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Diesel Engine Perormance Improvement by Using Cetane Improver

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***Abstract:**Green Fuel, also known as Biofuel is a type of fuel distilled from plants and animal materials. It is believed by most of the people to be more environmentally friendly than the widely used fossil fuels. Green fuel has evolved as a possible fuelling option as the world drains out its possible energy resources. It has a big role to play in the future as far as the replacements to the already existing fossil fuels are concerned. We, as a group, aim at evaluating the performance and combustion characteristics of one of the biofuels, bio diesel. The performance of biodiesel can be evaluated by an index called as cetane number. Cetane number is a measurement of combustion quality of diesel fuel during compression ignition. It is a significant expression of diesel fuel quality among a number of other measurements that determine overall diesel fuel quality.*

Data has been collected from the experiments done and comparison is drawn between the performance of diesel engine filled with biodiesel and diesel. This report also focuses of the manufacturing process of biodiesel, the different types of cetane improvers available and their effect on the performance of diesel engine

I. INTRODUCTION

During last decade there is a growing demand for the exploration of alternative sources of energy as the existing fossil fuels are running out. India ranks sixth in the world in terms of energy demand and this demand is expected to grow. Also due to gradual depletion of the world petroleum reserve, rising petroleum prices and global warming have generated an intense international interest in developing alternative non petroleum fuels.

Many researches have been made to use vegetable oil, animal fats as a source of alternative or renewable energy known as **biodiesel**. Waste vegetable oil is nothing but the used vegetable oil or cooking oil found in almost every kitchen. Many of the people throw out this used vegetable oil as they think it's of no use. But do you know that this used vegetable oil or waste vegetable oil can be used as a fuel?

Yes, it's true. The waste vegetable oil when recycled can be used as a fuel in the engine. Waste vegetable oils work best in diesel engines like diesel generators or diesel cars. The reason of using waste vegetable oil as fuel is that it has more advantages over petroleum diesel.

This takes us to a term known as **'Biodiesel'**. Biodiesel is a clean burning alternative fuel produced from domestic, renewable resources such as vegetable oil or animal fat.

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Biodiesel contains no petroleum, but it can be blended at any percentage with petroleum diesel to create a biodiesel blend. This can be used in many automobile engines.

Basic forms of biodiesel:

In creating basic forms of biofuel, crops are broken down into two types: sugar producing and oil producing. Sugar and starch producing crops, such as sugar cane or corn, are put through a fermentation process to create ethanol. Oil producing plants, like those used in vegetable oils, can be used much like fossil sources of oil; they create diesel that can be burned by cars or further processed to become biodiesel.

Recent technological innovations have created the fields of advanced biofuels, which focus on non-food sources and waster renewal as energy. By converting landfill material, as well as woodland inedible plant parts, into green fuel, we not only cut down on the use of fossil fuels but also effectively recycle enormous amounts of waste. These biofuels help quell the debate on whether growing crops for fuel will result in fewer available food crops.

A new form of fuel can literally called green, as it derives from green algae. Algae, often seen growing on bodies of water, are a tiny plant with a rapid growth rate. Its usefulness as fuel derives from the fact that it has an extremely high oil content that can be processed like other oil-producing crops. Many countries are now doing extensive research on algae, which is easy to cultivate and grows extremely quickly. According to some estimates by start-up algae oil companies, one acre of algae can produce 200 times as much oil as one acre of corn. Some detractors warn against the assumption that green fuel is free from pollution-causing attributes. The processing of sugar and starch plants into ethanol has come under heavy criticism in recent years; not only do these plants take away food-growing space, the fermentation process releases considerable pollution into the air. Moreover, green fuel when burned may emit carcinogenic substances.

It is not yet clear whether the green fuel currently available is the wave of the future or merely an interim step on the journey away from fossil fuel use. Governments around the world are devoting enormous resources to the research of clean, sustainable fuels to replace the pollutant and quickly disappearing oil reserves used today. Green fuel may not be a perfect solution to the problems of oil need and global protection, but it remains an important innovation that may pave the way to a better future.

Ways to extract biodiesel

There are few ways to extract biodiesel. Mentioned below are some of the resources from which we can extract biodiesel.

