EMISSION ANALYSIS OF CI ENGINE USING PALM OIL METHYL ESTER

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ABSTRACT

Recent studies reveal that increasing fuel prices and scarcity of its 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 B20 with preheating temperature 60^0C, break specific fuel consumption (BSEC) 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 tons 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 its blends (D100, B25, B50, B75, B100) leads to lower fuel consumption, CO, CO_2 and HC emission compare 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

I. METHODOLOGY

I. Transesterification

Oil or Fat + Methanol → Methyl ester + Glycerol

Methanol + KOH → Transesterification (60 to 65^{o}C, 1 hr) ← refined vegetable oil

↓

Methyl ester / Glycerol separation

↓

Methyl ester (biodiesel)

↓

Diesel engine

1. Mixing of alcohol and catalyst

Potassium hydroxide (KOH) and sodium hydroxide (NaOH) are generally used as alkaline catalyst with methanol (CH_3OH) for production of biodiesel.

2. Reaction

The alcohol / catalyst mix is charged into a closed reaction vessels and vegetable oil is added the reaction mixture is heated to the boiling temperature of the alcohol (Normally 60 to 65^{0}C).

3. Separation of glycerin and biodiesel

Once the reaction is complete, two major products are produced: glycerin and biodiesel. The quantity of produced glycerin varies according to the vegetable oil used, the process used and the amount of excess alcohol used. Both glycerin and biodiesel products have a substantial amount of the excess alcohol that is used in reaction.

4. Removal of alcohol

The fatty ester produced in the upper layer is neutralized and vaccum distilled for removal of excess methanol.

5. Glycerin neutralization

The by-product glycerin contains unused catalyst and soaps in the upper layer that are neutralized with phosphoric acid resulting in potassium phosphate, if potassium hydroxide is used as a catalyst. The crude glycerin is sent for storage.

6. Methyl ester washing

The methyl ester produced from the reaction is than washed with hot water and separated out by centrifugation.

II.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

Table-1 Properties of diesel and blend.

III.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.

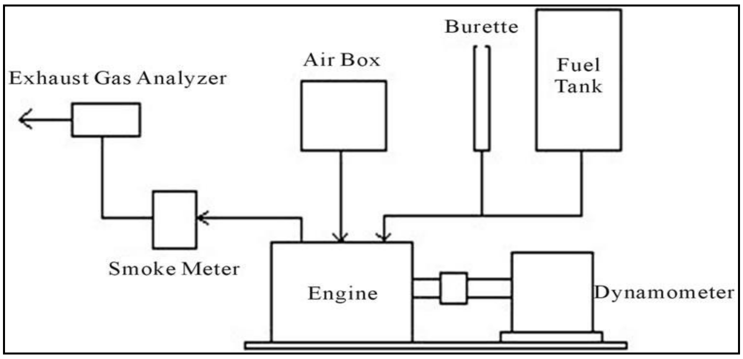

Figure1. Schematic engine diagram test setup

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 EngineSS
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

IV.RESULTS

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

i.CO emission

As shown in figure 2, decrease in CO emission for biodiesel blends was due to more oxygen molecules and lower carbon content in biodiesel blends as compared to that of diesel fuel which leads to better combustion.

