Review Paper

A Review of Recent Research on Palm oil Biodiesel as Fuel for CI Engine

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Abstract— **In India, Around 63513 hectare of land suitable for production of palm oil and comparable property of this oil to diesel compelled many researchers to investigate potential and performance of this palm oil biodiesel using Compression Ignition engine. Performance of single and multi cylinder CI engine using neat vegetable oil, blending oil with diesel, methyl ester of oil, blending palm bio-diesel with diesel is measured and compared to diesel. In the present review paper attempt is made to overview the research work done on non edible oil obtained from palm and its performance in CI engine. Moreover, remarkable research work had been done to optimize the yield of bio-diesel by varying critical parameter of esterification process. Recently some researchers carried out experiments with addition of some additives.**

Keywords-Biodiesel, Palmoil, Blend,Methylester,CI Engine

I. Introduction

The fossil fuels; oil, coal and natural gas are the primary energy sources that have powered modern industrial civilisation. In 2005 the global consumption of these resources was the equivalent of over 9 billion tonnes of crude oil. The demand for these resources is set to increase even further given the dramatic economic expansion occurring in countries such as China and India. However, this trend is not sustainable. Fossil fuels, by their very nature are finite and in the case of oil we are rapidly approaching the point at which this resource is being consumed faster than it can be recovered from the ground. Bio-diesel is fatty acid methyl or ethyl ester made from virgin or used vegetable oils (both edible & non-edible) and animal fats. The main commodity sources for bio-diesel in India can be non-edible oils obtained from plant species such as Jatropha Curcas, Karanj, Neem, Palm etc.. Bio-diesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a bio-diesel blend or can be used in its pure form. Just like petroleum diesel, bio-diesel operates in compression ignition engine; which essentially require very little or no engine modifications because bio-diesel has properties similar to petroleum diesel fuels. It can be stored just like the petroleum diesel fuel and hence does not require separate infrastructure. The use of bio-diesel in conventional diesel engines results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matters. Bio-diesel is considered clean fuel since it has almost no sulphur, no aromatics and has about 10 % built in oxygen, which helps it to burn fully. Its higher cetane number improves the ignition quality even when blended in the petroleum diesel.

II. Potential Of Palm oil biodiesel in India

Stewart et al.[9], The vegetable oils include soyabean oil, cottonseed oil, sunflower oil, rapeseed oil, palm oil, linseed oil, jatropha oil, neem oil and mahua oil. There are more than 350 oil bearing crops identified whose cetane number and calorific value are comparable with those of diesel fuels and are compatible with material vehicle fuel system. Vegetable oil is of special interest because it has shown to significantly reduce particulate emission relative to petroleum diesel. Recent studies indicates that cetane number, aromatic content and type, sulphur content, density are important factor for emission control.

India has great potential for production of biodiesel from non-edible oil seeds. From about 100 varieties of oil seeds, only 10-12 varieties have been tapped so far. The annual estimated potential is about 20 million tonnes per annum. Wild crops cultivated in the west land also form a source of biodiesel production in India and according to the Economic Survey of Government of India, out of the cultivated land area, about 175 million hectares are classified as waste and degraded land. Thus, given a demand-based market, India can easily tap its potential and produce biodiesel in a large scale.

Philip D. hill et al.[7] assessed and integrated the biological, chemical and genetic attributes of the plant and describes about the different tree borne oilseeds in India. Non edibles oils from the sources such as corn, sunflower, coconut, oil palm are easily available in many parts of the world including India, and are very cheap compared to edible oils. In India, there are several yields of various non -edible oils from

TABLE.1 POTENTIAL OF TREE BORN NON-EDIBLE OILS IN INDIA

Sl. no.	Tree born oil sources	Lbs Oil/acre	Us Gal/acre
1	Corn	129	18
2	Sunflower	714	102
3	Oats	244	35
4	Hemp	272	39
5	Soybean	335	48
6	Peanuts	795	113
7	Rice	622	88
8	Coconut	2018	287
9	oil palm	4465	635

different species such as mustard seed, palm oil, sunflower, corn, which could be utilized for biodiesel production processes. The total area existing under oil palm in the country during 2005 was 63513 ha. The state wise break up of area under oil palm is given in Table.2

