Volume 1 Issue 4
October 2013 - December 2013
ISSN: 2322-0821
INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING & APPLIED SCIENCES
www.irjeas.com

Performance Evaluation and Testing Of CI Engine with Bio-Diesel Blended with Karanja Oil and Waste Vegetable Oil

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Abstract— **Through transesterification, bio-diesel production from waste vegetable oil and karanja oil were studied, the oil produced were blended with neat bio-diesel and performance of CI engine is evaluated. This paper investigates the performance parameters of single cylinder 4 stroke diesel engine. Different proportions of blends of waste vegetable oil and karanja oil were tested. The results concluded that these blends can be used as an alternate fuel in CI engine without any engine modification**.

Keywords - Bio-diesel blends, Thermal efficiency, Performance parameters of CI engine.

I. INTRODUCTION

Biodiesel is the name of a clean burning relatively cheaper alternative fuel, produced from domestic, renewable resources. Biodiesel blend can be prepared by mixing the biodiesel with neat petroleum diesel. The blend can be used in compression-ignition (diesel) engines with little or no modifications. Since Biodiesel is simple to use, biodegradable, nontoxic, and free of sulfur and aromatics so can be used as eco-friendly fuels. Biodiesel is better for the environment because it is made from renewable resources and has lower emission compared to petroleum diesel Biodiesel is better for the environment because it is made from renewable resources and has lower emission compared to petroleum diesel. Biodiesel is made through a chemical process called transeterification whereby the glycerin is separated from the fat or vegetable oil. The process leaves behind two by products, methyl esters (the chemical name for biodiesel) and glycerin (a valuable byproduct usually sold to be used in soaps and other products). The transesterification is achieved with monohydric alcohols like methanol and ethanol in the presence of an alkali catalyst. The advantages of biodiesel are that it displaces petroleum thereby reducing global warming gas emissions, tail pipe particulate matter, hydrocarbons, carbon monoxide, and other air toxics. Biodiesel improves lubricity and reduces premature wearing of fuel pumps.Biodiesel can also be used as a diesel fuel additive for the purpose of keeping the injectors, pumps and their combustion components clean. A 1-2% blend should be sufficient for this purpose[7,10].

FUEL PROPERTY	BIO-DIESEL
FUEL STANDARD	ASTM PS 121
FUEL COMPOSITION	C12-C22 FAME
LHV, BTU/LB	120.910
KINETIC VISCOSITY AT 40°C	1.9-6.0
SP. GRAV., KG/L AT 60°F	0.80-0.88
DENSITY, LB/GAL AT 15°C	7.328

International Research Journal of Engineering & Applied Sciences
www.irjeas.com, ISSN: 2322-0821, Volume 1, Issue 4, Oct. 2013 – Dec. 2013, Page 13 - 18

WATER, PPM BY WT	0.05 % MAX.
CARBON, WT %	77
HYDROGEN, WT %	12
OXYGEN BY WT %	11
SULPHUR WT %	0
BOILING POINT, °C	182-338
FLASH POINT, °C	100-170
CLOUD POINT, °C	-3 TO 12
POUR POINT, °C	-15 TO 16
CETANE NUMBER	48-60

Table 1.1- Properties of Bio-diesel

II. CHEMISTRY BEHIND BIO -DIESEL

The major ingredients of vegetable oils are triglycerides. Triglycerides are esters of glycerol with long-chain acids (fatty acids). The composition of vegetable oils varies with the plant source. The fatty acid profile describes the specific nature of fatty acids occurring in fats and oils. The chemical and physical properties of fats and oils and the esters derived from them vary with the fatty acid profile. Transesterification is the process where an alcohol and an ester react to form a different alcohol and a different ester. For biodiesel, an ethyl ester reacts with methanol to form a methyl ester and ethanol. These ethyl esters react with methanol to form biodiesel and glycerol. The main purpose of transesterification is to reduce the viscosity of the oil so that it has properties closer to that of regular diesel used in CI engines. Methanol is the preferred alcohol for obtaining biodiesel because it is relatively cheaper than other alcohols and it is readily available. However, for the reaction to occur in a reasonable time, a catalyst must be added to the mixture of the vegetable oil and methanol to accelerate the speed of a reaction.

III. PROPERTIES OF KARANJA AND DIESEL:

The properties of the methyl ester derived from Honge Oil, diesel has been determined and summarized in table 3.1. [11].