Wheat:
Wheat crops can produce biofuel. Concerns are over how much is needed to feed an expanding population, and whether food will be diverted to fuel. A new wheat-based fuel refinery in the UK may consume more than the national harvest surplus. Food prices would be pushed up, affecting developing countries, and plans have met with criticism.
An environmental charity said, "Using wheat for fuel involves the displacement of agricultural land used for food production. At the end of that chain you need to create new farmland and that means cutting down forests."
Solid biofuels:
Examples of solid biofuels include wood, grass cuttings or agricultural waste, processed to produce a fuel product known as a pellet. There are growing concerns that solid biofuels
Emit considerable amounts of pollutants. The process to create the pellets also uses a significant amount of energy, requiring the use of fossil fuels, meaning solid biofuels cannot be considered sustainable on their own. They are also expensive to produce.
Rapeseed:
Rapeseed oil is a popular biodiesel, mainly due to its ability to produce a high oil yield per unit of land area. However, concerns have been raised about its effectiveness in helping the climate. In fact, rapeseed oil biodiesel has been calculated to actually produce up to 70% more greenhouse gases than fossil fuels. This is because manufacture of the plant generates emissions of nitrous oxide, which is 296 times more powerful as a greenhouse gas than carbon dioxide (Atmospheric Energy and Physics, The Times, 2007).
Algae:
Algae are a third-generation biofuel, which means that, similar to jatropha, it is not taking much-needed crops out of the food chain. The concerns with algae are its cost. One study found that capital cost, labor and operational costs by themselves are too high for algae biofuels to be competitive with conventional fuels. The United States Department of Energy estimates that if algae fuel replaced all the petroleum fuel in the United States, it would require 15,000 square miles, roughly the size of the state of Maryland (USDA, Washington Post, 2008).
Facts regarding the usage of biodiesel:
Biodiesel is made by breaking down vegetable oil with a catalyst and synthesizing a new molecule (methyl ester) which is biodiesel.

1. There is no conversion required to use biodiesel just like petroleum diesel. On pre-1990 vehicles you should replace any rubber fuel system components with synthetics. We also recommend that you replace your fuel filter after your first tank or two of biodiesel, since biodiesel is a very good solvent and will scrub out all the tars, varnishes and gums left by fossil diesel in your fuel system.
2. Properly made biodiesel will actually run cleaner and smoother than petroleum diesel.
3. Biodiesel which has had all the glycerin and alcohol removed can be used with confidence, especially in simpler devices like generators, tractors and home heating furnaces. Washing biodiesel removes the trace soaps (which petroleum also contains) and is recommended if you want to be extra cautious about your biodiesel quality.
4. You can use biodiesel just like petroleum diesel and mixed in any ratio
5. Biodiesel can be stored for years provided that it is kept free of condensation and bacteriological growths (just add a common diesel biocide) or by only washing your biodiesel down to a pH of 8.0.

Evaluation of Performance of a Diesel Engine:
Cetane number (CN) is a measure of the ignition quality of the diesel fuel and is determined by a standard engine test as specified by ASTM (ASTM D613).1The ignition quality is quantified by measuring the ignition delay, which is the period between the time of injection and the start of combustion (ignition) of the fuel. A fuel with a high CN has a short ignition delay period and starts to combust shortly after it is injected into an engine. The ignition quality of the diesel fuel depends on its molecular composition. Some of the Simpler molecular components such as the n-paraffin's can ignite in a diesel engine with relative ease, but others like aromatics have more stable ring structures that require higher temperature and pressure to ignite.We would be using different chemicals or additives to improve the cetane number. Therefore, they are termed as Cetane improvers.
Importance of cetane number:
There is no benefit to using a higher cetane number fuel than is specified by the engine's manufacturer**.** The ASTN Standard Specification for Diesel Fuel Oils (D-975) states. "The cetane number requirements depend on engine design, size, nature of speed and load variations, and on starting and atmospheric conditions. Increase in cetane number over values actually required does not materially improve engine performance. Accordingly, the cedtane number specified should be as low as possible to insure maximum fuel availability." This quote underscores the importance of matching engine cetane requirements with fuel cetane number.
Diesel fuels with cetane number lower than minimum engine requirements can cause rough engine operation**.** They are more difficult to start, expecially in cold weather or at high altitudes. They accelerate lube oil sludge formation. Many low cetane fuels increase engine deposits resulting in more smoke, increased exhaust emissions and greater engine wear. Using fuels which meet engine operating requirements will improve cold starting, reduce smoke during start-up.Improves fuel economy, reduce exhaust emissions, improve engine durability and reduce noise and vibration. These engine fuel requirements are published in the operating manual for each specific engine or vehicle.
The Role of 'Additives' for Diesel and Diesel Blended (biodiesel) fuels:
Around the world, there is a growing increase in bio fuels consumption, mainly ethanol and biodiesel as well as their blends with diesel that reduce the cost impact of bio fuels while retaining some of the advantages of the bio fuels. This increase is due to several factors like decreasing the dependence on imported petroleum; providing a market for the excess production of vegetable oils and animal fats; using renewable and biodegradable fuels; reducing global warming due to its closed carbon cycle by CO_2 recycling; increasing lubricity; and reducing substantially the exhaust emissions of carbon monoxide, unburned hydrocarbons, and particulate emissions from diesel engines.

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However, there are major drawbacks in the use of bio fuel blends as NOx tends to be higher, the intervals of motor parts replacement such as fuel filters are reduced and degradation by chronic exposure of varnish deposits in fuel tanks and fuel lines, paint, concrete, and paving occurs as some materials are incompatible.

