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"DIESEL ENGINE PERFORMANCE, COMBUSTION AND EMISSION CHARACTERISTICS FUELLED WITH BLENDED KARANJA BIODIESEL: A REVIEW"

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ABSTRACT

Biodiesel has become a key source as a replacement fuel and is making its place as a key opportunity renewable energy source. As an alternative fuel for diesel engines, it is becoming ever more important due to declining petroleum reserves and the environmental cost of exhaust gases from petroleum-fuelled engines The growth in industrialization of developing countries is resulting in increasing demand for new and alternative energy sources. reduction of petroleum resources has led to the search for alternative fuel which is renewable, recyclable and easily available. To satisfy this demand biodiesel derived from different plants oils is comparatively better option. Vegetable oils can be used directly or blended with diesel to fuel diesel engines. Conversion of vegetable oils into fatty acid methyl ester by trans-etherification is the most convenient method of transforming egetable oil to biodiesel. The proportional blends of Karanja can be used in existing Compression ignition engines without any modifications.

Key Words: *Biodiesel, Karanja, Compression ignition, Modifications , Thermal energy, Performance*

I. INTRODUCTION

The internal combustion engine is a heat engine that convert chemical energy in a fuel into mechanical energy, usually made available on a rotating output shaft. Chemical energy of the fuel is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gases within the engine and the high-pressure gas then expands against the mechanical mechanisms of the engine. This expansion is converted by the mechanical linkages of the engine to a rotating crankshaft, which is the output of the engine. The crankshaft, in turn, is connected to a transmission and/or power train to transmit the rotating mechanical energy to the desired final use. For engines this will often be the propulsion of a vehicle. Diesel engines are more fuel efficient because of their high calorific value. Due to its good fuel economy and low cost, diesel engine plays an important role in transportation and agriculture. However diesel engine can convert only one third of fuel energy into useful work and the remaining two third is lost as waste through coolant and exhaust. Thermal efficiency of the diesel engine would be improved, if the heat rejected could be reduced. It is better to reduce temperature levels by insulating CC walls, instead of providing extensive cooling. By coating the engine components, different properties like reduced thermal loads, reduced heat transfer to the cooling system, higher thermal efficiency can be achieved. Biodiesel, being renewable and eco-friendly, act as an alternative fuel to their diesel counterpart.

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BIODIESEL

Bio-diesel is an atmosphere friendly fuel similar to petroleum fuel in combustion properties. Increasing environmental concern, petroleum reserves and agriculture-based economy of India are the driving forces to promote bio-diesel as an alternate fuel. India has likely to be a leading producer of bio-diesel by harvested,non-edible oils like Jatropha Curcas, Pongamia Pinnata and Madhuca Indica plants. India consumed about 9 Million Metric Tonne of petrol and 47 MMT of diesel during the year 2005-06. As rapid increase in the demand for diesel and other petroleum products, India's dependence on oil import is expected to rise to 92% by the year 2030. Import of crude oil during the year 2011-2012 was 171.73 MT. To reduce dependence on ozil imports,important to develop renewable options like bio-diesel as a substitute fossil fuel.

Table 1.1 Diesel Demand and Future Biodiesel Requirements (in MT)

Year	Diesel requirement	Bio-diesel @ 5%	Bio-diesel @10%	Bio-diesel @20%
2010	66.07	3.3035	6.607	13.21
2020	111.92	5.596	11.192	22.384
2030	202.84	10.142	20.284	40.568
2040	385.13	17.320	38.324	53.573

DIESEL AND VEGETABLE OIL :

Conventional diesel fuel is a mixture of hydrocarbon molecules. Molecules contain no oxygen atoms. Some hydrocarbons consist of long, straight carbon chains, others branch like a tree or form rings. They may have double-bonded carbon that causes the chains to bend. On the other hand, vegetable oils are generally composed of Triglycerides whose molecular structures are branched and complex. As a result, the viscosity of vegetable oils is very high compared to diesel. Vegetable oils have oxygen molecules present in them, which would improve the combustion efficiency when compared to that of diesel. However, the presence of oxygen molecule also has an effect of lowering the calorific value. Hence, the calorific value of vegetable oils is lower than that of diesel.

