Experimental Investigation on the Performance and Emission Characteristics of Kenaf Biodiesel and Its Blends on Single Cylinder Diesel Engine

V. Achuthan, M. Chinnapandian

***Abstract*: The sources of petroleum fossil fuel will decay in the next few decades and it becomes very costly to produce power from fossil fuel thereafter (K. Arumugam et al 2013). In the present experimental investigation the performance and emission characteristics of the diesel fuel, kenaf biodiesel blended with petroleum diesel in the proportions B25 (25% kenaf biodiesel and 75% diesel) and B50 (50% kenaf biodiesel and 50% diesel), B75 (75% kenaf biodiesel and 25% diesel) and B100 (neat kenaf biodiesel) were determined.**

***Index Terms*: Kenaf, Biodiesel ,fossil fuels**

I. INTRODUCTION

The rapid depletion of petroleum reserves and the great uncertainty in the supply of petroleum fuels due to political and economical factors and the sharp escalations in the petroleum fuel prices have stimulated the search for suitable alternatives to petroleum fossil fuels (A.V. Krishna Reddy et al 2010). Besides the economy and development, on the other hand the petroleum fossil fuels fossil fuel leads to environmental associated problems like global warming and sudden climatic change. The global warming is mainly due to the emission of harmful gases like carbon monoxide (CO), oxides of nitrogen (NOX), and carbon dioxide (CO2) (N. Panigrahi et al November-December, 2012).

II. LITERATURE SURVEY

The increase in the industrialization and motorization of the world has led to step rise for the demand of petroleum based fossil fuels, since the Petroleum based fuels are obtained from the limited reserves (S.Tiwari et al March 2013). In recent days the automobile engine has to satisfy the strict environmental constraints and the standards of fuel economy to meet the competitiveness of the global market. The Indonesia government started its effort of biodiesel development since over ten years ago.

Since from May 20th 2006, Indonesia has formally started selling a B5 blend of biodiesel, with the trade name of BIOSOLAR, at a price equal to the subsidized automotive diesel oil. Even the higher price of biodiesel can be accepted if its characteristics are superior to the petroleum diesel (Soni S et al April 2008). Biodiesels is the ester based variety oxygenated fuels that can be easily derived from the natural renewable biological sources such as vegetable oils. The utilization of biodiesel helps in saving the crores of money that is being spent annually on importing petroleum fuels from other countries (Sunil I et al April 2013). In general the biodiesel contains no petroleum, but they can be blended at any desired level with petroleum diesel to produce a biodiesel blend. The availability and the cost of oil feedstock is the major problem associated in the production of biodiesel which is accounting over 70% of the total cost (Parekh.P.R March 2012). The test was carried out with neem oil methyl ester (NOME) blended with petroleum diesel in varying proportions (B20, B30) and diesel at varying load conditions from 0%, 25%, 50%, 75% to full load condition revealed that the blend B20 gives better performance, emission and combustion characteristics as compared to B30 and diesel (Gopinath et al). The investigation on roselle biodiesel showed that the blend B10 has better performance than other blends B20, B30 and B40. The blend B10 has the least brake specific fuel consumption, brake specific energy consumption, high brake power and brake thermal efficiency (Abhishek sahu et al September 2017). The research investigation of tamanu oil as a fuel in the diesel test engine showed that the specific fuel consumption of esterified tamanu oil decreases with the increase in the compression ratio of engine as 18. It is observed that the brake thermal efficiency of the esterified tamanu oil for the compression ratio of 18 is 30.4% at maximum load. The emission of exhaust gas and its temperature is found to be less when the compression ratio is varied from 14 to 18. The experimental investigation on a diesel engine using pongamia methyl ester (PME) under varying injection pressures revealed that the brake thermal efficiency is increased about 1.5% for 100% pongamia methyl ester at an injection pressure of 220 bar with decrease in brake specific fuel consumption, carbon monoxide (CO) emission and smoke when compared with 100% PME at 180 bar injection pressure. The results revealed that the brake thermal efficiency was found higher for the preheated cotton oil methyl ester (COME) due to improved combustion compared to diesel fuel and the brake specific fuel consumption

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for preheated cotton oil methyl ester (COME) is found to be 7.8% higher than the diesel (Shyam Kumar Ranganathan et al. 2012). In the experimental study of mustard oil methyl ester-diesel fuel blends as fuel in the diesel engine, the results also suggested that the lower and medium percentages of mustard oil methyl ester can be used as fuel to run a diesel engine without any modification (R. Sarala April 2012).