1. Overview:

According to the World Trade Organization, in 2004, the fuel market was responsible for an 11.1% share of the total trade in merchandising and primary products, corresponding to 48.1 billion dollars. Most is due to diesel that is essential for transport and heavy-duty engines. It contributes to the prosperity of the worldwide economy since it is widely used due to high combustion efficiency, reliability, adaptability and cost-effectiveness. However, pollutant emissions are a major drawback. Emissions from diesel engines seriously threaten the environment and are considered one of the major sources of air pollution. It was proved that these pollutants cause impacts in the ecological systems, lead to environmental problems, and carry carcinogenic components that significantly endanger the health of human beings. They can cause serious health problems, especially respiratory and cardiovascular problems. Increasing worldwide concern about combustion-related pollutants, such as particulate matter (PM), oxides of nitrogen (NOx), carbon monoxide (CO), total hydrocarbons (THC), acid rain, and photochemical smog and depletion of the ozone layer has led several countries to regulate emissions and give directives for implementation and compliance. It is commonly accepted that clean combustion of diesel engines can be fulfilled only if engine development is coupled with diesel fuel reformulation or additive introduction.

Types of Additives: Metal-Based Additives: Some metal-based additives are reported to be effective in lowering diesel emissions. They may reduce diesel emissions by two ways. First, the metals either react with water to produce hydroxyl radicals, which enhance soot oxidation, or react directly with carbon atoms in the soot, thereby lowering the oxidation temperature. When these additives are used after combustion in the engine, the metal acts as a nucleus for soot deposition.

Oxygenated Additives: Another group of fuel additives is oxygenated compounds. The idea of using oxygen to produce a cleaner burning of diesel fuels is half a century old. Since that early work, numerous researchers have reported the addition of a variety of oxygenated compounds to diesel fuel. Some oxygenate compounds used are ethanol, acetoacetic esters and dicarboxylic acid esters, ethylene glycol monoacetate, 2-hydroxy-ethyl esters,26 diethylene glycol dimethyl ether, sorbitan mono-oleate and poly-oxy-ethylene sorbitan mono-oleate,27 dibutyl maleate and tripropylene glycol monomethyl ether,28 ethanol and dimethyl ether,20 dimethyl ether (DME), dimethyl carbonate (DMC) and dimethoxy methane,3 1-octylamino-3-octyloxy-2-propanol and N-octyl nitramine,21 dimethoxy pro-pane and dimethoxy ethane,29 biodiesel,22,30,31 and a mixture of methanol and ethanol.

Ignition Promoters: In internal combustion engines operating on diesel fuel, the cetane number of the fuel is one of the most important characteristics of the combustion process. Improved ignition is detected as a decrease in the ignition delay time, the ignition delay time being measured as the time between the start of fuel injection and detectable ignition. Shorter ignition delay times have been directly correlated with a faster startup in cold weather, reduced NOx emissions, and smoother engine operation. This parameter is a function of the composition and the structure of the hydrocarbons present in the diesel. The utilization of cetane-improving additives is necessary to avoid difficulties in cold starting and other performance problems associated with low cetane numbers. Ignition promoters have traditionally been given to alkyl nitrates.

Types of additives for diesel – biodiesel blends:

Characteristics of Diesel-Biodiesel Blends versus Diesel: Biodiesel is defined as alkyl esters of fatty acids, obtained by the trans esterification of oils or fats, from plants or animals, with short-chain alcohols such as methanol and ethanol. It has an engine performance comparable to that with conventional diesel and could be used pure or blended with diesel. Biodiesel is nonflammable, nonexplosive, biodegrade-able, and nontoxic. Besides, its use provides a reduction of many harmful exhaust emissions. A nearly complete absence of sulfur oxide (SOx) emissions, particulate and soot, and reduction in polycyclic aromatic hydrocarbons emissions can be achieved.

Lubricity Additives:Fuel lubricity can be enhanced by the addition of lubricity additives. They comprise a range of surface-active chemicals. They have an affinity for metal surfaces, and they form boundary films that prevent metal-to-metal contact that leads to wear under light to moderate loads. Much research shows that the addition of lubricity additives is not necessary in low-sulfur diesel-biodiesel blends once vegetable oil methyl esters enhance the fuel lubricity.48,65-67 This mixture provides a stable film on the metal surface and substantially reduces the wear scar diameter.

Cetane Number Additives: The cetane number measures the readiness of the fuel to auto ignite when injected into the engine and is one of the most significant properties to specify the ignition quality of any fuel for internal combustion engines. An increase in cetane number decreases the delay between injection and ignition. One of the more obvious effects of running on a low cetane number fuel is an increase in engine noise. In general, aromatics and alcohols have a low cetane number. A high cetane number leads to a reduction of both emissions.

Stability Additives: Special attention is focused on the stability of biodiesel during its storage and use. Esters of unsaturated fatty acids are particularly unstable to the action of light. When exposed to air during storage, autoxidation of biodiesel can cause degradation of fuel quality by affecting properties such as kinematic viscosity, acid value, and peroxide value. One approach for increasing the resistance of fatty derivatives against autoxidation is to treat them with oxidation inhibitors (antioxidants). Mittelbach and Schober investigated the influence of different synthetic and natural antioxidants on the oxidation stability of biodiesel from rapeseed oil, sunflower oil, used frying oil, and beef tallow.

Perspectives:

Two basic trends are driving the up-to-date research and marketing of diesel additives: the progressive reduction of sulfur content and the increasing use of biofuels. The first should be applied not only to diesel but also to their blends (E-diesel, biodiesel-diesel, biodiesel-ethanol-diesel, and vegetable oil mixes).