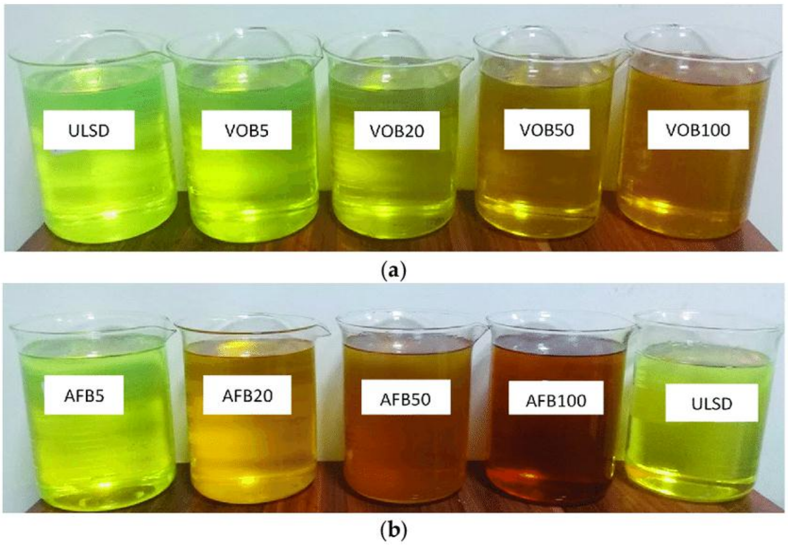

Figure No. 1.2 Alternative fuels and their blends:
(a) ultra-low-sulfur diesel (ULSD), vegetable oil biodiesel (VOB) and its blends, respectively;
(b) Animal fat biodiesel (AFB), its blends and ultra-low-sulfur diesel (ULSD), respectively
(Image Source :- [14] Candan, F., et al.)

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KARANJA BIODIESEL

The trees of Mahua, Karanja, Jatropha, Neem, Babassu and Tobacco are available in many regions of the country. Table 1 shows the overview of the Area of trees, oil content and oil production of different non-edible feedstock in India. The oil yield and properties of the oil depend on the location and climate conditions. India has potential of 1 million tons of such oil per year. The price of Karanja oil is reasonable as compared to other oils.

The oil that are used as Karanja is 55,000 t per year out of which only 6% is utilized for fuel production. Millentia Pinnata is the species of the pea family, fabacea, native in tropical and temperate Asia including parts of India, China, Japan, Malaysia, Australia and Pacific islands. It is often known by the synonym Pongamia Pinnata and it was moved to the genus Millletia only recently.

Diesel combustion is compression induced and depends to a major extent on successful vapourisation and mixing over an extremely short time, which is more complex and difficult than that of the spark ignition engine. The thermodynamic diesel cycle differs from the constant volume cycle of spark ignition engine as conceived by Otto. In reality, it tends to constant volume cycle but it is actually a combination of constant volume and constant pressure cycle.

II. Literature Review

[1] M.S. Gad (2020) Fuel demand rise coupled with its harmful emissions has contributed to the continuous search of substitute for diesel oil. Biodiesel properties were measured and agreed with ASTM standards. Biodiesel blend was obtained by blending of 20% volume respectively about B20. Biodiesel blend with CNTs and graphene nano sheet concentrations of 100 ppm achieved the highest decreases in smoke emissions by 28 and 54% but the maximum decreases in CO emission were 27 and 47%, respectively about B20

[2] Nambaya Charyulu Tatikonda (2020), In a standard internal combustion engine, a large amount of heat energy is being wasted through the cooling and exhaust systems. So, to minimize these losses one advanced technology for coating applications grows rapidly. Hence, to improve engine performance and fuel economy one or more parts of the combustion chamber such as piston crown, inlet valves, exhaust valves and cylinder head are getting coated with ceramic materials without changing the original dimensions. The present work deals with the performance characteristics of a single-cylinder diesel engine with an eddy current dynamometer loading fuelled with Cymbopogon (Lemongrass) oil methyl ester (CME) when the piston crown was coated with yttria stabilized zirconia of thickness 350 microns equal to 0.35mm of thickness using plasma spray coating technique. Test samples were prepared and designated as CME10D90 (B10), CME20D80(B20), and CME30D70(B30).

