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PERFORMANCE ANALYSIS OF CI ENGINE USING PALM OIL METHYL ESTER

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ABSTRACT

Recent studies reveal that increasing fuel prices and scarcity of it's supply have promoted interest in development of alternative sources for petroleum fuels. Biodiesel is receiving increasing attention each passing day because fuel of properties and compatibility with petroleum based diesel fuel. Therefore in this paper the prospects and opportunities of using methyl ester of palm oil as fuel in an engine is studied. In the present research work tests were conducted on four stroke single cylinder DI diesel engine with diesel and various blends of biodiesel at various compositions. The results of performance and emission tests are compared with various blends of palm oil biodiesel with that of neat diesel. The results indicates that at blend B25 with preheating temperature 60^0C, break specific fuel consumption(BSFC) is lowest and highest exhaust gas temperature as compared to other blends. While neat diesel gives lowest stroke density.

Keywords: Palm oil, Methyl ester, Biodiesel, Properties of CI engine, BSFC.

I.INTRODUCTION

Energy is major need for the development of country and the increase in population needs more energy for both economic and social development. The major part of world transport and agriculture sector are depends on internal combustion engines especially diesel engine. Increase in the cost and depletion of fossil fuel and environmental pollution necessary to find alternative. An alternative fuel is expected to be easily available, cheap, clean and environmentally friendly. Some vegetable oil have good fuel properties and are also cheaper compared to diesel fuel the main advantage of these type of alternative fuel is being non-toxic, biodegradable and sulphur free. At present, more than 95% of world biodiesel is produced from vegetable oils like palm, soybean, and sunflower. The palm oil production is 45 million tones of palm oil produced per year in the world. Malaysia is one of the leading palm oil producers in the world.

The utility of straight vegetable oil as alternative fuel without engine modification creates poor atomization due to high viscosity leads to incomplete combustion and carbon deposits on engine part such as piston rings, cylinder walls etc. Many researchers research on palm oil biodiesel which provides exhaust emissions reduction in carbon dioxide (CO_2), unburned hydrocarbon (HC) and increase nitrogen. It is also observed that engine output power and mechanical efficiency were decreased and fuel consumption was increased by using biodiesel. Using biodiesel and it's blends (B25, B50, B75, B100) leads to lower fuel consumption, CO, CO_2 and HC emission compared with diesel fuel. To increasing the palm biodiesel-diesel blends leads to specific fuel consumption and NO_x emission increases and CO and HC emission decreases.

Nomenclature:

D100	100% Diesel
B25	25% palm oil + 75% Diesel
B50	50% palm oil + 50% Diesel
B75	75% palm oil + 25% Diesel
B100	100% palm oil
HC	Hydrocarbon
CO	Carbon Monoxide
CO_2	Carbon Dioxide
NO_X	Nitrogen Oxide

II.METHODOLOGY:

I. Transesterification

Oil or Fat + Methanol → Methyl ester + Glycerol

Methanol + KOH → Transesterification (60 to 65^oC, 1 hr) ← refined vegetable oil

↓

Methyl ester / Glycerol separation

↓

Methyl ester (biodiesel)

↓

Diesel engine

Biodiesel was prepared from palm oil using transesterification process. In this work, biodiesel was prepared with single stage transesterification process. The production of biodiesel was accomplished in the college laboratory using materials like palm oil, potassium hydroxide (KOH), methanol. To produce Bio diesel/fatty acid methyl esters (FAME) the regular methodical reaction called trans-esterification is implied always which signifies oil to be mixed with methanol and base-catalyst using a methanolysis reaction.