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The additives for biofuels must observe emission regulations and motor and combustion requirements, and their composition and concentration are highly dependent on the biodiesel source. The growing popularity of biodiesel blends is closely related with emissions legislation and the increasing desire for renew-able energies, although their economic viability will depend on international crude oil prices and on the market price of biodiesel co-products.

Although biodiesel is renewable and has good lubricity, it has several drawbacks. It is more expensive than diesel, has lower energy content, has water contamination, does not have good operation under cold weather, is corrosive, often contains methanol, has short shelf life, and affects fuel filters. It is necessary to highlight the worrisome lack of available toxicity studies and information regarding how the new additives and fuels modify the toxicity of the engine exhaust emissions, both in terms of PICs and the unburned additives themselves, as well as secondary toxic species formed during atmospheric transport.

Results:

Due to the worldwide effort to make renewable energy economically viable as well as to use cleaner fuels, additives will become an indispensable tool in global trade. Their technical specifications not only cover a wide range of subjects but also most subjects are interdependent. This makes the expertise of additives technology indispensable in the global trade of fuels. It is likely that, as energy sources become cleaner and renewable, we might find ourselves facing issues that are quite hard to overcome, and diesel additives may become a worldwide indispensable tool. The additives share in the world market should increase in the next few years as long as energy sources become cleaner and renewable.

We learnt that there are many additives available in the world which when subjected to some reactions or used normally acts as cetane improvers. The primary motive is to boost the cetane number and in turn improve the performance of diesel engine.

So, the best possible cetane improver is selected keeping in view the important factors such as the fuel properties.

Measurementsofdifferent fuelproperties:

The important physical and chemical properties of karanja oil weredeterminedbystandardmethodsandcomparedwiththediesel.Thedifferentpropertiesconsideredare asfollows:

Relative Density:

Otherwiseknownasthespecificgravityreferstotheratioofthedensityofafueltothedensityofwateratsametemperature.Withitotherpropertiescouldbejudged.Thedensityofthefuelswasmeasuredbymeansofacapillarystopperrelative densitybottleof 20ml capacity.

Flash andFirepoint:

Flashpointisthelowesttemperaturecorrectedtoastandardatmosphericconditionatwhichapplicationofatestflamecausesthevapour of aspecimentoignite underspecifiedconditionsof test.

Fire point is the lowest temperature at which the flame burns for atleast five seconds

Pour Point:

Pour point is the lowesttemperature,expressedasmultipleof 3^{0}Catwhichtheoil isobservedtoflowwhencooledandexaminedunderprescribedconditions.

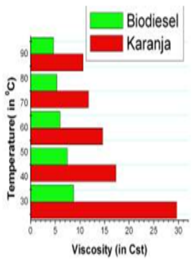
Calorificvalue:

Calorificvalueofafuelisthethermalenergyreleasedperunit quantity of fuelwhen the fuel is burned completely and the products ofcombustionarecooledbacktotheinitialtemperatureofthecombustiblemixture.Itmeasurestheenergycontentinafuel.Thisisan importantpropertyofthebiodieselsthatdeterminesthesuitabilityofthematerial.

Theheatingvalueofthepreparedbiodieselwasdeterminedwiththehelp ofBombCalorimeter.Aknownamountoffuelwasburntinabombandthetemperaturedifferencewasnoteddown.Theeffectiveheatcapacity(waterequivalent)ofthesystemwasalso determined using the same procedure with dry and pure benzoic acid (6324calories/gmor26460kj/kg).

Viscosity measurements:

Theresistancetoflowexhibitedbyfuelblendsis expressedinvariousunitsofviscosity.Itisamajorfactorofconsequenceinexhibitingtheirsuitabilityforthemasstransferandmeteringrequirementsofengineoperation.Highertheviscosityresults lowvolatilityandpooratomizationofoilduringinjectioninCIengine,thatresultsinincompletecombustionand ultimately carbon deposits on injector nozzle as well as in the combustion chamber. The viscosities of Karanja oil as well as derived bio diesel are measured by Red Wood Viscometer (AsperIP70) and acomparative study is madeat differenttem perature. Differenttemperature dependentviscositiesareshownin table 1.



	Karanja oil		Derived bio diesel	
Sl No.	Temp (^{0}C)	Viscosity (cSt)	Temp (^{0}C)	Viscosity (cSt)
01	30	29.65	30	8.73
02	45	17.34	45	7.44
03	60	14.62	60	5.97
04	75	11.74	75	5.34
05	90	10.63	90	4.62

Table 1: viscosity dependency on Temperature variation

Cetane Number: The physical and chemical properties of fuel play very important role in delay period. The cetane number (CN) of the fuel is one such important parameter which is responsible for the delay period. Cetane number of a fuel is defined as the percentage by volume of normal cetane in a mixture of normal cetane and α-methyl naphthalene, which has the same ignition characteristics (ignition delay) as the test fuel, when combustion is carried out in a standard engine under specified operating condition. A fuel of higher cetane number gives lower delay period and provides smoother engine operation. American Petroleum Institute (API) and National Bureau of Standards jointly devised an arbitrary scale expressing the gravity or density of liquid petroleum product in terms of degree API. For current fuel it is found to be degree API as 28.93and Diesel index as 47.79. The cetane number is calculated as more than 56.64, which proves the suitability as a diesel fuel.

