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MEASURING ENGINE PERFORMANCE CHARACTERISTICS USING PETROL FUEL FROM MECHANICAL HAND PUMP OPERATED FUEL STATIONS (MHOPSS) AGAINST BASE PETROL FUEL

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ABSTRACT
Mechanical Hand Operated Pump Stations (MHOPSS) known as the local or "Ghaw-ghaw" petrol stations are common fuel stations found in both rural and urban communities. Undoubtedly the services of these local fuel stations always face with critics due to the quality of fuel they sell. The paper focused on measuring the performance characteristics of an engine with the use of petrol fuel from Mechanical Hand Operated Pump Stations (MHOPSS) against a base fuel from Tema Oil Refinery (TOR). Eight (8) MHOPSS from different local fuel stations were used. Comparative study of engine performance characteristics in the application of these petrol fuels was determined with the use of engine dynamometer. Engine performance Characteristics such as engine torque, brake power, indicated power, overall mechanical efficiency and frictional losses were determined using Morse test. The results of the experiment showed that petrol fuel from mechanical hand operated pump stations compared with the base petrol fuel from Tema Oil Refinery has different performance characteristics. Whereas overall performance mechanical efficiency for all cylinder working condition of the test engine using petrol specimen from TOR gave a result of 98%, that of MHOPSS 1-8 gave a performance results of 84.36%, 88.1%, 95.4%, 14.85%, 30.93%, 92.85% and 83.13%, respectively. The results of the experiment concludes that engine performance characteristics using petrol fuel from the mechanical hand operated pump stations also known as the Ghaw-ghaw stations compared with the performance characteristics of an engine with the use of base fuel are not the same. It is recommended that those who patronise the services of these fuel terminals should be sure of the quality of their product in order to safe guard the life span of their engine.

Keywords: Petrol Engine Performance, MHOPSS Fuel Quality, Base Petrol Fuel

INTRODUCTION

In the spark ignition and compression ignition piston type engines the energy contained in the fuel is converted to mechanical energy by burning the fuel with air behind a piston within the engine cylinder Kett (1982). However, the power developed by the engine is dependent on a

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number of factors including the quality of fuel put into the engine. Engine performance characteristics of spark ignition engines are improved as a result of the quality of fuel or correct mixture strength possess by the fuel being admitted into the engine. Sheet and Yamin (2013) in their study established that improvement in some of the fuel properties like calorific value, sulfur content, total water content among others are achieved with the use of original fuel**.** The report from these writers suggests that an improved engine performance can be achieved if undiluted fuel is used. Many writers have defined fuel adulteration in deferent perspective. Ale 2002 defined fuel adulteration as an act of rendering the fuel impure by adding cheaper products to the fuel. Ale (2002) further attributed the main reason for adulteration of automotive petrol and diesel to be for financial gains. Ale describes the effect of the use of adulterated fuel as increased harmful pollutants emissions into the atmosphere. Compliment to Ale's report Taksande and Hariharan (2006) have also indicates that adulterated fuels make exhaust gases more poisonous, worsening the pollution crisis and causes acute respiratory infections and other ailments. In Ghana, when fuel adulteration is mentioned, attention is drowned mostly to the mechanical hand operated filling stations known as local or "ghaw-ghaw" stations. When it comes to engine performance characteristics, the perception out there is that those who patronise the services of the "ghaw-ghaw" fuel stations are at risk of consequent engine breakdown. Some of the drivers who patronize the services of the local filling stations (locally called Ghaw-ghaw stations) in most cases also complain about their fuel quality among others. According to Matijošius and Sokolovskij (2009) quality of fuels is one of the key factors that have impact upon the operational performance of the engine. According to them, quality is defined in terms of a range of quality properties.