TABLE.2 STATE WISE AREA UNDER OIL PALM (2005-06) [8]

Sl. No.	Name of the State	Area (ha)	Districts/Growing Areas
1	A & N Islands	1593	Little Andamans
2	Andhra Pradesh	45370	East Godavari, Guntur, Khammam, Krishna, Nellore,
3	Chattisgarh	4	Bastar & Dantewada
4	Goa	823	North & South Goa
5	Gujarat	200	Valsad, Surat, Navsari & Bharuch
6	Karnataka	4464	Belgaum, Davangere,
7	Kerala	5501	Alappuzha,Idukki, Kottayam,
8	Maharashtra	1000	Sindhudurg
9	Mizoram	1000	Kolasib & Lunglei
10	Orissa	131	Dhenkanal, Gajapati, Jajpur, Kendrapada,
11	Tamilnadu	3307	Trichy,Karur, Nagapattinam, Perambalur,
12	Tripura	120	
	Total	63513	

III. TRANESTERIFICATION PROCESS

Syed Khaleel Ahmed et al[4] investigated three basic routes to biodiesel production from oils and fats.(1)Base catalyzed transesterification of the oil (2) Direct acid catalyzed transesterification of the oil (3)Conversion of oil to its fatty acids and then to biodiesel. Transesterification reaction is a stage of converting oil or fat into methyl or ethyl esters of fatty acid, the general reaction for obtaining biodiesel through transesterification is

Oil or Fat + Methanol → Methyl Esters +Glycerol (1)

Oil or Fat + Methanol → Ethyl Esters +Glycerol (2)

Author explains the palm oil production process based on catalyzed based transesterification, this reaction can be catalyzed by alkalis, acids, or enzymes. Alkalis include sodium hydroxide, potassium hydroxide, carbonates, and corresponding sodium and potassium alkoxides such as sodium methoxide, sodium ethoxide, sodium propoxide, and sodium butoxide. Sulphuric acid, sulfonic acids, and hydrochloric acid are usually used as acidic catalysts. In the industry, transesterification is generally done with alkali mediums, because they present better yield and lower reaction time

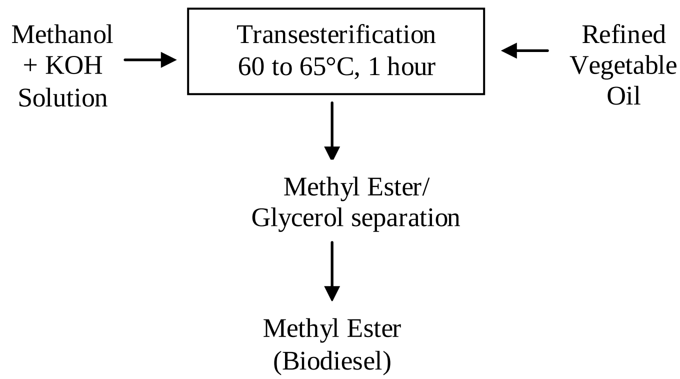

FIG.1: PROCEDURE OF MANUFACTURING BIODIESEL THROUGH TRANSESTERIFICATION

S.Siga et al [6] observed the properties change by the transesterification process based on catalyst because of low temperature and pressure in the process. This method also has high conversion ratio of almost 98% with minimal side effects and reaction time. This method is advantageous as no intermediate compound is required and the oil can directly be converted to biodiesel. Fig.2 shows the chemical reaction of the process.