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Properties	Karanja Oil	Bio diesel
Viscosity (cSt) at 30^0C	29.65	8.73
Calorific value (kj/kg)	-	35879
Flash point (^{0}C)	241	217
Fire point (^{0}C)	253	223
Cloud point (^{0}C)	7	6
Pour point (^{0}C)	3	3
Specific gravity (at 30^0C)	0.912	0.882

Table2:fuelpropertiesofKaranjaoil

Properties	Bio Diesel	Diesel
Viscosity (cSt) at 30^0C	8.73	2.5
Calorific value (Mj/kg)	35879	43500
Flash point (^{0}C)	217	52
Fire point (℃)	223	63
Cloud point (℃)	6	5
Pour point (℃)	3	4
Specific gravity (at 30^0C)	0.882	0.835

Table3:Comparativestudyofdiesel and bio-diesel.

As shown in Table 2 viscosity and specific gravity of bio diesel obtained are very high compared to the suitability in CI engine, therefore it is evident that dilution or blending of bio diesel with other fuels like diesel fuel would bring the viscosity and density close to a specification range. Therefore bio diesel obtained from karanja was blended with diesel oil in varying proportions to achieve the required viscosity and density close to that of a diesel fuel. The important physical and chemical properties of the bio diesel thus prepared are given in Table 3.

% of bio diesel (v/v)	% of diesel oil (v/v)		Viscosity (cSt) at 30^0C	Specific gravity	Calorific value (kj/kg)	observation
0	100	diesel	2.5	0.835	43500	Stable mixture
5	95	B5	2.78	0.837	43119	Stable mixture
10	90	B10	2.89	0.840	42738	Stable mixture
15	85	B15	3.06	0.842	42357	Stable mixture
20	80	B20	3.64	0.844	41956	Stable mixture
25	75	B25	3.98	0.847	41595	Stable mixture
100	0	B100	8.73	0.882	35879	Stable mixture

Table3: properties of karanja – diesel blends

Preparation and studies of different blends of biodiesel:

To study engine performance and emission, the experiments were done in Kirloskar make vertical single cylinder, direct injected compression ignition diesel engine (Engine model – AVI). The power output of the engine is 5HP @ 1500rpm having compression ratio 16.5:1.

Fuel	% load	BSFC Kg/Kw - hr	BSEC Kj/Kw - hr	η	Fuel	% load	BSFC Kg/Kw - hr	BSEC Kj/Kw - hr	η
Diesel	0	0	0	0	B15	0	0	0	0
	25	0.5756	25039	14.37		25	0.5539	23462	15.35
	50	0.3591	15621	23.04		50	0.3406	14427	24.95
	75	0.2684	11675	30.83		75	0.2949	12491	28.82
	100	0.2402	10449	34.45		100	0.2704	11453	31.43
B5	0	0	0	0	B20	0	0	0	0
	25	0.5419	23366	15.41		25	0.5462	22927	15.7
	50	0.3362	14497	24.83		50	0.3389	14226	25.3
	75	0.2753	11871	30.33		75	0.2778	11661	30.87
	100	0.2538	10944	32.89		100	0.2557	10733	33.54
B10	0	0	0	0	B25	0	0	0	0
	25	0.5571	23810	15.12		25	0.5484	22811	15.78
	50	0.3526	15069	23.89		50	0.3395	14122	25.49
	75	0.2902	12403	29.03		75	0.2782	11572	31.11
	100	0.2636	11266	31.96		100	0.2565	10669	33.74

Table 4: Engine Performance Data

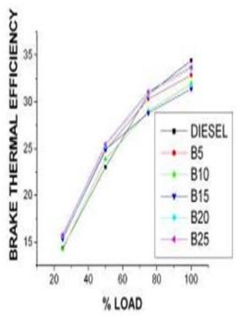

Fig: 2

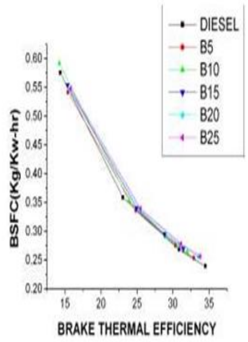

Fig: 3

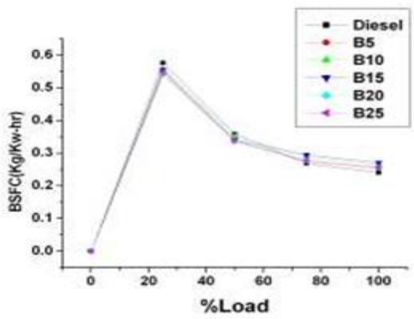

Fig:4

Brake Thermal Efficiency:

The variation of Brake Thermal efficiency with load for different fuel blends are shown in fig: 2. In all the cases brake thermal efficiency is increased due reduced heat loss with increased in load. The maximum efficiency obtained in this experiment was 33.74% (B25) and 33.54% (B20). But considering the viscosity B20 is the better option and this value is comparable with the maximum brake thermal efficiency for diesel (34.45%).