The use of adulterated transport fuel affects vehicle engine performance, increases vehicle maintenance cost and also increases exhaust emission levels. The high cost of replacing vehicle engine and the cost of part replacement or maintenance made it necessary for one to be mindful of the source of fuel put into the engine. Again looking at the current trend of automobile technological vehicle being manufactured it is also necessary to create awareness for people to know that, one cannot use any form of fuel product and get the same performance result. Local fuel stations also known as "ghaw-ghaw" stations are not only located in the rural community, they are also located in the Urban communities as well. There is no doubt that they contribute significantly in economic development. Their location and economic importance deem it necessary to undertake this research so that, those who patronises their product may be aware of what they are buying. The issue of fuel filtrations prior to dispensing the fuel into the tank of the motor vehicle should be a concern to those who patronise theses fuel terminals. Questions such as the environment in which these fuel stations operate, their storage tanks and the source of their fuel product should be of a bother to their customers.

Dickerson et al., (2006) are of the view that, since fuel dispensers are the focal point of distributing fuel to the general public, and the fact that fuel is a hazardous substance, they should be subjected to stringent requirements regarding safety, accuracy and security. The question is whether or not these manual pump fuel dispensing stations have regulations regarding their activities. The paper aims at measuring engine performance using petrol fuel from Mechanical Hand Pump Operated Fuel Stations (MHOPSS) against Base Petrol Fuel. The paper, therefore, seeks to measure the influence of engine performance characteristic on the basis of the use of petrol fuel from the ghaw-ghaw or local stations. To find out about the performance

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characteristics such as engine brake power developed, engine indicated power developed, efficiency of the engine and frictional power losses using fuel product from mechanical hand operated fuel service stations (MHOPSS) known as local (Ghaw-ghaw) filling stations.

MECHANICAL HAND OPERATED FUEL SERVICE STATIONS (MHOPSS)

Mechanical hand operated fuel service stations (MHOPSS) known as local (Ghaw-ghaw) filling stations. In this station dispensing of fuel into vehicle tank are done with hand pumps operated manually using human power and mechanical advantage. There are many different types of hand pump available for different purposes, mainly operating on a piston, diaphragm or rotary vane principle with a check valve on the entry and exit ports to the chamber operating in opposing directions. Most hand pumps have plungers or reciprocating pistons, and are positive displacement. Figure 1 shows a typical manually operated hand pump used to dispensed fuel into vehicle tanks. One of the problems with this unit is absence of a fuel filter to filter the fuel from the underground storage tank before being dispensed into the vehicle tank. Another issue is the storage tank; the question is whether or not the tank is coated with protective material to prevent possible water from contaminating the fuel.

Fig 1 Mechanical Hand Operated Pump station (MHOPSS) Source : (Fieldwork 2017)

Fuel Quality and Engine Performance Characteristics

Performances characteristics of an engine can be determined by conducting series of test on the engine. One of the factors that could influence positively or negatively to the performance of the engine is the type of fuel used and since fuel plays a crucial role in engine performance a number of researchers have drawn their attention to blends of fuels and how they impact on the engine performance. Saravanan et al., (2013) assert that internal combustion engines generate undesirable emissions during combustion process due to partial or full replacement of the fuel. This assertion could be due to the quality of the fuel product being burnt. Tesfa et al.,(2013) indicated , that physical properties of fuel affect significantly the performance of the engine. Karabektas et al., (2016) also indicated in their recent study, that the use of emulsified fuels brings about significant increase in CO and HC emissions at low engine loads, while they cause moderate CO and HC emissions at high engine loads. A study by Yadav and Rawat (2015) indicates that engine compression ratio is influence with the use of ethanol-gasoline blending on

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the performance. Dhanapal et al., (2016) established in their study that the blend of un -leaded gasoline with diethyl ether increases the octane number which in turn in -creases the power output which leads to increase in the brake thermal efficiency of the engine. In sharing the views of these writers, this study is of the view that whatever form fuel is blended there are some significant influences on the engine performance. Blend of fuel may come either in a form of adulteration or an introduction of a product in attempt to increase some component of the performance characteristics. A blend of fuel from the fuel dispenser unit could be done either deliberately for financial gain or could be as a result of negligence.

