Engine Performance Characteristics Of Biodesiel From Oils Of Sandbox Seed And Moring As Feedstock

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Nomenclature

BSFC = Brake specific fuel consumption **ET =** Engine torque
BTE = Brake thermal efficiency**DF=** diesel fuel
BP = Brake power
BS = Biodiesel of sandbox **BM =** Biodiesel of moringa
BSM_{20} DF_{80} = 20% Biodiesel of (sandbox + moringa) + 80% diesel fuel
BSM_{25} DF_{75} = 25% Biodiesel of (sandbox + moringa) + 75% diesel fuel
BSM_{30} DF_{70} = 30% Biodiesel of (sandbox + moringa) + 70% diesel fuel
BSM_{35} DF_{65} = 35% Biodiesel of (sandbox + moringa) + 65% diesel fuel
BSM_{40} DF_{60} = 40% Biodiesel of (sandbox + moringa) + 60% diesel fuel
BS_{20} DF_{80} = 20% Biodiesel of sandbox+ 80% diesel fuel
BS_{25} DF_{75} = 25% Biodiesel of sandbox + 75% diesel fuel
BS_{30} DF_{70} = 30% Biodiesel of sandbox + 70% diesel fuel
BS_{35} DF_{65} = 35% Biodiesel of sandbox + 65% diesel fuel
BS_{40} DF_{60} = 40% Biodiesel of sandbox + 60% diesel fuel
BM_{20} DF_{80} = 20% Biodiesel of moringa + 80% diesel fuel
BM_{25} DF_{75} = 25% Biodiesel of moringa + 75% diesel fuel
BM_{30} DF_{70} = 30% Biodiesel of moringa + 70% diesel fuel
BM_{35} DF_{65} = 35% Biodiesel of moringa + 65% diesel fuel
BM_{40} DF_{60} = 40% Biodiesel of moringa + 60% diesel fuel

***Abstract*—Biodiesel is an alternative fuel produced from different kinds of vegetable oils and animal fats. It is an oxygenated, non-toxic, low in sulfur, biodegradable and renewable fuel that can be used in diesel engines without significant modifications. Performance and exhaust emissions of diesel engine have been experimentally investigated with sandbox and moringa biodiesel and their blends (B20, B25, B30, B35 and B40) with diesel fuel. Engine performance parameters namely engine torque, brake power, brake specific fuel consumption and brake thermal efficiency were determined at various engine speed of 1500-2700 rpm. Result indicates that there is a slight decrease in brake power (BP) and engine torque (ET), brake specific fuel consumption (BSFC) for all the blend fuels when compared to diesel fuel. On the whole, biodiesel of sandbox, moringa and its blends with diesel fuel can be used as an alternative fuel for diesel in direct injection diesel engines without any significant engine modification.**

Keywords: brake power, brake specific fuel consumption, engine torque, brake thermal efficiency, diesel fuel

1.INTRODUCTION

Biodiesel is a natural and renewable source. It is a clean burning diesel replacement fuel made of renewable sources such as new and used vegetable oil and animal fats. The attention of using unconventional and renewable fuels in diesel engines has been amplified lately due to a rapid decrease in world petroleum reserves, increase in the prices of the conventional petroleum fuels and limitations on exhaust emissions [1]. Currently many countries are substituting their conventional energy sources with renewable and sustainable ones. Physical characteristics of biodiesel are very similar to those of conventional diesel fuel. Biodiesel is produced from abundant oil seed crops (edible and non-edible) namely rapeseed oil, cotton seed oil, jatropha seed oil, rice bran oil, soybean oil, palm oil etc., and animal fats like beef tallow, waste lard, animal tallow, yellow grease etc. [2-3]. Waste cooking oils and animal fats are eye-catching feed stocks for biodiesel production because they are economical than refined vegetable oils and are available in large quantities to fulfil the market demand for biodiesel production [4].

The advantages of using biodiesel compared to die sel fuel include reduced exhaust emissions, improved biodegradability, reduced toxicity and improved lubricity, higher flash point, and lower vapour pressure [5-6].