Properties	DIESEL	KARANJA BIO-DIESEL
Density(kg/m³)	840	870
Sp.gravity	0.840	0.870
Flash point(°c)	56	170
CV(kj/kg)	43000	36100

Table 3.1 - Properties of diesel honge oil (karanja oil)

IV. ENGINE PERFORMANCE WITH BIODIESEL

Many studies were conducted to study the performance (Engine performance is an indication of the degree of success with which it is doing its assigned job i.e. the conversion of the chemical energy contained in the fuel into the useful mechanical work) of an engine with alternate fuels. Blended fuels and compare this performance with performance of engine working with neat fuel. Study of performance is done on the basis of some basic performance parameters they are following. Power and Mechanical Efficiency. Mean Effective pressure and Torque Specific Output, Volumetric Efficiency, Fuel- Air ratio, Specific fuel consumption Thermal Efficiency and Heat Balance Exhaust Smoke and other emission parameter. It is already illustrated that the alternate fuels are being used in day to day use of a common man so it is desperately needed to analyze the effect of a competent alternate fuel like biodiesel on performance of and engine with following performance parameters.

- Power and Mechanical Efficiency
- Mean Effective pressure and Torque
- Specific Output
- Volumetric Efficiency
- Fuel- Air ratio
- Specific fuel consumption
- Thermal Efficiency and Heat Balance
- Exhaust Smoke and other emission
- Specific weight

Though many workers have conducted performance tests with different biodiesel fuels like Coconut oil , Peanut oil , Palm oil Rapeseed oil ,Sunflower oil ,Soya bean oil ,Cotton seed oil, Linseed oil, Caster oil etc .A brief literature survey will be presented .A naturally aspirated direct injection diesel engine is more sensitive to fuel quality [4]. The main problem of using waste vegetable oil in unmodified form in diesel engine is its high viscosity. It is necessary to reduce the fuel viscosity before injecting it in the engine. High viscosity of waste vegetable oil can be reduced by heating the oil using waste heat of exhaust gases from the engine and also blending the waste vegetable oil with diesel [3]. Viscosity of waste vegetable oil and diesel was measured at different temperatures to find the effect of temperature on viscosity. A typical engine system widely used in the agricultural sector has been selected for present experimental investigations. A single cylinder, four stroke, constant speed, water cooled, direct injection diesel engine was procured for the experiments. The technical specifications of the engines are given in Power-star make electric dynamometer was used to measure torque or brake power. It consisted of an alternator to which electric bulbs were connected to apply load. The main components of the experimental setup are two fuel tanks (waste vegetable Diesel blend), heat exchanger, exhaust gas line, and performance and emissions measurement equipment. The engine is started with diesel and once the engine warms up, it is switched over to waste vegetable oil-Diesel blend. After concluding the tests with waste vegetable blend, the engine is again switched back to diesel before stopping the engine until the waste vegetable-Diesel blend is purged from the fuel line, injection pump and injector in order to prevent deposits and cold starting problems. A heat exchanger was designed to preheat the blend using waste heat of the exhaust gases. The temperature of the blend was maintained within the required range by providing a by-pass valve in exhaust gas line before the heat exchanger. A thermocouple was provided in the exhaust line to measure the temperature of the exhaust gases.

Engine performance is an indication of the degree of success of the engine performs its assigned task, i.e. the conversion of the chemical energy contained in the fuel into the useful mechanical work. The performance of an engine is evaluated on the basis of the following parameters:

V. PARAMETER DESCRIPTION

- Fuel Consumption Rate
- Air Intake Velocity
- Load
- Mean Effective Pressure
- Actual Speed
- Temperature Of water Inlet to Calorimeter
- Temp. Of water Outlet From Calorimeter
- Gas Inlet Temperature to Calorimeter