From fig: 2, it is found that brake thermal efficiency for biodiesel in comparison to diesel engine is a better option for part load on which most engine runs.

Brake Specific Fuel consumption: The variation of BSFC at different load and with the different brake thermal efficiency is shown in figure 3 and fig: 4.

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For all cases BSFC reduces with increase in load. The reverse trend in the BSFC may be due to increase in biodiesel percentage ensuring lower calorific value of fuel. Another reason for the change in BSFC in biodiesel in comparison to petro diesel may be due to a change in the combustion timing caused by the biodiesel's higher cetane number as well as injection timing. At quarter load BSFC reduces a minimum of 3.2% (B10) and a maximum of 5.85% (B5). But for full load, BSFC increases at a minimum of 5.66% (B5) and a maximum of 20.82% (B10).

Engine emission:

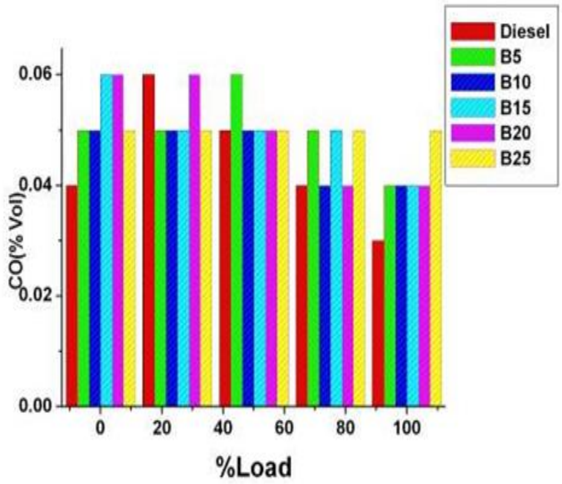

Fig: 5

CO emission: The variation of CO produced with diesel and Diesel blends are presented in fig:5. For B20 blend the maximum and minimum CO produced is 0.42gm/Kw-hr and 0.05 gm/KW-hr, which is much less than, mentioned in EURO–IV Norms (max 1.5gm/Kw-hr). It is an indication of the complete combustion of biodiesel being an oxygenated fuel.

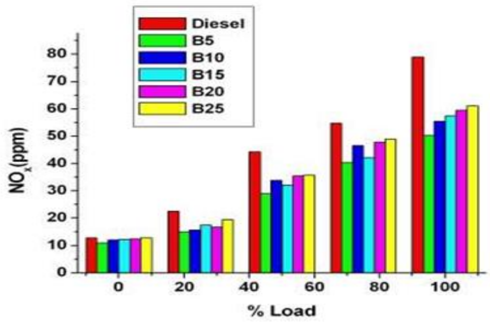

Fig: 6

NOX Emission: The variation of NOX at different engine load is presented in fig: 6. The reason for the increase in NOX is not clear. The cetane numbers of the biodiesel are generally higher than that of diesel fuel associated with lower NOX emission. The injection timing advancement associated with these effects could be partially responsible for the increase in NOX emissions. For B20 blend the maximum and minimum NOX produced is 0.04gm/Kw-hr and 0.002 gm/Kw-hr, which is much less than, mentioned in EURO – IV Norms (max 3.5gm/Kw-hr).

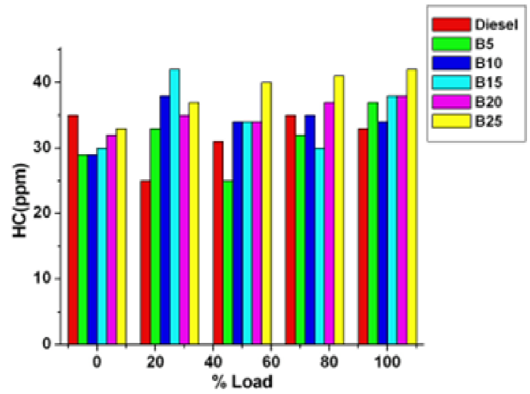

Fig.7

Hydrocarbons: The variations of un-burnt hydrocarbon at different engine load for different diesel blends are shown in fig: 7. The shorter ignition delay associated with biodiesel higher cetane number could also reduce the over mixed fuel which is the primary source of un-burnt hydrocarbons. For B20 the maximum and minimum HC produced is 0.02gm/Kw-hr and 0.004 gm/Kw-hr, which is around same as that is mentioned in EURO – IV Norms (max 0.02 gm/Kw-hr).

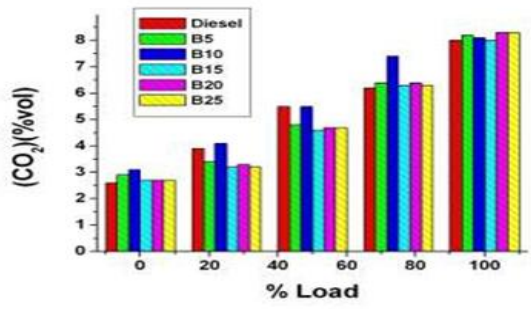

Fig.8

CO2 Emission: The variation of CO2 produced at different engine load is presented in fig: 8. For B20 blend the percentage increase for minimum and maximum load is 3.8 and 3.75. This increase in percentage is may be due to complete combustion of the fuel.