[3] T. M. Yunus Khan (2020) The ever-increasing demand for transport is sustained by internal combustion (IC) engines.The demand for transport energy is large and continuously increasing across the globe. Though there are few alternative options emerging that may eliminate the IC engine, they are in a developing stage, meaning the burden of transportation has to be borne by IC engines until at least the near future. Hence, IC engines continue to be the prime mechanism to sustain transportation in general. However, the scarcity of fossil fuels and its rising prices have forced nations to look for alternate fuels. Biodiesel has been merged as the replacement of diesel as fuel for diesel engines.

[4] A. Prabu (2019) In this study, modernization of new fuel additives such as antioxidants, oxygenates and nanoparticles are mixed with jatropha biodiesel with the aim of diluting the level of pollutants from the engine exhaust and upgrading the performance of the engine. Most significant reduction of NO emission by 30 % is observed for antioxidants and nanoparticles blended test fuels and significant enhancement in the brake thermal efficiency almost equal to that of neat diesel is observed for oxygenates and nanoparticles blended test fuel, along with substantial reduction of smoke opacity by 43 %, carbon monoxide by 60 % and unburned hydrocarbon by 33 %.

[5] İsmet Sezer (2019), This study was compiled from the results of various researches performed on usage diethyl ether as a fuel or fuel additive in diesel engines. Three different methods have been used the reduction of the harmful exhaust emissions of die-sel engines. The first technique for the reduction of harmful emissions has im-proved the combustion by modification of engine design and fuel injection sys-tem, but this process is expensive and time-consuming. The second technique is the using various exhaust gas devices like catalytic converter and diesel particu-late filter. However, the use of these devices affects negatively diesel engine performance.

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[6] M. Vijay Kumar (2018) Engine modification through reducing nozzle hole diameter (NHD) (i.e., from the base value of 0.28 to the modified value of 0.20 mm) has been shown as an effective strategy in improving engine performance, combustion, and emission parameters. However, it has also led to substantial increases in NOx emission as a major shortcoming. In light of that, the present study was aimed at overcoming this challenge through the application of a partially-cooled exhaust gas recirculation (EGR) system. More specifically, Mahua oil biodiesel-diesel blend (B20) and neat diesel were tested on a modified single cylinder diesel engine under five different engine loads (i.e., 2.46, 4.92, 7.38, 9.84, and 12.3 kg) and in the presence of varying EGR rates.

[7] Chandan Kumar (2018) The consumption of diesel fuel is increasing day by day due to its wide application in agriculture and transportation sectors which is also responsible for deteriorating condition of environment due to emissions i.e., smoke, CO, HC, NOx, etc. These emissions may be reduced by adding methanol in diesel fuel. As compared to diesel, lower value of viscosity and density of methanol-diesel lends helps in easy pumping. The lower boiling point of methanol helps in reducing the ignition delay and thereby avoiding knocking. Methanol with higher oxygen content also helps in easy vailability of more oxygen in the vicinity of the diesel for its quick and better combustion. To improve the working of diesel engine and control its emission level, blend diesel version definitely plays a very important role.

[8] A. Prabu (2018) This experimental work investigates the performance, combustion and emission characteristics of a single cylinder direct injection (DI) diesel engine with three fuel series: biodiesel–diesel (B20), biodiesel–diesel–nanoparticles (B20A30C30) and biodiesel–nanoparticles (B100A30C30). The nanoparticles such as Alumina (Al2O3) and Cerium oxide (CeO2) of each 30ppm are mixed with the fuel blends by means of an ultrasonicator, to attain uniform suspension. Owing to the higher surface area/volume ratio characteristics of nanoparticles, the degree of mixing and chemical reactivity are enhanced during the combustion, attaining better performance, combustion and emission attributes of the diesel engine. The brake thermal e□ciency of the engine for the nanoparticles dispersed test fuel (B20A30C30) signi□cantly improved by 12%, succeeded by 30% reduction in NO emission, 60% reduction in carbon monoxide emission, 44% reduction in hydrocarbon emission and 38% reduction in smoke emission, compared to that of B100.