III. SEED PROCESSING

The seeds of kenaf are collected from the local market. The collected seeds are winnowed and washed with water to remove the presence of impurities in it and shade dried for a period of five days. The oil is then recovered from the seeds by means of mechanical extraction process. The seed of kenaf has an oil content of 26%. The kenaf oil is found to be yellowish brown and highly viscous.

IV. TRANSESTERIFICATION

Transesterification is the conventional and simplest chemical process employed to improve the quality of oil derived from vegetable sources or from seed sources. In this experimental investigation, during the process of transesterification 1 mole of oil is made to react with 6 mole of alcohol (methanol) in presence of a catalyst (NaOH) to form kenaf oil methyl ester. The process of transesterification is carried in a batch reactor at a reaction temperature of 550C. The result of transesterification is two distinct layers comprising kenaf oil methyl ester at the top and glycerol at the bottom. The glycerol is separated from the kenaf biodiesel by means of gravity separation method. The kenaf biodiesel thus produced is washed well with distilled water and heated slightly above the boiling point of water to remove the water particles present in it.

V. EXPERIMENTAL METHODOLOGY

The experimental investigation is carried in a single cylinder, water cooled diesel engine equipped with eddy current dynamometer to vary the load, data acquisition system to measure the performance and combustion parameters, exhaust gas analyzer to measure the exhaust emissions and smoke meter to measure the smoke density. Initially the engine is fuelled with neat diesel and the performance and emission parameters are noted down. Then under the same operating condition the engine is fuelled with the neat kenaf biodiesel and its blends B25, B50 and B75 respectively. The readings of neat diesel, the blends of kenaf biodiesel ad neat kenaf biodiesel are tabulated and compared.

VI. RESULT AND DISCUSSION

A. Fuel Consumption

The fuel consumption of diesel, kenaf biodiesel and its blends are shown in the figure 1.

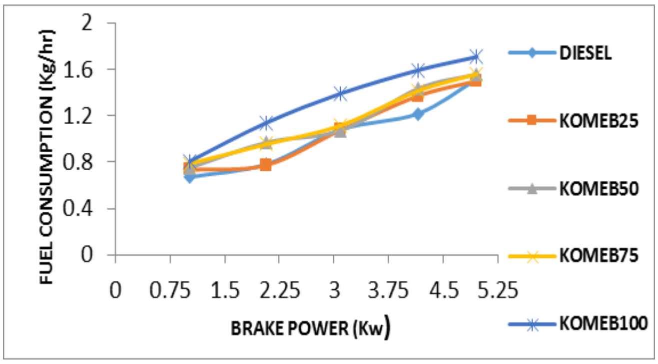

Fig. 1 Fuel consumption of diesel, kenaf biodiesel and its blends

The fuel consumption is found minimum for diesel at 20% load condition and maximum for the blend B100 at full load condition. The fuel consumption of the blends of kenaf oil methyl ester is found gradually increasing with increase in load. At all the load condition the fuel consumption is found maximum for the blend B100 and found minimum for diesel.

B. Specific Fuel Consumption

The specific fuel consumption of diesel, kenaf biodiesel and its blends are shown in the figure 2.

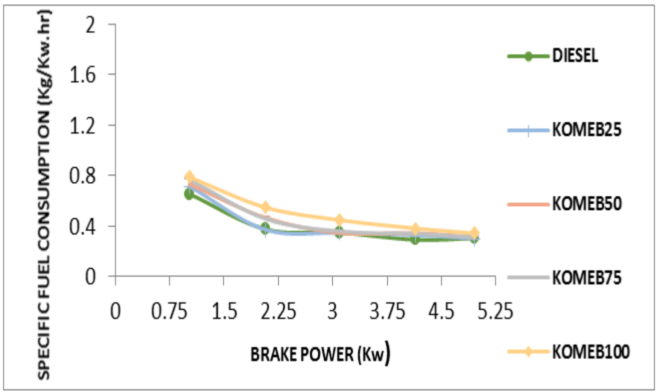

Fig. 2 Specific fuel consumption of diesel, kenaf biodiesel and its blends

The specific fuel consumption is found maximum for the blend B100 at all load condition. At 20% and 60% load condition the value of specific fuel consumption increases gradually with the rate of blending. The specific fuel consumption of the B25 is found minimum at 40% and full load condition. The specific fuel consumption of the blend B100 is found relatively high at all the respective loads.

C. Brake Thermal Efficiency

The brake thermal efficiency of diesel, kenaf biodiesel and its blends are shown in the figure 3.