Set up of synthesis of Bio Diesel Separation of Bio Diesel

Steps for preparation

1. Mixture of potassium hydroxide (pallets) is measured to 3gms and added in 180ml of Methanol. The solution containing KOH and Methanol is stirred till all the pallets of potassium hydroxide get dissolved in Methanol.
2. Later the solution of Potassium Meth-oxide is blended with 900ml of Palm oil in a round bottom flask and heated indirectly using Magnetic stirrer with hot plate at a constant temperature of 65^{O}C (at constant rpm) for $1^{1/2}$ hrs. The reaction involving production of bio diesel is endothermic in nature and hence in order to reduce the temperature required for reaction, where in the catalyst used to reduce the temperature of reaction.
3. After the stipulated time, the mixture is cooled and poured in separating funnel and allowed for gravity separation process, during which glycerol content gets separated and is removed as it settles in the bottom of separating funnel.
4. Further demineralised water (in Proper Proportion) is poured with the crude biodiesel in separating funnel and mixed/stirred and allowed for phase separation process of glycerol and ester. The process is called washing biodiesel and is done so as to remove glycerol which might embedded with Palm oil Methyl Ester/Biodiesel.
5. Biodiesel ready to use into the CI engine.

III.FUEL PROPERTIES

The physical and thermal properties of raw, preheated palm oil and diesel fuel as per ASTM standards and results are presented in **Table- 1.**the flash point each blends higher than 65^{0}C, the blends are to be considered safer than diesel.

Properties	Regular Diesel	B25	B50	B75	B100
Density (kg/m^3)	830	824	839	851	871
Calorific value (MJ/kg)	42.4	41.45	40.93	39.71	38.9
Flash point (^{0}C)	75	96	109	114	133
Viscosity at 40^{0}C (cst)	1.3	2.1	3.1	3.3	5.7

IV.EXPERIMENTAL SETUP

The experimental process was carried out using a single cylinder, four stroke, air cooled, direct injection, constant compression ratio, diesel engine with a developing power of 5.77KW at 1500 rpm. The engine is tested for measure performance characteristics such as engine speed, torque, brake power, brake specific fuel consumption(BSFC), brake thermal efficiency(BTE) along with measuring the inlet and exhaust temperature, engine lubrication oil temperature, engine water inlet and outlet temperature using an engine data acquisition and control system.

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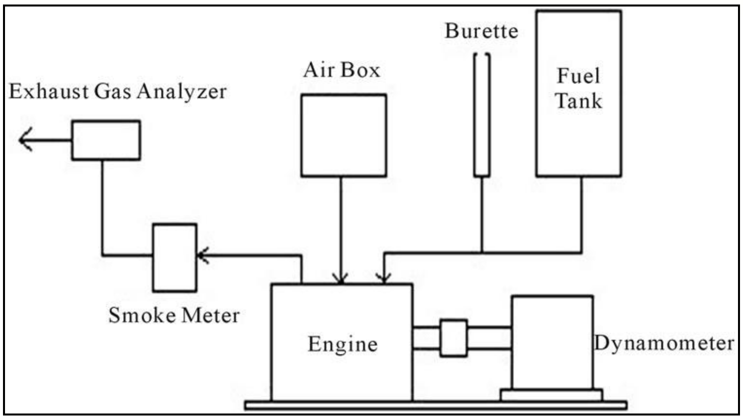


Figure1. Schematic engine diagram test setup

AC generator of maximum electric power output of 10.5 KW equipped with a load controller and other auxiliary items have been coupled directly test engine to determine the engine output brake power. Calibrated thermocouple probes were used for temperature measurement at different location in the experimental set up; including: intake air manifold and exhaust gas. The crankshaft rotational speed was measured using speed tachometer. The gas analyzer used for the measurement of various exhaust gas emission such as CO, HC and NO_x. The fuel flow meter were used for fuel flow measurement. The experiment was carried out by varying engine load from zero to full load by maintaining constant speed throughout experiment. All the equipments were calibrated in accordance to the respective manufactures specifications, prior to conduct in the test.