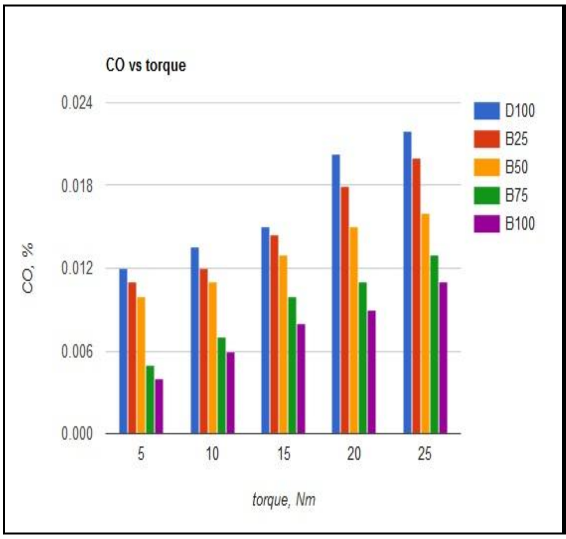

Figure 2. CO vs torque

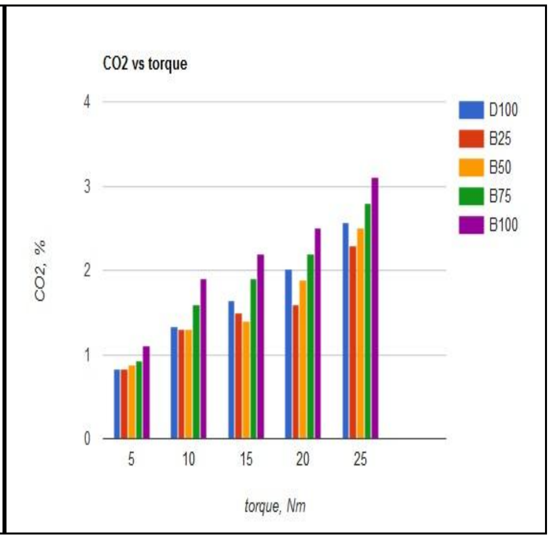

Figure 3. CO_2 vs torque

ii. CO_2 emission

As shown in figure 3, decrease in the CO_2 emission up to B50 then increases due to there are lesser molecules of hydrocarbon (HC) available in the biodiesel than the diesel fuel

iii. HC emission

As shown in figure 4, physical composition of palm bio fuel content less hydrogen carbon molecules than for a similar quantity of diesel fuel, due this reason decrease in HC emission with increases blends.

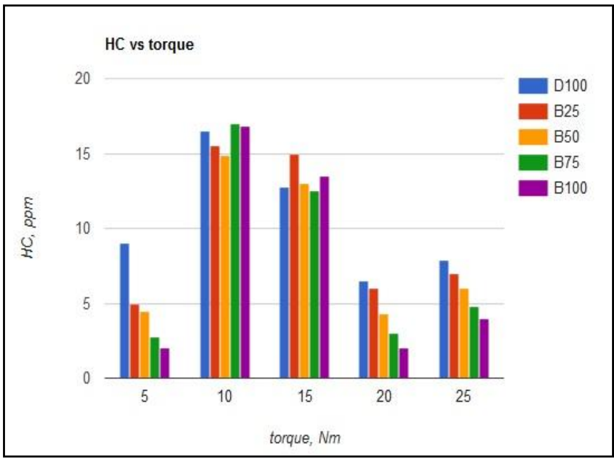

Figure 4. HC vs torque

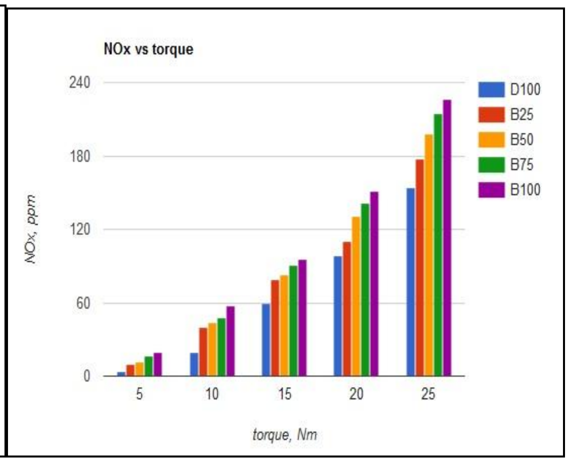

Figure 5. NO_X vs torque

iv. NOx emission

As shown in figure 5, NO_x emission increased with the increase in percentage of biodiesel blends, due to increase in amount of fuel burn and cylinder temperature which is responsible for thermal NO_x formation.

V.CONCLUSION

The performance and emission 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.
b. The emissions of hydrocarbon (HC), carbon monoxide (CO) decreases and carbon dioxide (CO_2) are increases with using methyl ester palm biodiesel.
c. The NO_x emission increases with methyl ester palm biodiesel.

For considering the emission aspects, switching from fossil fuel to renewable fuel will contribute greatly to the reduction of HC, CO and CO_2 reduction. Hence prevent environmental pollution.

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