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Emission Characterization of Diesel Engine Run on Coconut Oil Biodiesel its Blends and Diesel

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ABSTRACT: The use of biodiesel in running diesel has been called for, with a view to mitigating the environmental pollution, depletion, cost and scarcity associated with the use diesel in running diesel engine. So the need to characterize the emissions from these biodiesel, cannot be overemphasized, hence this paper presents the evaluation of the emissions of particulate matter (PM), carbon monoxide(CO), hydrocarbon(HC) and oxides of nitrogen(NO_X) from diesel engine run on coconut oil biodiesel, its blends and diesel for comparison. The result of the evaluation showed that NO_X emission increased with increase in percentage of the biodiesel in the blend, while PM, CO, HC decreased with increase in the percentage biodiesel in the blend. In comparison with diesel, diesel has the least emission of NO_X and the highest emission of PM, CO and HC. © JASEM

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KEYWORDS: Diesel engine, diesel, coconut oil biodiesel, blends, emissions

Introduction

It is quite common nowadays to learn that every country is in the race to find suitable and affordable alternative fuel options for diesel engine (Savariraj et al, 2013). The quest for finding alternative fuel options for diesel engine stemmed from the depletion, dwindling price and the environmental pollution associated with the use of diesel. Kantharaju et al(2015) opined that the air we breathe is proven to be unhealthy, the various emission from the automobile exhaust like CO, HC, NO_X, particulate matters, soot etc., are highly harmful for human health and apart from that, animals and plants are also facing a negative impact by emission caused by automobiles. Automobile exhaust emission has also actively participated in increasing global warming. According to Gopal and Karupparaj (2015), finding suitable sustainable fuel alternatives has become a high priority for many countries. Chiatti et al (2014) asserted that increasing attention has been devoted to the use of biodiesel fuel in internal combustion diesel engine due to its positive attributes as compared to the other types of fuel: e.g., being a renewable source, non-petroleum-based, with lower carbon monoxide, hydrocarbon, and particulate matter emissions. Xue et al(2011) remarked that the use of biodiesel leads to the substantial reduction in PM, HC and CO emissions accompanying with the imperceptible power loss, the increase in fuel consumption and the increase in NOx emission on conventional diesel engines with no or fewer modification. Maharana and Chnadra(2015), however stated that biodiesel can be used in the existing engine without any modifications. Bio-diesel, by the name, is a clean burning alternative fuel for diesel which is distilled from renewable sources such as vegetable oils, animal fats and waste bio products. It is considered to be more environmental friendly compared to existing fossil fuels which is a limited resource (Manorathna and Nanayakkara, 2011). There are numerous types of bio-diesel available today that come from various sources. Some common oils that are used for fuel as biodiesel are olive kernel oil, corn oil, sunflower oil, soybean oil, cottonseed oil, palm oil, rapeseed oil, and their methyl ester derivatives (Rakapolous, et al., 2006} cited by Brendan(2010). Biodiesel has become an interesting alternative to be used in diesel engine which is due to the similar properties to the conventional fossil diesel fuel in terms of power and torque and none or very minor of engine modification is required (Belaid et al, 2011) cited by Islam et al, (2014). Moreover, the biodiesel has a few special features which are biodegradability and being much more environmentally friendly compared to the conventional fossil diesel (Janaun and Ellis, 2010). A lot of work has been done partly or wholly by many researchers on emissions and performance of diesel engine running on biodiesel from edible and non-edible plants and its blends. Musa et al (2016) remarked that coconut oil and biodiesel produced from it have been characterized and from the results obtained and discussed, it became very evident that

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coconut oil is a good feedstock for biodiesel production and the biodiesel can be used in convectional diesel engine without modification because of close fuel properties.

The aim of the study is to characterize the emissions from diesel engine run on coconut oil biodiesel and its blend in comparison with diesel.

MATERIALS AND METHODS

The fuel materials used for this study include diesel fuel, biodiesel produced from coconut oil by Teran and Saraki(2015), whose fuel properties have been determined by Musa et al, (2016) and the blends of the biodiesel. The test rig used for this study includes GD411 diesel Honda 9.0 an air cooled, 4-cycles, single cylinder and 9 horse power engine manufactured by Honda Motor Company, Japan, coupled to dynamometer, equipped with sensors, data acquisition and digital display systems. A total gas analyzer (Motorscan 8050) made in Italy which can measure the concentration of the emission of carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxides (NOx) was employed.