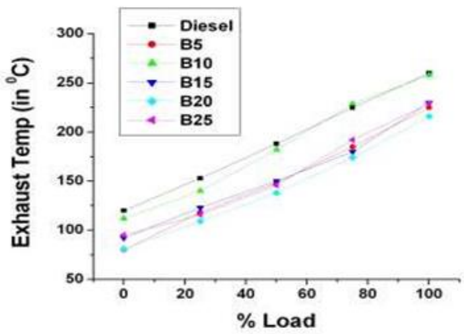

Fig: 9

Exhaust temperature: The exhaust temperature variation profile for different diesel blends are shown in fig: 9. for diesel engine the minimum and maximum exhaust temp--erature is 1200C and 2600C, whereas for B20, it is found to be 810C and 2160C.

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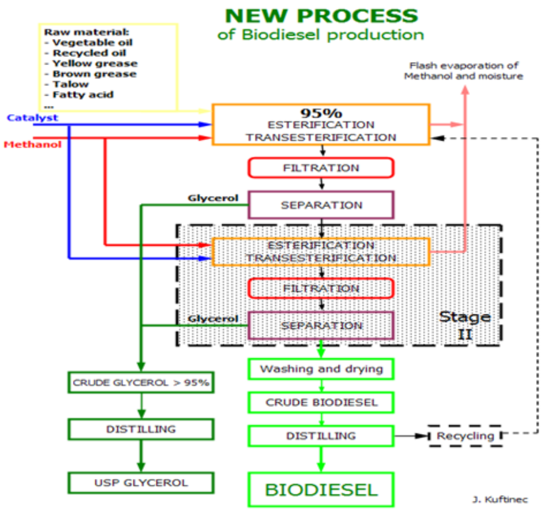
Conclusions: Based on the result of this study i.e. physical and chemical properties of karanja oil suggest that it cannot be used directly as CI engine fuel due to higher viscosity, density which will result in low volatility and poor atomization of oil during oil injection in combustion chamber causing incomplete combustion and carbon deposits in combustion chamber.

Manufacturing Procedure of Biodiesel:



Understanding stages of production:

Biodiesel production is a complex process. Simply explained, one method of producing the fuel isto firstly pass seeds or other raw materials through a mill to release their oil (Stage 1). Subsequently,the product is transferred to a centrifuge, which removes seeds from the oil by separating the twobased on density differentials (Stage 2). A filter then removes fine particles with the same density as the oil that could not be detected earlier by the centrifuge (Stage 3). After this stage, the oil is ata pure form and is ready for trans esterification (Stage 4), a process whereby it reacts with methanol and produces methyl ester (biodiesel). A small amount of glycerine by-product is also produced during this process. The final stage of processing separates the glycerine by-product from the biodiesel and is generally achieved through gravity separation or centrifugal force (Stage 5).

Problems during the filtration stage:

An international food company was supplying rapeseed oil to biodiesel producers and had to ensurethe oil was free of any contaminants before the producers could undertake the final stages of processing. At their site in Belgium, the food company was originally using two self-cleaningfilters using piston-cleaning systems and wedge wire screens to remove small particles from theOil (Stage 3). Unfortunately, the machines were experiencing numerous problems with screen blockage. However, this damaged their material and meant stopping production to manually cleanthe filters and replace parts.

A source at the company commented: “With our old filters, there was essentially too much foreign material passing through. This included sticks, debris and other large particles. Our spare parts costswere extremely high as a result. We needed a more powerful solution to handle our material in an efficient way.”

Advantages and disadvantages of Biodiesel over Diesel fuel**:**

1. Blends of 20% biodiesel with 80% petroleum diesel can be used in unmodified diesel engines. Biodiesel can be used in its pure form but many require certain engine modifications to avoid maintenance and performance problems.
2. It was stated that about half of the biodiesel industry can use recycled oil or fat, the other half being soybean, or rapeseed oil according to the origin of these feed stocks.
3. Biodiesel is nontoxic, biodegradable. It reduces the emission of harmful pollutants (mainly particulates) from diesel engines (80% less CO_2 emissions, 100% less sulfur dioxide) but emissions of nitrogen oxides (precursor of ozone) are increased.
4. Biodiesel has a high cetane number (above 100, compared to only 40 for diesel fuel). Cetane number is a measure of a fuel's ignition quality. The high cetane numbers of biodiesel contribute to easy cold starting and low idle noise.
5. The use of biodiesel can extend the life of diesel engines because it is more lubricating and, furthermore, power output are relatively unaffected by biodiesel.
6. Biodiesel replaces the exhaust odor of petroleum diesel with a morepleasant smell of popcorn or French fries.
7. By developing methods to use cheap and low quality lipids as feedstocks, it is hoped that a cheaper biodiesel can be produced, thus competing economically with petroleum resources.

