesel blends are competitive with other alternative fuels on a life cycle cost basis because of its lower associated infrastructure cost (no extensive engine or refueling modification needed), the possible energy or

balanced discussed above, the efficiency of the fuel on a per BTU basis. Used in conjunction with the CI engine which much more efficient than SI engine. Biodiesel compares quite favorably with CNG, ethanol & methanol the other leading alternative fuels in the market place today.

- It is considered readily biodegradable & nontoxic. Continued testing indicates that biodiesel degrades as fast as & is safe as sugar in the environment. These characteristics may prove valuable in certain markets.
- Biodiesel & its blend significantly reduce harmful tail pipe emission as documented in tests using U.S.EFP protocols.
- The emission smells better & appears to help to reduce nausea in those breathing the fumes.
- It smells better than the conventional diesel value that works in close proximity to the fuel.
- It is having high & good extension than crude oil (i.e. diesel fuel).
- The biodiesel can be stocked everywhere.
- Can be used in CI engine without changing any modification in the injection nozzle. It has no negative effect on the engine.
- It can be blended with diesel easily.
- By using biodiesel there is possibility of cancer to reduce 90%.
- In the biodiesel the % of the oxygen is 11%. There is no sulphur present in it.
- The life of the engine increases because the biodiesel gives a good lubricating effect than diesel fuel. In spite of this the fuel consumption (SFC), auto ignition power (P), % torque (T) all these factors remains as it is.
- The handling & transportation is very safe.
- The flash point is very high about 250 deg.F, than diesel (125 deg.F), so it is very easy and safe.
- Biodiesel is in U.S.A. since 20 years and about 3 crores of distance had been covered by using biodiesel, proved its efficiency.
- Due to certain no. it can be used in high capacity engine also.
- Due to high lubricating property the capacity of engine &life is more.
- The burning of hydrocarbons completes due to high % of oxygen.
- Development of the bio-diesel industry would strengthen the domestic, and particularly the rural, agricultural economy of agricultural based countries like India.
- It is a renewable fuel that can be made from agricultural crops and or other feed stocks that are considered as waste.
- It has 80% heating value compared to that of diesel.
- It contains low aromatics.

CONCLUSIONS

From the above observations we can draw the conclusion as per experimental investigation:-

- Brake thermal efficiency of 10% blend and diesel fuel is almost same at full load.
- The torque and brake power are almost same for diesel fuel and all the blends.
- We get BTE better at 30% than 0%, 10% & 20% and also carbon % is within limit at 30% blending.
- 50% & 100% blends exceed carbon emission limits so they are not preferred.
- To obtain the better results for 50% and 100% blends certain engine modification are necessary. Chicken fat oil had very high kinematic viscosity which can be reduced by transesterification.
- So we can conclude that 30% blend gives satisfactory results as or better than, that of conventional diesel fuel.
- Biodiesel is advisable taking in to account that it is a renewable resource and that because of its biodegradability and lower emissions it presents a favourable impact on the environment. Vegetable oil leads to biodiesel that is easier to produce and cleaner with equivalent amounts of processing.
- Conventional energy sources such as coal, oil, diesel, petrol and others are adversely affecting human life. These sources are scares and depleting fast, so it is necessary to control their depletion. The research is going on finding the alternative fuels for I.C. engine and how it can be used in it to reduce the use of conventional energy sources as well as reduce the emissions from engine as compared to conventional sources.

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