1 <u>Original Research Articles</u> 2 PERFORMANCE EVALUATION OF A DIESEL ENGINE 3 RUN ON BIODIESEL PRODUCED FROM COCONUT 4 OIL AND ITS BLENDS

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8 ABSTRACT 9

This paper presents the evaluation of performance parameters viz a viz Brake specific fuel consumptions(BSFC), brake powers and mechanical efficiencies of a diesel engine run on biodiesel, its blends and diesel. The results of the evaluation showed that all the parameters exhibit similar variations. Mechanical efficiencies of the diesel engine run on the blends of biodiesel with diesel containing 30%, 40% and 50% biodiesel denoted by B30, B40 and B50 respectively were found to be higher than when it was run on diesel and a blend of biodiesel with diesel containing 20% biodiesel denoted by B20. Mechanical efficiencies of the diesel engine run on the blend of biodiesel with diesel containing 10% biodiesel and solely biodiesel denoted by B10 and B100 respectively were found to be lesser than when it was run on diesel denoted by B0, with increase in brake powers. The mechanical efficiencies of the diesel engine run on B10,B30,B40,B50 and B100 were found to be lesser with increase in engine loads in comparison to when it was run on diesel. BSFC of the diesel engine that was run on biodiesel and its blend were found to be higher than when it was run on diesel. They increased with increase in percentage of biodiesel added to diesel as the engine load increases. However they were found to increase with increase in brake power in the following order B0,B10,B20, B30, B40, B50 and B100.

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Keywords: Biodiesel, BSFC, diesel, diesel engine, engine load, mechanical efficiency.

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1. INTRODUCTION

Diesel fuels have an essential function in the industrial economy of developing and developed 15 countries(Awolu and Layokun.2013) and it is used in most types of transportation. Diesel engines are 16 the power behind our machines- trucks, train, ships and submarine. They generate more power more 17 efficiently when compared with petrol engines. Diesel engines are the most efficient prime movers, 18 from the point of view of protecting global environment and concerns for long term energy security, it 19 20 becomes necessary to develop alternative fuels with properties comparable to petroleum based fuels(Rao et al,2009). Beg et al(2010) opined that the source of crude oil in which diesel is a product, 21 22 would be ruined in future as the demand of petroleum products is growing at faster rate day by day. In 23 the quest for finding alternatives, biodiesel has gained a lot of attention. As it is known the use of 24 biodiesel (B100), instead of diesel oil (B0), shows interesting environmental benefits, even though for 25 economic reasons, today a complete replacement of fossil fuel is not possible(Friso, 2014). Shetye(2013) stated that biodiesel is an alternate fuel that can be produced from renewable 26

27 feedstock such as edible non edible vegetable oil, wasted frying oils and animal fats. It is oxygenated 28 sulphur free, non toxic biodegradable and renewable fuel. Savarirag et al(2013)a, stated that many technical papers revealed that the application of biodiesel in diesel engine is suitable for better 29 performance, combustion and emission properties. A lot of work has been done partly or wholly on 30 31 emissions and performance of diesel engine running on biodiesel from edible and non edible plants 32 and its blends .This is in line with Teran and Yaman(2015) who opined that some notable researchers have produced biodiesel from different types of vegetable oils and animal fats. Remarkable sources 33 of the aforementioned biodiesel which have been used to run diesel engine, whose emissions and 34 35 performance parameters have been studied are fish oil(Savarirag et al, 2013)b, sunflower and olive oil(Kalligerous et al, 2003), palm oil(Wirawan et al, 2008), cotton seed oil(Nabi et al, 2009 and 36 37 Gowthaman and Velmurugan, 2012), castor oil (Islam et al, 2014), almond (Nadal and Khaled, 2014), rapseed (Oberweis and Al-Shemmeri, 2010), pongamia (Gopal and Karupparai, 2015), 38 jathropha oil(Rao et al.2009), waste oil, rapeseed oil and corn oil(Tesfa et al.2014). Mahua oil(Lenin 39 40 et al.2013 and Brahma and Babu.2013), ricebran(Umesh et al.2014, mustard oil(Sharma et al.2013) safflower oil and milk scum oil(Kotil et al, 2014). The results of their studies of the emission from 41 42 biodiesel and its blends in comparison with diesel when they were used to run diesel engine revealed 43 that emissions from biodiesel are lower than that from diesel, except NO_x and the emissions decrease with increase in the concentration of the blend of the biodiesel. The results of the 44 45 performance evaluation varied from one researcher's work to another because of different sources of 46 biodiesel. performance parameters and the variation between them they individually 47 considered Biodiesel has been produced from coconut oil, characterized and the emissions was 48 studied by Teran and Yaman(2015), the results of the emission test obtained from the biodiesel and 49 its blend revealed the potentials of being use to run diesel engine. So the aim of this research is to use the biodiesel, its blends, and diesel to run a diesel engine and evaluates its performance in terms 50 51 of operational parameters. 52

2. MATERIAL AND METHODS

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The fuel materials used for this study include diesel fuel, biodiesel produced from coconut oil and characterised by Teran and Yaman(2015) and the blends of the biodiesel. The test rig shown in plate I was used for this study. It 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.