Experimental Procedure: According to Dharmadhikari et al, 2012, the blend of biodiesel and diesel has density close to that of mineral diesel and the biodiesel can be directly mixed with diesel fuel. So , Blends of coconut oil biodiesel and diesel fuel were produced in the ratio of 10:90, 20:80, 30:70, 40:60 and 50:50 by volume, denoted by B10, B20, B30, B40 and B50 respectively. The engine was made to run for 30 minutes in line with the work of Savariraj et al(2013) wisth 100% diesel fuel denoted by B0 as base fuel or reference fuel at constant speed of 1000 rpm which was measured by digital Tachometer. The engine load was applied by employing dynamometer that was coupled to it. The fuel consumption rate was measured using a glass burette and stopwatch. A total gas analyzer (Motorscan 8050) made in Italy was used to measure the concentration of the emission of carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxides (NOx) from the engine through the exhaust as shown in plate I. The particulate matter (PM) was measured by adopting Akeredolu and Oyawale (2000), method where a re-weighed 2μm cellulose filter paper was held in place by a filter holder to trap the particulate matter. After completing the experiment with 100% diesel denoted by B0, the engine was allowed to run with 100% biodiesel denoted by B100 and biodiesel blends that is B10, B20, B30, B40, and B50 respectively. Each test was repeated five times and the arithmetic means of the readings or observations were taken as the results and depicted in Table 1.

Plate I: Engine exhaust gas measurement (Motorscan 8050 gas analyzer).

RESULTS AND DISCUSSION

Experimental results obtained from the diesel engine when it was run on diesel, the coconut oil biodiesel and its blends are shown in Table 1.

Table 1: Emissions from the diesel engine run on diesel, coconut oil biodiesel and its blends and the fuel consumption rate.

Fuel	PM%	CO%	HC%	NO_X	Speed	Fuel Consumption (ml/min)
Diesel(B0)	10	2	3	2	1000	50
B100	-47	-48	-67	31	1000	24.75
B50	-40	-41	-51	10	1000	25
B40	-34	-34	-40	8	1000	25.51
B30	-23	-22	-31	7	1000	38.46
B20	-12	-12	-20	6	1000	43.48
B10	-7	-8	-12	4	1000	45.46

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The negative sign in the emissions of PM, CO and HC in Table 1 indicates the reduction of the percentage change in emission. It can be seen from Table 1 that NO_X emission increased with increase in the percentage of biodiesel in the blend, while PM, CO and HC decreased with increase in the percentage of bio diesel in the blend and diesel has the least emission of NO_X and the highest emission of PM, CO and HC when they were respectively used to run the diesel engine . The decrease of PM and HC is as a result of the additional oxygen content in the fuel, which helps to oxidize these combustion products and improve combustion in the cylinder(Enweremadu and Mbarawa, 2009). On the other hand, the reduction of CO and HC is due to the oxygenated fuel of biodiesel, it leads to a more complete combustion(Islam et al,2014)

It is evident in Table 1 that fuel consumption rate of the diesel engine was 50ml/min when diesel was solely used to run the engine, while it was 24.75ml/min when biodiesel (B100) was solely used to run the engine, which indicates almost 50% reduction in fuel consumption rate. However the fuel consumption rate increased with decrease in the percentage of biodiesel in the blends.

CONCLUSION

Emissions of PM, CO, HC and NO_X from diesel engine run on coconut oil biodiesel, its blends and diesel have been characterized. The following conclusion can be made: emission of NO_X in the coconut oil biodiesel and its blend is higher than that of diesel. PM, CO and HC decreased with increase in the percentage of biodiesel in the blend and are higher than those of diesel. Less fuel consumption rate can be achieved for coconut oil biodiesel and its blend compare to diesel when they are used to run diesel engine. Coconut oil biodiesel and its blends can be used to run diesel engine without any modification, since there was no manifestation of any problem when it was used to run the diesel engine.

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