Therefore, this study is aimed at Engine performance characteristics of biodiesel from oils of sandbox and moringa as feedstock.

2. MATERIALS AND METHODS

100kg of the Sandbox fruit was purchased from Wukari in Taraba state, 100kg of Moringa pod was purchased from Wurukum market in Benue State while AGO was purchased at Bayero University Kano, Kano State.

The fuels used in this study include diesel fuel, biodiesel and biodiesel blends. The experiments were carried out by using neat diesel fuel as the base line fuel(denoted as DF), 20% biodiesel + 80% diesel fuel (denoted as B20), 25% biodiesel + 75% diesel fuel(denoted as B25), 30% biodiesel + 70% diesel fuel (denoted as B30), 35% biodiesel + 65% diesel fuel(denoted as B35) and 40% biodiesel + 60% diesel fuel(denoted as B40) at different engine speed from 1500 rpm to 2700 rpm rated engine speed in approximate steps of 200 rpm. Two fuel tanks are used for storing diesel fuel and biodiesel separately with a burette and three way stop cock. The fuel is changed from diesel fuel to biodiesel by operating individual valves provided in each fuel tank and a three way stop cock. Before running the engine to a new fuel, it was allowed to run for sufficient time to consume the remaining part of fuel from the previous experiment. The engine was started initially with diesel fuel and warmed up to obtain its base parameters. Then, the same tests were performed with biodiesel and its blends. For each test fuel and in each speed approximately three times readings were taken to get an average value. When the engine reaches the stabilized working condition, parameters like fuel consumption and speed were measured. The fuel consumption was measured with a burette and a stopwatch. The performance and emission parameters of diesel fuel (DF) and its blends (B20, B25, B30, B35 and B40) were determined in comparison with baseline. Performance parameters namely, engine torque (ET), brake power (BP), brake specific fuel consumption (BSFC) and brake thermal efficiency (BTE) were determined and excel software was used to solve the mathematical equation. To ensure the accuracy of measured value to be high, the gas analyzers were calibrated with standard gases and zero gas before each test. The following components are mounted on the control panel; Torque Controller cum indicator: The loading of dynamometer is controlled by digital torque indicator cum controller, Engine Speed Indicator: The Engine speed is measured by magnetic pickup. The output of sensor is given to the RPM indicator mounted on panel

3. RESULTS AND DISCUSSION

3.1Engine performance

3.1.1Torque

The effects of sandbox, moringa biodiesel and blends on the engine torque with respect to the engine speed are shown in Fig. 1.

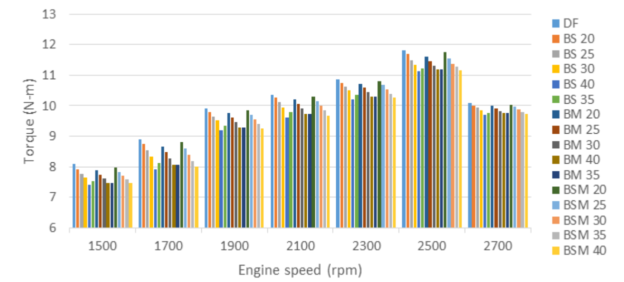

Figure 1: Variations of engine speed on engine torque

Considering torque performance with all the blend fuels tested, it can be said that the trend of these parameters as a function of speed is almost similar to DF.

Torque initially increases with increasing of engine speed until it reaches a maximum speed of 2500rpm and then decreases with further increasing engine speed. There are two main factors due to which the torques of the engine decreased.

The first one is considered to be the lowered volumetric efficiency of the engine due to the increase in the corresponding engine speed.

The second one is thought to be the augmentations in the mechanical losses [7].

The maximum torque values were observed at 2500 rpm of engine, for all test fuel samples. However, the torque of the engine fuelled with DF is higher than that of blend fuels.