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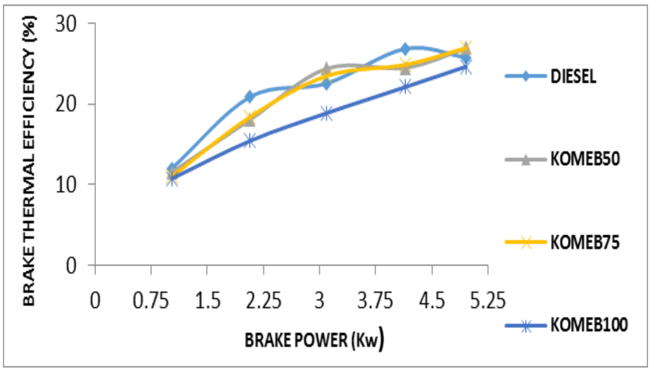

Fig. 3 Brake thermal efficiency of diesel, kenaf biodiesel and its blends

The brake thermal efficiency is found maximum for the blend B25 at 40%, 60% and full load condition when compared with diesel and diesel blends. The brake thermal efficiency is found increasing with increase in load. At 20% load condition the brake thermal efficiency is found maximum for diesel and minimum for the blend B100. At 40% load condition the brake thermal efficiency is found maximum for the blend B25 and minimum for the blend B100. At 60% load condition the brake thermal efficiency is found maximum for the blend B25 and minimum for the blend B100. At 80% load condition the brake thermal efficiency is found maximum for diesel and minimum for the blend B100. At 100% load condition the brake thermal efficiency is found maximum for the blend B25 and minimum for the blend B100

D. Exhaust Gas Temperature

The exhaust gas temperature of diesel, kenaf biodiesel and its blends are shown in the figure 4.

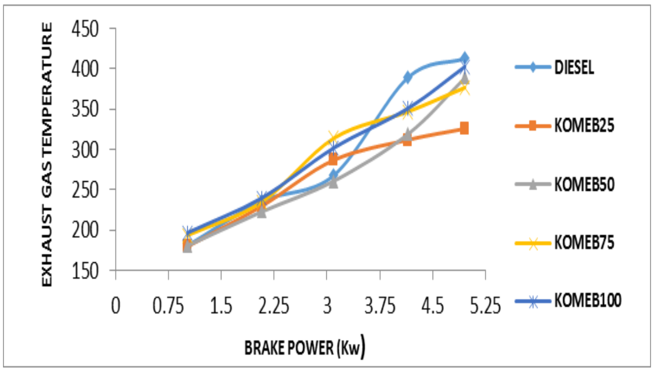

Fig. 4 Exhaust gas temperature of diesel, kenaf biodiesel and its blends

The exhaust gas temperature is found maximum for the blend B100 at 20% and 40% load condition and for diesel at 80% and full load condition. The exhaust gas temperature is found to get increase with increase in load. The exhaust gas temperature of the blend B25 is found to be satisfactory at all the load condition except 60%loadcondition.

E. Smoke Density

The smoke density of diesel, kenaf biodiesel and its blends are shown in the figure 5.

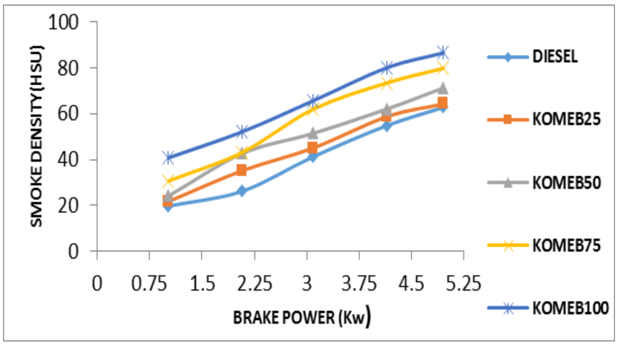

Fig. 4 Smoke density of diesel, kenaf biodiesel and its blends

The smoke density is found minimum for diesel at all the load condition. At all the load conditions the smoke density increases with increase in the blending ratio. The smoke density is found lower at low loads and higher at high load conditions. At all the load conditions the smoke density of diesel is found minimum and the smoke density of the blend B100 is found maximum. Other than diesel the blend B25 resulted in less smoke density when compared with the other blends.

F. Emission of Carbon Monoxide (Co)

The smoke density of diesel, kenaf biodiesel and its blends are shown in the figure 6.