RESEARCH METHODOLOGY

Samples of petrol fuel collected from different sources for the study fell under two categories; namely: Category 1. (Base fuel): This sample of petrol fuel was collected from Tema Oil Refinery (TOR). It is a first hand or primary fuel collected from the plant to be used for the basis of comparism with fuels collected from the other fuel service stations. The quantity of base fuel collected was 4.5 litres. Category 2 (Mechanical Hand Operated Pump Service Stations - MHOPSS): Petrol fuel sample were collected from eight (8) mechanical hand operated fuel stations popularly called the "ghaw-ghaw" stations. About 4.5 litres of sample fuel was collected from each of the station earmarked for the research. Each sample was tagged with a specimen number for easy identification. The given specimen number was counted from MHOPSS 1 to MHOPSS 8, where the inscription MHOPSS represent mechanical hand operated pump fuel station specimen.

Experiment Test Equipment

The experimental set up consists of a four stroke, twin cylinder carburettor spark ignition (S.I) engine. The engine was coupled to a hydraulic dynamometer for measuring its brake power (b.p). The engine is a water cooled engine and a wet sump lubrication system with four cylinders of 70mm bore, 90mm stroke, a cubic capacity of 1.6 and a compression ratio of 7.4:1 respectively. The dynamometer consists essentially of a rotor running in a casing through which water flows steadily via the inlet and out let pipes. The flow of the water is controlled by pump driven by a motor. The pump inlet is connected to a water reservoir to suck water and pressurised it to run the dynamometer rotor coupled to the engine flywheel. The dynamometer has motor/pump capacity of kW 1.1 and an overall dimension of 3800 x 2500 x1500 respectively.

Laboratory tests

The Laboratory tests conducted were the engine torque developed by the application of the base petrol fuel and that of the mechanical hand operated service station (MHOPSS). The engine torque produced by each specimen was used to determine performance characteristics such as brake power, indicated power, mechanical efficiency and frictional losses. MAT LAB programming software was used to generate graphical results for comparative analysis.

RESULTS AND DISCUSSION

The Morse tests conducted using base petrol fuel from Tema Oil Refinery and mechanical hand operated fuel stations (MHOPSS) also called the local fuel stations varied in engine torque given different performance characteristics respectively. The graphical result as generated using MAT LAB programming software gave different performance curve comparatively.

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Engine Brake Power

Figure 2. Shows the engine brake power available at the crankshaft of the engine with the petrol samples collected from MHOPSS 1-8 with respect to the base fuel from TOR. The base petrol fuel from TOR recorded an average brake power of 0.0133kw different from what was obtained for MHOPSS 1, 2,3,5,6, 7 and 8 respectively. The brake power and the torque curve of MHOPS deviate from the performance curve obtained for the base fuel. According to Zamit (1986) the falling of torque curve at increase engine speed is due to decrease in the volumetric efficiency of the engine. This efficiency can be influence by a number of factors including correct mixture strength.