Engine Specification

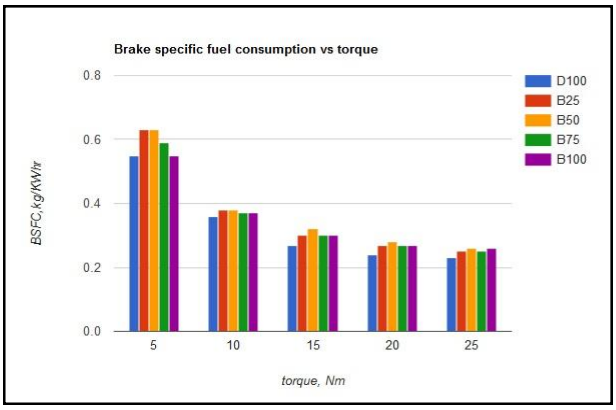
Model	Rocket Engine
Output power	4.2KW at 1500 rpm
Dynamometer	Eddy Current , 50KW at 1500rpm
Compression Ratio	17.5
Injection Pressure	220,240,260 Bar
Injection Timing	23,19,27 TDC
Injector Type	Jerk
No. of cylinder	1
No. of stroke	4
Type of cooling	Water
Bore	87.5mm

V.RESULTS

The experiment conducted consecutively with diesel and blends like B20, B25, B40, B50, B75, B100. Conducting performance test from zero to hundred percent with step of 25% load.

i. Brake specific fuel consumption

a. As shown in figure 2, BSFC is directly depends on the product of the amount of fuel injected and the calorific value of the fuel. BSFC decreases as the engine load increases irrespective of the blends and than increases slightly after 75% load applied.



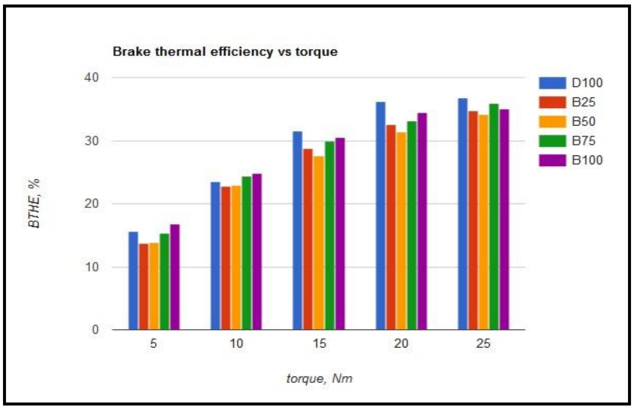


Figure 2 BSFC vs torque

Figure 3 BTHE vs torque

ii. Brake thermal efficiency

a. As shown in figure 3, the brake thermal efficiency increases with increasing load irrespective of the blend. At low load, the fuel contain higher concentration palm oil have lower brake thermal efficiency. This behavior can be accounted due to lower calorific values, high viscosity and low air-fuel mixing. At higher load leads higher temperature of the combustion zone, provides better evaporation and mixing of palm oil, results increasing brake thermal efficiency.

iii. Brake specific energy consumption:

As shown in figure 4, brake specific energy consumption is decreases with increasing the blending. Diesel consumption is less than other blendings after that B75 is less consuming while B50 has more consumption.

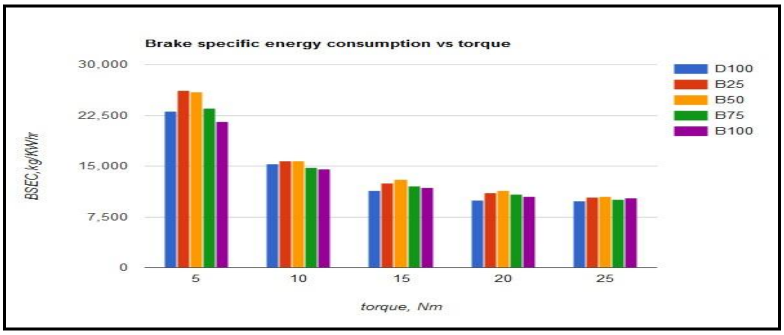


Figure 4

VI.CONCLUSION

The performance characteristics of a compression ignition engine fueled with petroleum diesel and with methyl ester palm biodiesel are studied. In comparison with the diesel fuel, the following conclusions can be observed about methyl ester palm biodiesel.

a. When methyl ester palm biodiesel fueled with diesel than the performance and the efficiency of the compression ignition engine drops in the engine.

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