- 64 Plate I Test Rig.
- The specifications of the engine in the test rig are shown in Table1.

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Table 1. Engine specifications

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Parameters	Specifications
Engine model	GD411
Engine tune	Air appled 4 strate
Engine type	Air cooled, 4 stroke,
	direct injection diesel
	engine.
Number of cylinders	1
Bore(mm)x Stroke(mm)	82x78
Displacement(cm ³)	411
Compression ratio	18.2:1
Maximum power output	9HP(6.6Kw) at 3600rpm
Fuel Tank capacity	4.6 l
Engine dimensions	440mmx405mmx490mm

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70 2.1 Experimental procedure

7172 Blends of biodiesel a

Blends of 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.

74 The engine was made to run for 30 minutes in line with the work of Savariraj et al (2013)b with 100% 75 diesel fuel denoted by B0 as base fuel or reference fuel at constant speed of 1000rpm which was 76 measured by digital Tachometer. The engine load was applied by employing dynamometer that was 77 coupled to it. The fuel consumption rate was measured using a glass burette and stopwatch. After 78 completing the experiment with 100% diesel, the engine was allowed to run with 100% biodiesel 79 denoted by B100 and biodiesel blends, that is B10, B20, B30, B40, B50 respectively. Each test was 80 repeated five times and the arithmetic mean of the readings or observations was used for calculation and 81 analysis. The performance parameters determined, include engine load, brake specific fuel consumption 82 (BSFC), brake power and mechanical efficiency.

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85 3. RESULTS AND DISCUSSION

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87 The variation of mechanical efficiency with brake power is shown in figure 1.



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Figure.1 Variation of mechanical efficiency with brake power

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91 It can be seen from figure 1 that mechanical efficiency increased with increase in brake power. The 92 mechanical efficiency of the diesel engine when it was run on the blends, B50, B30, B40 are higher 93 than when the diesel engine was run on diesel(B0) and the same when the diesel engine was run on 94 B20. It is evident in figure 1, that the mechanical efficiency of diesel engine when it is run on diesel is 95 higher than when it is run on B10 and B100.

96 The variation of brake specific fuel consumption with brake power is shown in figure 2



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Figure. 2 Variation of brake specific fuel consumption with brake power

99 100 It can be seen from figure 2 that the diesel engine has higher BSFC when it was run on B100 than when 101 it was run on others and has the least BSFC when it was run on B0. However BSFC increased with 102 brake power except when the diesel engine was run on B50 where the BSFC initially decreased from 103 441g/kWhr at 10kW brake power to 422g/kWhr at 13kW brake power and finally increased with brake 104 power. The reason for initial decrease in BSFC could be that percentage increase in fuel to run the 105 engine was less than the percentage increase in brake power output.

106 The variation of brake specific fuel consumption with engine load is depicted in figure 3



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110 It can be seen in figure 3, that BSFC of the diesel engine when run on B0, B10,B20, B30,B40 and B100 increased with increase in engine load, while when run on B50, decreased with increase in engine load 111 to about 25Kw and increased with increase in engine load. The decrease in BSFC with increase in 112 engine load as experienced by the diesel engine when it was run on B50, might be due to the fact that 113 percentage increase in fuel required to operate the engine was less than the percentage increase in 114 brake power as relatively less portion of the heat losses occurred at higher engine loads (Raheman, et 115 al,2013) BSFC of the diesel engine run on the coconut biodiesel and its blends are higher than those of 116 117 diesel engine run on diesel at all loads. This is because of lower calorific value of coconut oil biodiesel 118 and its blends compare to diesel and this is in line with the position of Singh and Singla(2015) and 119 Savariraj et al (2013)b.

120 The variation of mechanical efficiency with engine load is shown in figure 4.



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Figure 4 Variation of mechanical efficiency with engine load.

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124 It can be seen from figure 4 that mechanical efficiency increased with increase in engine load for the 125 diesel engine when it was run on diesel(B0), biodiesel(B100) and all the blends of the biodiesel. This 126 could be attributed to minimal power that was lost as the load increased. It is evident in figure 4 that the 127 desel engine has the highest mechanical efficiency when it was run on B20 compared to when it was run 128 on diesel and others. This level of efficiency is caused by high temperature and unique ignition of the 129 biodiesel blend(B20)/air mixture.

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132 **4. CONCLUSION**

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Performance analysis of a diesel engine has been carried out. From the results obtained, the following conclusions can be made. Biodiesel produced from coconut oil and its blend can be used in running diesel engine quite effectively. Engine parameters evaluated, are similar to those with diesel from fossil fuel, which makes biodiesel an alternative fuel to mitigate the present energy and environmental crises.

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