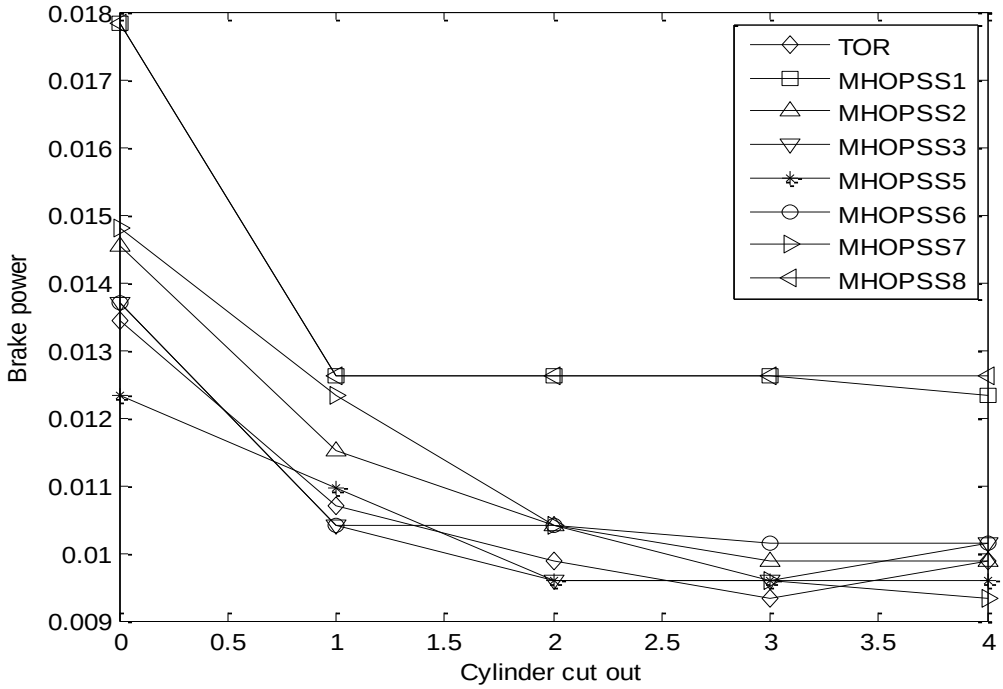

Figure 2. Variation of cylinder cut out with Brake Power (TOR Vs MHOPSS)

The brake power obtained from MHOPSS 3, indicates values of 0.0121, 0.0115, 0.0011kw respectively at cylinder 1to 4 was cut out respectively. These values from the graph indicate a close relation of 0.0133kw brake power shown by the base fuel. Similar values could also be read from MHOPSS 5 and 6 respectively. These are indication that, though there are several hand operated fuel stations, fuel product from these stations differ from one station to another. From the graph it is noticed that there is a significant difference of 0.0012kw in engine brake power with base petrol fuel from TOR and that of the MHOPSS. It may be attributed to different combustion taking place in the cylinder at different compression ratio as a result of different fuel mix given different brake power performance.

Indicate Power

Figure 3 further shows the indicated power of the engine as the power actually developed in its cylinders with use of petrol fuel from MHOPSS respectively. Variation in engine indicated

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power with engine torque at cylinder cut out shows that indicated power generated from MHOPSS 6 and 7 have almost similar indicated power as indicated by the base fuel from TOR. The result again showed value on the other MHOPSS with indicated power far from that as indicated by TOR. From the graph whereas the base fuel shows an Indicated power of 0.025 kW at cylinder 1to 4 cut out respectively, specimen from MHOPSS shows otherwise.