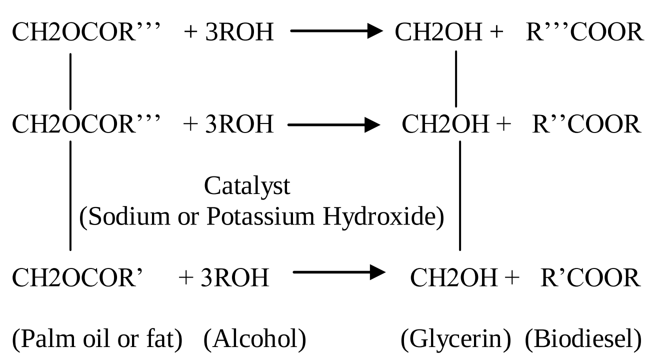

FIG.2: EQUATION OF PALM OIL INTO BIODIESEL

R', R" and R'" shown in the fig shown in the figure above is the representation of the fatty acid chains of the palmitic oil or fat. Authors also give palm oil biodiesel production process based on above transesterification process. In this process (1)The catalyst mixed with alcohol. The catalyst usually dissolved in the alcohol using a standard mixing machine. (2) The mix is then put into a closed reaction vessel and the palm oil or fat is added. A closed system is done in the process to prevent the loss of alcohol to the atmosphere. (3) The mix is kept at the temperature above the boiling point of alcohol at about 70 ◦C so that the reaction takes place. The reaction time varies from 1 to 8 h and excess alcohol usually used to ensure complete conversion of palm oil into methyl esters. (4) Once the reaction have completed, there will be two outputs which are glycerin and biodiesel.

Dr.G.Lakshmi Narayan rao et. Al [5] investigated that the properties of palm oil biodiesel are improve by catalyst transesterification process and they also compare the properties of palm bio diesel with the diesel fuel corresponding Indian standards. Table.3 shows the properties before esterification. And the Table.4 shows the variation in properties after esterification and comparison with diesel as per Indian standards.

TABLE.3 BEFORE ESTERIFICATION

Property	**Palm oil**
Density (Kg/m^2)	918
Kinematic (c.stokes)	39.6
Flash point(°C)	267
Fire point(°C)	296
Heating value (KJ/Kg)	36220
Specific gravity	0.9180

TABLE.4 AFTER ESTERIFICATION

Property	**Palm oil Methyl Ester**	**Diesel**	**IS For Biodiesel**
Density(kg/m^2)	880	850	860-900
Kinematic viscosity c.stokes	6.2	3.05	2.5-6
Flash point(°C)	164	56	120
Fire point (°C)	171	63	130
Heating value KJ/Kg	38050	42800	37270
Specific gravity	0.897	0.85	0.86-0.90

Author also measured the properties of Palm oil methyl esters (POME) by standard techniques. They found that the properties of the methyl esters satisfy Indian standards for Biodiesel. The Properties of methyl esters with different blends and diesel are show in Table.5

TABLE.5 THE PROPERTIES OF METHYL ESTERS WITH DIFFERENT BLENDS AND DIESEL

Fuel	Property			
	Specific Gravity	Calorific Value (KJ/Kg)	Kinematic Viscosity (mm2/sec)	Flash Point C
Diesel	0.85	42800	3.05	56
POME B20	0.8620	42270	4.9	68
POME B40	0.8733	41010	5.26	74
POME B60	0.8810	39580	5.55	106
POME B80	0.8898	38740	5.91	132
POME B100	0.8970	38050	6.2	164

IV. PALM BIO DIESEL IN CI ENGINE

The property of bio-diesel is very comparative to diesel. The viscosity of bio-diesel is 5-7 times more than that of diesel. This lower viscosity of bio-diesel reduces problems associated with vegetable oil such as clogging, higher emission of CO and HC, requirement of higher injection pressure and preheating of fuel. Bio-diesel can be blended in any percentage with diesel without any engine modification. The performance of blend up to 20 % have showed brake thermal efficiency and brake specific fuel consumption same as diesel and emission of CO and HC is reduced compared to diesel. Whereas the blends above 20 % have lower thermal efficiency due to low volatility of bio-diesel results in lower rate of heat release