The reason for the reduction of torque with blends can be attributed to the lower heating value of the fuel. The average torque reduction compared to DF is found as 2.20%, 2.83%, 1.41% for 1500 rpm, 1.05%,1.53%,0.66% for 2100 rpm, 0.70%, 0.91%, 0.54%, for 2700 rpm for BS 20, BM 20 and BSM 20.

3.1.2Brake power (BP)

Figure 2 below shows the engine brake power for diesel fuel (DF), biodiesel of sandbox (BS), biodiesel of moringa (BM) and blends of biodiesel of sandbox and moringa (BSM) at different engine speeds. The peak BP for diesel fuel (DF), biodiesel of sandbox (BS), biodiesel of moringa (BM), and blend of biodiesel of sandbox and moringa (BSM) were 30.930, 30.600, 30.399 and 30.799 kW for DF, BS20, BM20 and BSM20, 30.930, 30.100, 30.001, 30.200 KW for DF, BS25, BM25 and BSM25, 30.930, 29.700, 29.569, 29.799 KW for DF, BS30, BM30 at the engine speed 2500 rpm. BS20, BM20 and BSM20 reduced by 1.07%, 1.72% and 0.42%, BS25, BM25 and BSM25 reduced by 2.68%, 3.00% and 2.36%, BS30, BM30 and BSM30 reduced by 3.98%, 4.40% and 3.66% compared to diesel fuel at engine speed of 2500 rpm when compared to DF.

The blend of biodiesel of sandbox and moringa (BSM) performed best while of sandbox (BS) performed better than biodiesel of moringa (BM) in terms of brake power (BP), an increase in biodiesel leads to a decrease in brake power. When the speed of diesel engine increase, BP also increase up to 2500 rpm and after that BP reduce, these is in agreement as reported by [8-11]

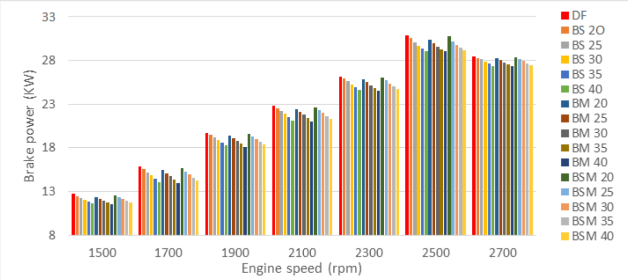

Figure 2: Variations of engine speed on brake power

3.1.3Brake specific fuel consumption (BSFC)

Brake specific fuel consumption (BSFC) with respect to engine speed for diesel fuel, biodiesel and biodiesel blend is shown in Figure 3 below. For all the test fuels, the brake specific fuel consumption decreases with an increase in engine speed which is in agreement with most of researches [12-14]. Among the fuels tested the lowest BSFC values are obtained with diesel fuel due to low fuel consumption rate and high brake power. The brake specific fuel consumption in general, was found to increase with increasing proportion of biodiesel in the test fuels under all conditions. This is due to lower calorific value, higher viscosity and density of biodiesel in comparison with diesel fuel. As the density of biodiesel was higher than that of diesel fuel, which means the same fuel consumption on volume basis resulted in higher specific fuel consumption in case of biodiesel. For all the test fuels, the specific fuel consumption values are higher at low engine speed and decreases to minimum values when engine speed increases because of the lower calorific value of biodiesel.

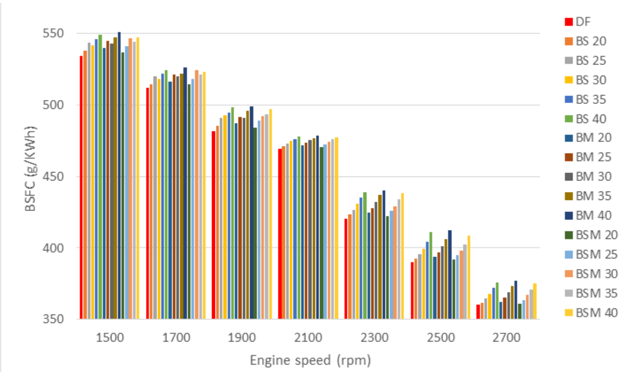

Figure 3: Variations of engine speed on brake specific fuel consumption

3.1.4Brake thermal efficiency **(BTE)**

Figure 4 below, show that brake thermal efficiency in general, decreases with increasing proportion of biodiesel in the test fuels. The brake thermal efficiency for diesel fuel (DF), biodiesel of sandbox (BS), biodiesel of moringa (BM), and blends of biodiesel of sandbox and moringa (BSM).