[9] Bhaskar Kathirvelu1 (2017) This paper is based on experiments conducted on a stationary, four stroke, naturally aspirated air cooled, single cylinder compression ignition engine coupled with an electrical swinging field dynamometer. Instead of 100% diesel, 20% Jatropha oil methyl ester with 80% diesel blend was injected directly in engine beside 25% pre-mixed charge of diesel in mixing chamber and with 20% exhaust gas recirculation. The performance and emission characteristics are compared with conventional 100% diesel injection in main chamber. The blend with diesel premixed charge with and without exhaust gas recirculation yields in reduction of oxides of nitrogen and particulate matter. Adverse effects are reduction of brake thermal efficiency.

[10] S. Jaichandar (2015) studied methyl ester derived from jatropha oil (JOME) and its blends of 20 and 50% on a volume basis with standard diesel as a source of fuel for a compression ignition engine. The engine tests were carried out at 0%, 25%, 50%, 75% and 100% load using a single-cylinder, four-stroke, constant speed diesel engine to study the performance, emission and combustion characteristics of these fuels. The results showed a 21% reduction in smoke, 17.9% reduction in HC emissions and 16% reduction in CO emissions for 20% JOME, with a 3.8% increase in NOx emission at full load.

[11] Dawody and Bhatti (2014) studied the performance of soyabean oil methyl esters in a single cylinder diesel engine and compared the results with diesel. The results showed that the brake thermal efficiency reduced by 3% with that of diesel. The increase in NOx emission was 35% and reduction in smoke emission was 48%. Marginal reduction in HC and carbon monoxide was observed in the tests. It was finally concluded that the performance of B20 was comparable with that of diesel.

[12] S. Jaichandar1 , K. Annamalai (2016), The use of jatropha oil as a fuel for diesel engines is gaining more interest. Biodiesel is defined as a transesterified alternative fuel obtained from vegetable oils or animal fats having

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properties comparable to those of diesel. In the present investigation a methyl ester derived from jatropha oil (JOME) was considered as fuel. This paper presents a comparative study on the use of JOME and its blends of 20 and 50% on a volume basis with standard diesel as a source of fuel for a compression ignition engine. The engine tests were carried out at 0%, 25%, 50%, 75% and 100% load using a single-cylinder, four-stroke, constant speed diesel engine to study the performance, emission and combustion characteristics of these fuels. The results showed a 21% reduction in smoke, 17.9% reduction in HC emissions and 16% reduction in CO emissions for 20% JOME, with a 3.8% increase in NOx emission at full load.

[13] Obed Majeed Ali1, Rizalman Mamat, Nik R. Abdullah, Abdul Adam Abdullah (2016) , Biodiesel fuel can be used as an alternative to mineral diesel, its blend up to 20% used as a commercial fuel for the existing diesel engine in many countries. However, at high blending ratio, the fuel properties are worsening. The feasibility of pure biodiesel and blended fuel at high blending ratio using different chemical additives has been reviewed in this study. The results obtained by different researchers were analysed to evaluate the fuel properties trend and engine performance and emissions with different chemical additives. It found that, variety of chemical additives can be utilised with biodiesel fuel to improve the fuel properties. Furthermore, the chemical additives usage in biodiesel is inseparable both for improving the cold flow properties and for better engine performance and emission control. Therefore, research is needed to develop biodiesel specific additives that can be adopted to improve the fuel properties and achieve best engine performance at lower exhaust emission effects.

[14] Candan, F., et al. (2017) , In this study, methanol in ratios of 5-10-15% were incorporated into diesel fuel with the aim of reducing harmful exhaust gasses of Diesel engine, di-tertbutyl peroxide as cetane improver in a ratio of 1% was added into mixture fuels in order to reduce negative effects of methanol on engine performance parameters, and isobutanol of a ratio of 1% was used as additive for preventing phase sepa-ration of all mixtures. As results of experiments conducted on a single cylinder and direct injection Diesel engine, methanol caused the increase of NOx emission while reducing CO, HC, CO2, and smoke opacity emissions. It also reduced torque and power values, and increased brake specific fuel consumption values.