Almeida et al.[10] studied the performance and the exhaust gas emissions of a naturally aspirated MWM 229 direct injection four-stroke, 70 kW diesel-generator, fuelled with preheated palm oil and diesel fuel. The tests showed that, when the engine was operating with palm oil, exhaust temperature increased with load and specific fuel consumption was almost 10% higher at low loads. It was also observed for both fuels that, increasing the load, the CO emission also increased. Tests also showed that: the HC emissions of both fuels were low (up to 75% of the load) but tended to increase at higher loads; NOx emissions increased as the load increased and, compared with diesel fuel, NOx emissions were lower when the engine was fueled with palm oil; the levels of CO2 and O2 emissions were almost the same, regardless the engine was operating with diesel or biodiesel; and the lowest CO emissions were obtained with diesel.

P.Prabhakaran et al.[2] studied the performance and the exhaust gas emissions of single-cylinder, four-stroke, direct injection diesel engine, fuelled with palm oil and diesel fuel. The tests showed that, The break specific fuel consumption decreases with increase in torque, compression ratio and injection pressure. It is lowest for 20Nm, 18 compression ratio and injection pressure 250bar. The difference between fuel consumption of biodiesel and diesel is not significant. At full torque, the Break Thermal efficiency is less by 2.58% than that for diesel respectively. The biodiesels have lower heating value due to which lower Break Thermal efficiency is obtained for biodiesels. The Exhaust gas temperature for biodiesels is slightly less as compared to that for diesel. It is observed that HC emissions are less in case of biodiesel whereas NOx is more with biodiesel. There is reduction in HC emissions with the increase in Compression Ratio and Injection Pressure whereas no significant variation is observed with increase in torque. At a condition of 20Nm, 18 Compression Ratio and 200 Injection Pressure the HC emissions are 5 and 2 ppm for diesel and Palm biodiesels respectively. At a torque of 20Nm, the NOx levels measured in ppm for palm biodiesel is 176 ppm respectively. The NOx emissions increase with increase in torque, Compression Ratio and Injection Pressure.

Soni S.Wirawan et al.[3] studied the performance and the exhaust gas emissions of a automotive diesel engine test has been carried out to obtain comparative measurement of engine performance (torque, power, specific fuel consumption) and emission of pollutants, and to evaluate the behavior of a diesel engine running on palm biodiesel blend.

The emission of CO, HC and particle decreased considerably with the increase in biodiesel blend. The reduction in particle emission was very sharp at 10% blend (B10), while the sharp reduction in HC emission started at 20% blend (B20). The results also shows lower NOx emission as well as higher torque and power for biodiesel blend compare to that of pure petro-diesel fuel. This result could be as a consequence of the properties of tested palm biodiesel, which has higher cetane number and lower viscosity value compared to the petrodiesel fuel sample.

Jawad Nagi et al.[4]observed that, palm biodiesel gives lower performance on diesel engines for torque and thermal efficiency, compared to petroleum diesel. This is caused by the lower heat value of palm biodiesel to that of petroleum diesel, which produces a lower work to reach a higher torque the effective thermal efficiency of palm biodiesel was also observed to be lower than the petroleum diesel, which is caused due to the lower calorific value of palm biodiesel. Exhaust gas emissions using palm biodiesel blends and petroleum diesel were measured for a diesel engine. It was observed that palm biodiesel blends produced lower CO emissions than petroleum diesel for the entire engine load range, The palm biodiesel blends had a tendency to reduce CO2 emissions compared to petroleum diesel,The reduction of CO2 emissions is logical because of the oxygenated nature of palm oil and the lower amount of carbon in the palm biodiesel blends All blends of palm biodiesel produced lower emissions of unburned hydrocarbons (HC). However, palm biodiesel blends increased the concentration of NOx emissions especially at the higher engine loads. The additive oxygen content in palm biodiesel is the cause of this, as more oxygen during combustion will raise the combustion bulk temperature. Higher NOx emissions of palm biodiesel are also resulted from its other properties or by interaction with the fuel injection process and combustion chamber dynamics

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