Environmental Benefits:

1. In 2000, biodiesel became the only alternative fuel in the country to have successfully completed the EPA-required Tier I and Tier II health effects testing under the Clean Air Act. These independent tests conclusively demonstrated biodiesel’s significant reduction of virtually all regulated emissions, and showed biodiesel does not pose a threat to human health.
2. Biodiesel contains virtually no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter.

Energy Security Benefits:

1. With agricultural commodity prices approaching record lows, and petroleum prices approaching record highs, it is clear that more can be done to utilize domestic surpluses of vegetable oils while enhancing our energy security. Because biodiesel can be manufactured using existing industrial production capacity, and used with conventional equipment, it provides substantial opportunity for immediately addressing our energy security issues.
2. If the true cost of using foreign oil were imposed on the price of imported fuel, renewable fuels, such as biodiesel, probably would be the most viable option.

Economic Benefits:

1. Biodiesel has added $4.287 billion to the Gross Domestic Product (GDP). Biodiesel has the potential to support more than 78,000 jobs by 2012. A stable, thriving biodiesel industry is necessary if the U.S. is to eventually benefit from the commercial scale production of algal-based biofuels. The NBB estimates that for every 100 million gallons of biodiesel that is produced from algae, 16.455 jobs will be created and $1.461 billion will be added to the GDP.

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Quality Benefits:

1. Biodiesel is registered as a fuel and fuel additive with the EPA and meets clean diesel standards established by the California Air Resources Board (CARB). B100 (100 percent biodiesel) has been designated as an alternative fuel by the U.S. Department of Energy and the U.S. Department of Transportation. Moreover, in December 2001, the American Society of Testing and Materials (ASTM) approved a specification (D675) for biodiesel fuel.

EPAct Benefits:

Effective November 1998, Congress approved the use of biodiesel as an Energy Policy Act (EPAct) compliance strategy. The legislation allows EPAct-covered fleets (federal, state and public utility fleets) to meet their alternative fuel vehicle purchase requirements simply by buying 450 gallons of pure biodiesel and burning it in new or existing diesel vehicles in at least a 20% blend with diesel fuel.

Disadvantages

1. The capital cost is over 700 million dollars to develop secondary biofuel processes which would yield a better quality and more efficient fuel and reduce greenhouse gas emissions even more.
2. Biofuels are neither carbon neutral or negative as all the processes which are used to create them such as transportation, fertilizer manufacturing, and fuel used for machinery, et cetera.
3. Sometimes the production of some biofuels actually leads to more greenhouse gas emissions then they decrease such as in the case of rapeseed corn.
4. The techniques used to find out how good biofuels are for the environment usually do not take into account other gasses emitted such as nitrous oxide which sometimes happen to be more prominent after biofuels have been used.
5. Biofuels take a large expanse of area to grow. Land will have to be cleared for more growth. If rainforests and other high biomass lands are cleared on a mass scale for biofuel production (which may happen in lower income countries) then the amount of greenhouse gases emitted would be staggering, up to 420 times more GHG's emitted. Multiple studies have been found to draw the same conclusion.
6. Biofuel may raise the price of certain foods, which are also used for biofuel such as corn.
7. Biofuel development and production is still heavily dependent on Oil.
8. As other plants are replaced, soil erosion will grow.
9. A lot of water is used to water the plants, especially in dry climates.
10. Deforestation in South America and South Eastern Asia causes loss of habitat for animals and for indigenous people living there.
11. Biodiesel has excellent solvent properties. Hence, any deposits in the filters and any other delivery systems may be dissolved by biodiesel and result in need for replacement of filters. Petroleum diesel forms deposit in vehicular fuel systems, and because biodiesel can loosen those deposits, they can migrate and clog fuel lines and filters.
12. The solvent property of biodiesel could also cause other fuel-system problems. Biodiesel may be incompatible with the seals used in the fuel systems of older vehicles and machinery, necessitating the replacement of those parts if biodiesel blends are used.
13. Biodiesel tends to reduce fuel economy. Energy efficiency is the percentage of the fuel's thermal energy that is delivered as engine output, and biodiesel has shown no significant effect on the energy efficiency of any test engine. The energy content per gallon of biodiesel is approximately 11 percent lower than that of petroleum diesel. Vehicles running on biodiesel are therefore expected to achieve about 10% fewer miles per gallon of fuel than petro diesel.

Conclusion

Taking into account all the advantages and disadvantages of biodiesel, they are used as an alternative to the already existing diesel fuels. These biodiesels have a great role to play in the future as the world is running out its fossil fuel resources. Moreover, biodiesels are very environment friendly and non-toxic, so these can be used not only as a replacement but also usage of these biodiesels lends you a better future. There are arguments regarding the usage stating that the manufacturing process of biodiesel is not that economical and also we need a large harvest in order to obtain a fraction of biodiesel. A study reveals that the extraction of biodiesel from the crop harvest requires a large farm land which is greater than the human need. So, there is also a problem of food security. Research is still on in the field of biodiesels and it takes few years for us to switch on to the usage of biodiesels efficiently

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