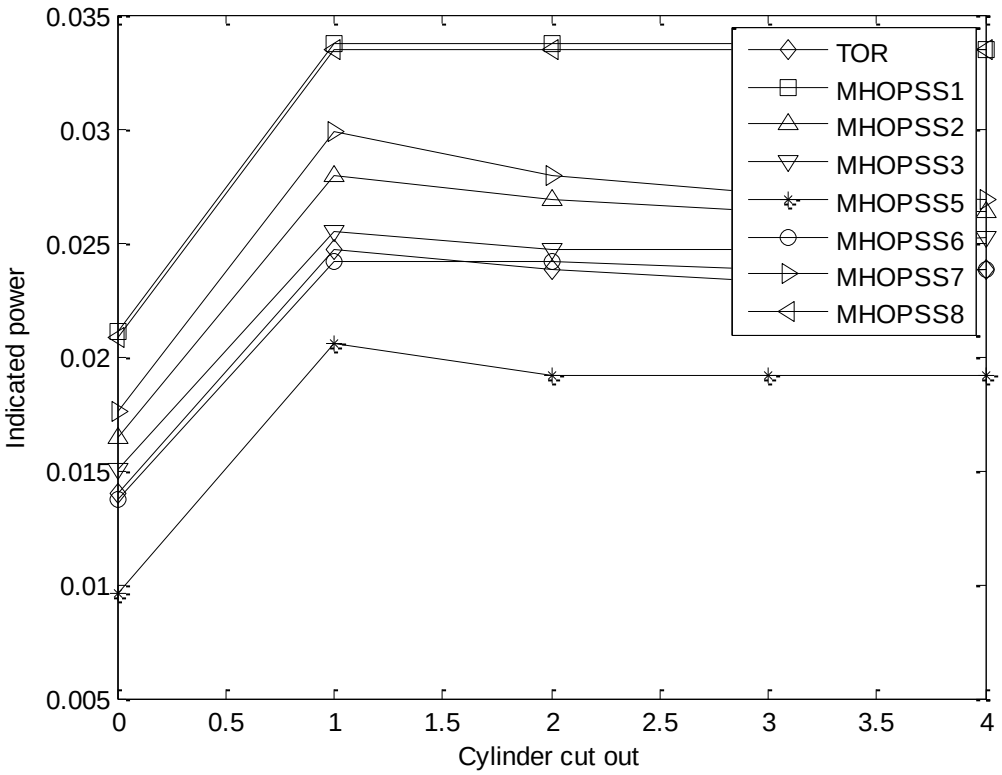

Figure 3. Variation of Cylinder Cut Out with Indicated Power (TOR Vs MHOPSS)

Mechanical Efficiency

Figure 4. shows variation in engine mechanical efficiency which is the ratio of the useful power available at the output shaft to the power developed in the cylinders of the engine. With engine torque at Cylinder Cut out with the use of petrol fuel from TOR and that from MHOPSS, higher amount of mechanical efficiency close to TOR product were observed for MHOPSS 3 and 6. This implies that MHOPSS 3 and 4 are relatively good products. Mechanical efficiency observed for products at various cylinder cut out from MHOPSS 1,2, 4,5,7 and 8 respectively were far below that of TOR's .

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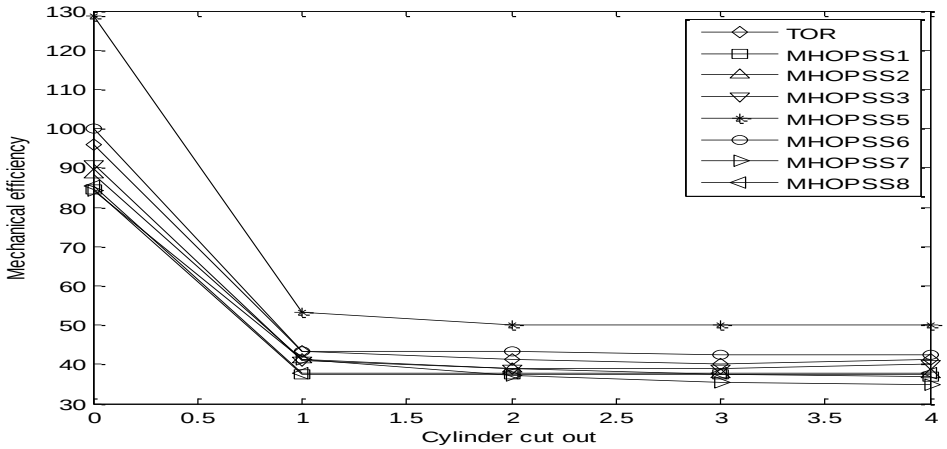

Figure 4 Cylinder cut out with Mechanical Efficiency (TOR Vs MHOPSS)

The indicated power and the brake power of an engine are always different as a result of power losses between the cylinder and the output shaft, due, mainly, to friction between the moving parts of the engine and the pumping power needed to clean and recharge the cylinder.