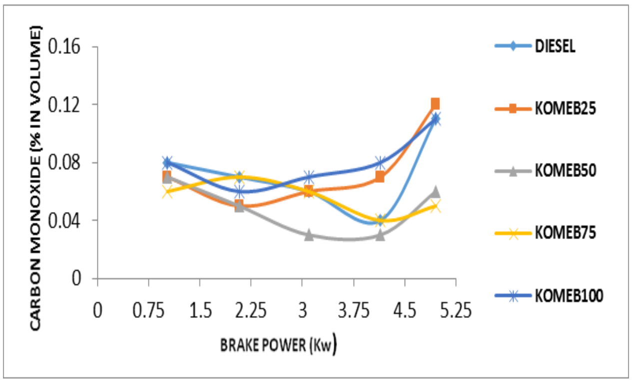

Fig. 6 Carbon monoxide emission of diesel, kenaf biodiesel and its blends

The emission of carbon monoxide is found maximum for the blend B100 at all the load condition and minimum for the blends B50 at 80% load condition and B75 at full load condition. At full load condition except the blend B25, all other blends and diesel produced high rate of carbon monoxide emission. Except at 60% load condition the blends B25 and B75 resulted in similar carbon monoxide emission and the blend B100 recorded less emission of carbon monoxide. The blend B25 produced satisfactory performance in the emission of carbon monoxide when compared with the other blends at 20% load condition.

G. Emission of Hydrocarbon (Hc)

The smoke density of diesel, kenaf biodiesel and its blends are shown in the figure 7.

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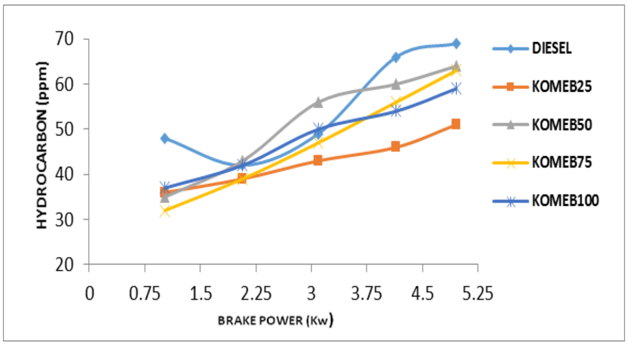

Fig. 7 Carbon monoxide emission of diesel, kenaf biodiesel and its blends

The emission of hydrocarbon is found maximum for diesel at 20%, 80% and at full load condition and found minimum for the blend B250 at 60%, 80% and at full load condition. The emission of hydrocarbon is found less at low load condition and high at higher loads. The blends of kenaf oil methyl ester resulted in satisfactory hydrocarbon emission except at 40% and 60% load conditions. At 20% load condition the hydrocarbon emission of diesel is found maximum and the hydrocarbon emission of the blend B75 is found minimum. At 40% and 60% load condition the hydrocarbon emission of the blend B50 is found maximum and the hydrocarbon emission of the blend B25 is found minimum. At 80% and 100% load condition the hydrocarbon emission of the diesel is found maximum and the hydrocarbon emission of the blend B25 is found minimum

H. Emission of Nitrous Oxide (No_x)

The Nitrous oxide of diesel, kenaf biodiesel and its blends are shown in the figure 8.

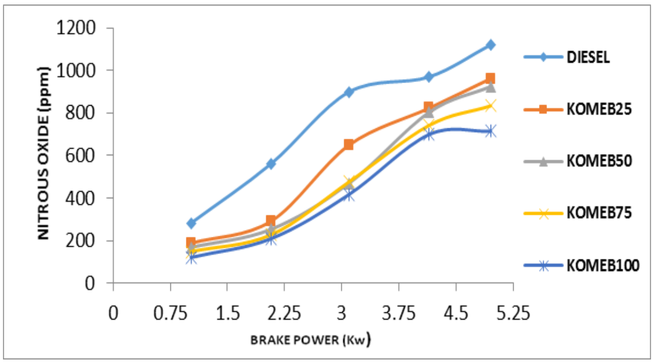

Fig. 8 Nitrous oxide emission of diesel, kenaf biodiesel and its blends

The emission of nitrous oxide is found maximum for diesel at full load condition and minimum for the blend B100 at all the load condition. The emission of nitrous oxide is found increasing with increase in load for diesel and the blends of kenaf oil methyl ester due to higher operating temperature. The emission of nitrous oxide starts decreasing for higher biodiesel blends at all load conditions. The blend B100 is found to provide satisfactory emission of nitrous oxide when compared with diesel and other blends of kenaf oil methyl ester. At all load conditions the nitrous oxide emission of diesel is found maximum and the nitrous oxide emission of the blend B100 is found minimum.

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