VI. GRAPHICAL REPRESENTATION

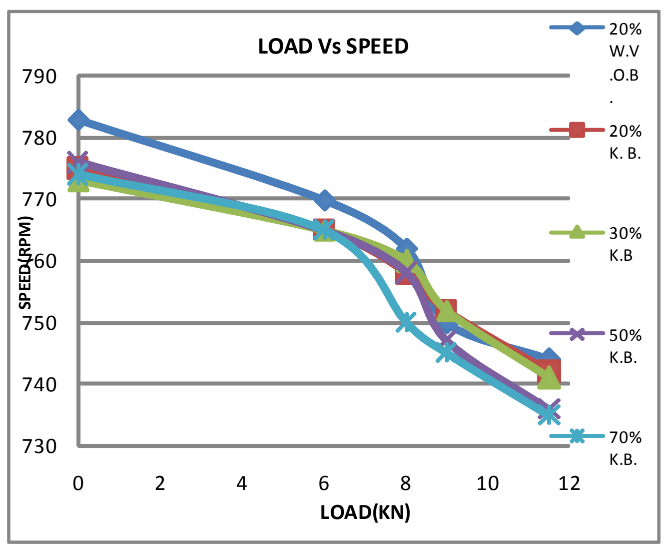

Fig.6.1 Variation of Speed with Load for W.V.O.B &K.B Blended With Diesel.

In fig 6.1 As we see in the graph, in case of 20% w.v.o.b. and 30% k.b. the speed decreases more slowly than other percentage of blends. As the percentage of the blends increases the more rapidly speed decreases. This is because of the fact that the total specific calorific value decreases with the greater percentage of blend.

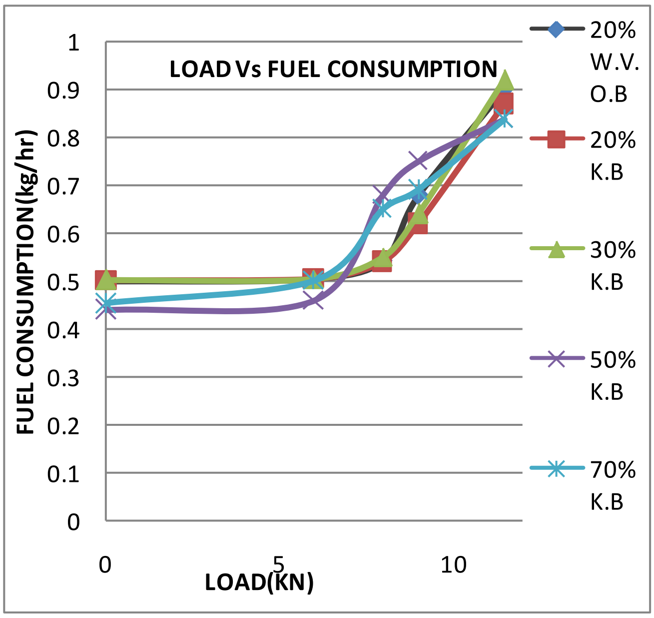

Fig.6.2 Variation Of Fuel consumption With Load For W.V.O.B &K.B Blended With Diesel.

In Fig.6.2 at 20%(v/v) of waste vegetable and 20% of karanja biodiesel blends, fuel consumption is nearly same at same load. Fuel consumption increases as load increases. At all loads, it is observed that rate of biodiesel

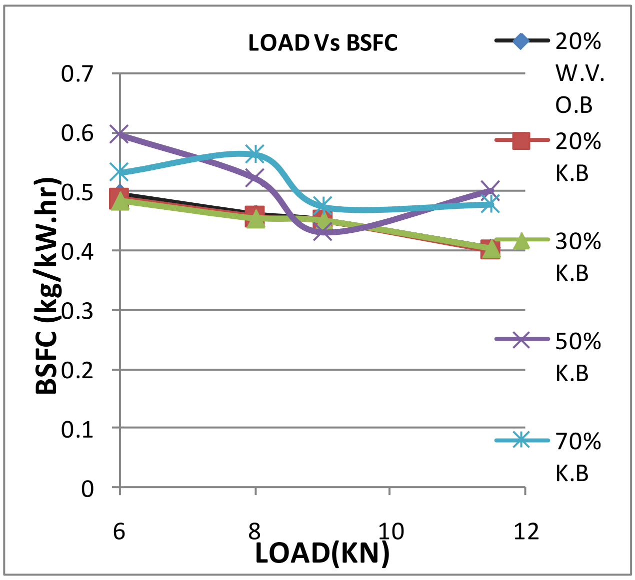

Fig.6.3 Variation Of BSFC With Load For W.V.O.B &K.B Blended With Diesel

Fig. 6.3 BSFC is plotted against the load for karanja oil biodiesel blended with diesel, BSFC is approximately same at 20%(v/v) of waste vegetable oil and karanja oil. If the percentage of karanja biodiesel increased, BSFC increases as load increases.