Frictional Power and Pumping Losses

The frictional losses also include the power needed to drive the essential engine auxiliaries, such as the water pump, the fuel feed pump, the dynamo and fan, among others. Figure-5. shows variation in frictional power and losses occurred with the use of TOR and MHOPSS petrol fuel respectively with engine torque at various cylinders cut out. The results show that apart from MHOPSS 3 and 6 which were close to TOR, all other result indicated frictional and pumping losses far from that indicated by TOR.

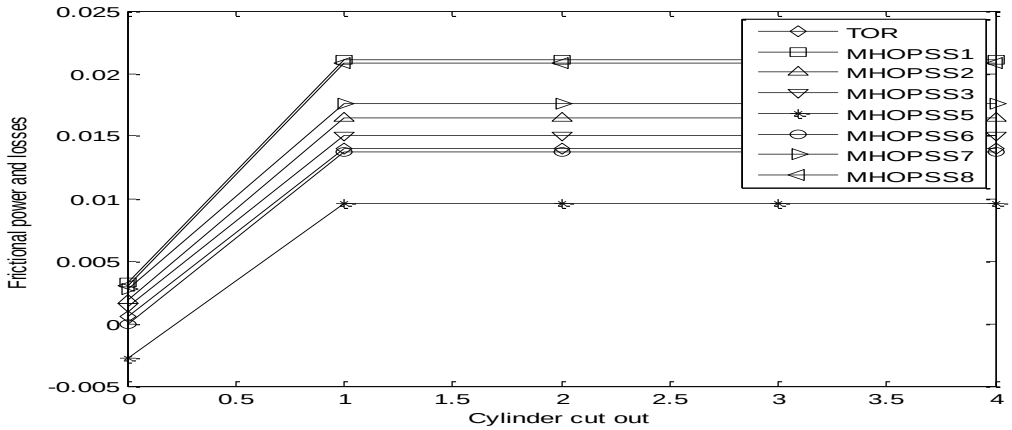

Figure 5. Variation Cylinder cut out with Frictional Power (TOR Vs MHOPSS)

CONCLUSION

The paper, therefore, seeks to measure the influence of engine performance characteristic on the basis of the use of petrol fuel from the ghaw-ghaw or local stations. To find out about the performance characteristics such as engine brake power developed, engine indicated power

developed, efficiency of the engine and frictional power losses using fuel product from mechanical hand operated fuel service stations (MHOPSS) known as local (Ghaw-ghaw) filling stations. It was observed that there is a significant difference in the performance characteristics of an engine with the use of petrol fuels from the MHOPSS known as local "ghaw-ghaw"filling stations as against the base fuel from TOR. Engine performance efficiency of 67.9% deviation was obtained against 98% engine efficiency from the use of TOR specimen. That different brake power, indicated power, frictional power and mechanical efficiency exists with the used of specimen from different Mechanical Hand Operated Pump Stations (MHOPSS) against the base fuel. That high frictional loss exists in using petrol fuels containing properties other than the normal standard petrol fuel. The paper concludes that one of the factors that influence engine performance is the source and quality of fuel being used in the operation of the engine. Though the result of the study established some differences in performance characteristics with the use of the ghaw-ghaw fuel against the base fuel, there is hope for improvement. Again the study established that, some of the ghaw-ghaw stations had better result compared to others. It can be concluded that not all the ghaw-ghaw fuel stations fuel product gives lower engine performance. It is recommended that, those who buy their product should be sure of the quality before they buy. Based on economic importance, location and environmental considerations, is recommended that, the government as well as the regulatory bodies such as the National Petroluim Authority (NPA), Ghana Standard Board (GSB), Tema Oil Refinery (TOR) and the Oil Marketing companies (OMCs) should step in to monitor the activities of these fuel stations since they also play a crucial role in economic development.

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