[15] Gaurav paul et al (2014) carried out experimental and numerical investigation on the performance and emission tests on a diesel engine with blends of jatropha biodiesel. Experiments results showed that the thermal efficiency reduced by 8% and NOx emission increased by 24% for B100 when compared to diesel. Significant reduction in particulates and smoke emissions were observed. It was reported that the presence of oxygen in biodiesel increased the NOx emission and reduced the smoke emission.

[16] Ameya vilas Malvade et al (2013) investigated the effects of using palm oil biodiesel in a stationary single cylinder compression ignition engine. The properties of palm oil biodiesel were comparable with that of diesel. The results of the performance tests showed that the brake thermal efficiency and specific fuel consumption were comparable with diesel for blends up to B30.

[17] Boubhari chokri et al (2012) conducted performance and emission test on a compression ignition engine with blends of waste vegetable oil esters. The results showed that there is a decrease in power output by about 5% with every 10% increase in biodiesel by volume. The NOx emission decreased by 2.5% whereas the particulate emission decreased by 10% for increase in biodiesel blends.

[18]Dattatray bapu halwan et al (2011) investigated the effects of blends of biodiesel and ethanol with diesel in a multi cylinder diesel engine. It was reported that injection timing has to be changed to 18^o CA instead of the actual injection timing of 13^o CA before top dead centre. This was due to the displacement of 50% diesel by the blends. NOx emissions were doubled, while smoke emissions were reduced by 60-70% for all the blends. The carbon monoxide emission reduced significantly at lower loads.

[19] Rao (2011) studied the effects of 100% biodiesel in normal mode and preheated mode in a single cylinder diesel engine. A reduction in brake thermal efficiency and increase in NOx emission were observed for normal operation mode. In preheated mode of operation the efficiency and NOx emission were comparable with that of diesel. It was

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reported that high NOx emissions were due to the presence of unsaturated fatty acids and the advanced injection caused by higher density of jatropha biodiesel.

[20] Enweremadu et al (2010) carried out experiments with used cooking oil (UCO) biodiesel and its blends in a diesel engine. The blends of biodiesel reduced the engine performance marginally compared to diesel. BSFC increases with increase in percentage of UCO biodiesel in the blend and is due to the lower heating value of UCO biodiesel and its blends. NOx emissions were slightly higher while un-burnt hydrocarbon (UBHC) emissions were lower for UCO biodiesel when compared to diesel fuel due to the presence of oxygen. The ignition delay of UCO biodiesel decreases with increase in percentage of UCO in the blend and is less when compared to that of petroleum diesel. The peak pressure of UCO biodiesel and its blends is higher than that of diesel fuel. The rate of pressure rise and heat release for UCO biodiesel and diesel are similar. The exhaust gas temperature increase with increase in percentage of UCO in the blend. Increased oxygen content which improves combustion is a reason given for higher exhaust gas temperature.

[21] Aydin et al (2010) conducted the performance and emission tests of a diesel engine with cottonseed oil methyl ester. For the study, cottonseed oil methyl ester (CSOME) was added to diesel fuel by volume of 5% (B5), 20% (B20), 50% (B50) and 75% (B75) as well as pure CSOME (B100). The effects of CSOME diesel blends on engine performance and exhaust emissions were examined at various engine speed and load condition. Results showed that with the increase of CSOME in the blends, the torque was decreased due to higher viscosity and lower heating value of CSOME. At rated power output, brake specific fuel consumption of B20 was lower than those of other fuels including diesel fuel. It may be due to the fuel based oxygen and higher cetane number, leading to more complete combustion at low speeds.

III. CONCLUSION

From the study of literature, it is concluded that biodiesel blends in different concentrations can easily be used to provide alternative fuels to diesel. A held an experimental research to sightsee the use of biofuels performance by using Castor and Karanja oil in diesel engine.

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