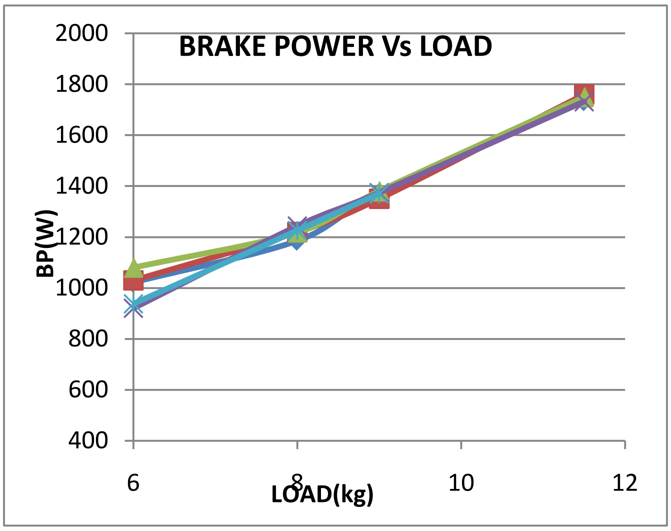

Fig.6.4 Variation of Brake power with Net load for W.V.O.B &K.B blended with diesel.

In Fig.6.4 at 20%(v/v) of waste vegetable and 20% of karanja biodiesel blends, fuel consumption is nearly same at same load. Fuel consumption increases as load increases. At all loads, it is observed that rate of biodiesel consumption is higher.

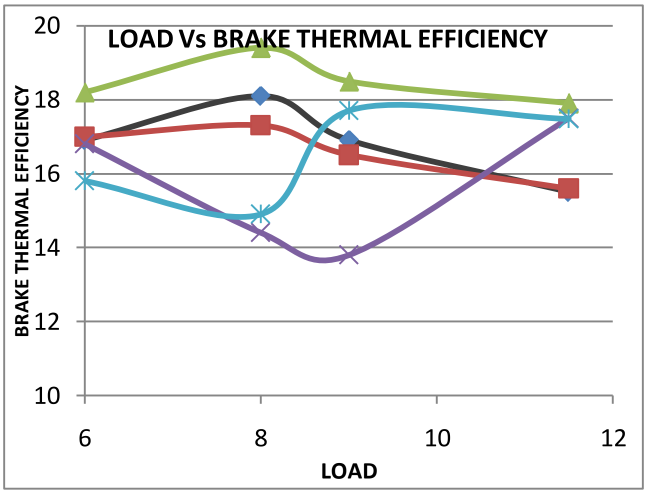

Fig.6.5 Variation of BMEP with Net load for W.V.O.B & K.B blended with diesel

Fig. 6.5 Brake thermal efficiency is plotted against the load for 20%waste vegetable biodiesel blended with diesel and 20% of karanja biodiesel. BTE is some higher in case of waste vegetable biodiesel blends initially but if load the load is increased BTE decreases at same percentage of blend, As we see in the graph the maximum brake thermal efficiency is obtained in case of 30%(v/v) blend of K.B. 20%(v/v) KB and 20%(v/v) W.B.O.B shows similar trend of variation. In case of 50%(v/v) KB and & 70%(v/v) KB the least BTE is obtained.

VII. Conclusion and Future Scope:

- 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.
- The physical and chemical properties of all blends show that blends of up to 20%(v/v) straight karanja have value of viscosity and density equivalent to specified range for CI engine fuel, therefore it can be concluded that, up to 20%(v/v) blend can be used to run the stationary CI engine at short term basis. Further study of low volatility of karanja oil need to be investigated to know the effect on engine.
- The properties of blend may be further improved to make use of higher percentage of karanja oil in the blend by preheating the blend.
- Maximum pressure and heat release rate increases with increase in load. Maximum heat release rate is for diesel as compared to bio diesel and its blends. Mechanical efficiency increases with load but as compared to diesel the efficiency of bio diesel decreases with increase in content of bio diesel.
- Cetane number also plays an important role in reducing NOx emission. The component of unsaturated compound in bio diesel also has great impact on NOx emission. Larger the amount of unsaturated compound less will be the NOx emissions.
- Above results indicate that karanja oil can be used as a one of the alternate fuel for diesel engine, which is cheap, easily produced and etherified, easily blended with diesel in wide range of proportion, satisfactorily performance and low emission.

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