At engine speed of 1500, 2100 and 2700 rpm were 8.612%, 8.340%, 8.244%, 8.542% for 1500 rpm, 9.803%, 9.521%, 9.425%, 9.735% for 2100 rpm, 12.778%, 12.396%, 12.270%, and 12.688% for 2700 rpm at DF, BS20, BM20 and BSM20. BTE reduced by 0.272%, 0.368%, 0.070% for 1500 rpm, BTE reduced 0.28%, 0.37% 0.090% for 2100 rpm, BTE reduced 0.382%, 0.508%, 0.090%, for 2700 rpm. The higher viscosity leads to decreased atomization, fuel vaporization and combustion and hence the thermal efficiency of biodiesel is lower than that of diesel fuel which is in agreement with most researcher [15-17]

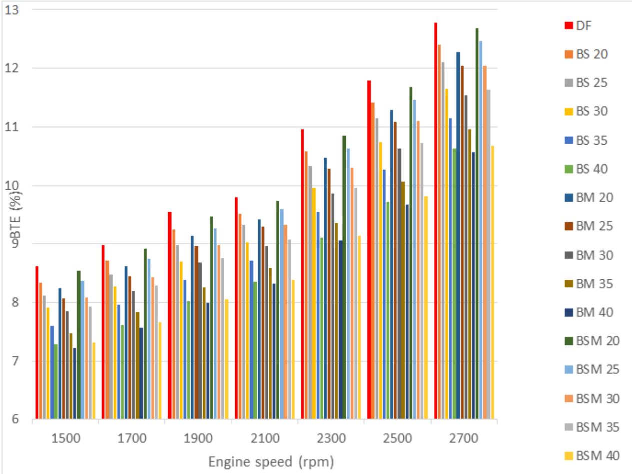

Figure 4: Variations of engine speed on brake thermal efficiency

4. Conclusions

An alternative to conventional fuel, biodiesel produced from renewable and domestic sources, emerged as a sustainable source of energy and will therefore show an increasingly significant role in providing the energy requirements for transportation and other domestic use. Therefore, more researches are focused on the biodiesel engine performances in the past decades. Although there have been inconsistent trends for biodiesel engine performances due to the different tested engines, the different used biodiesel or reference diesel, the different operating conditions or driving cycles, the different measurement techniques or instruments etc. This work presents the result of engine performance characteristics of biodiesel from oils of sandbox seed and moringa as feedstock.

Torque initially increases with increasing of engine speed until it reaches a maximum speed and then decreases with further increasing engine speed. There are two main factors due to which the torques of the engine decreased.

Brake power (BP) increase in biodiesel leads to a slight decrease in brake power. When the speed of diesel engine increase, BP also increase and after that BP reduce.

The brake specific fuel consumption in general, was found to increase with increasing proportion of biodiesel in the test fuels under all conditions. This is due to lower calorific value, higher viscosity and density of biodiesel in comparison with diesel fuel. As the density of biodiesel was higher than that of diesel fuel, which means the same fuel consumption on volume basis resulted in higher specific fuel consumption in case of biodiesel.

The BTE of blended fuel is very close to diesel fuel. Thus the difference in BTE between diesel fuel and blend is very significant at maximum engine speed. Fuel consumption increases due to higher density and lower heating value consequently, brake thermal efficiency decreases.

Overall, biodiesel, especially for the blends with a small portion of conventional fuel, is technically feasible as an alternative fuel in internal combustion engines with no or minor modifications of engine. For ecological and economic reasons, their popularity may soon grow.

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