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Experimental Analysis of Exhaust Gas Emission on Two Stroke Spark Ignition Engine

[1*] Okuma S.O, [2]Idowu A.A,

[1]Department of Mechanical Engineering, Nigeria Maritime University, Okerenkoko, Delta State, Nigeria. (silas.okuma@nmu.edu.ng)
[2]*Department of Mechanical Engineering, Ladoke Akintola University of Technology,Ogbomoso,Oyo State, Nigeria*

**Corresponding Author: Okuma Silas, silas.okuma@nmu.edu.ng (+234 706 442 3066)*

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Abstract: *Two stroke spark ignition engine is common due to its inbuilt high power to weight ratio, but it poor combustion process, excessive products of NO, NO2, HC and CO gas emission are the main impediment to universal acceptance. The analysis involve varying engine speed and the load carrying capability as it affect the exhaust gas emitted from the two stroke engine. Exhaust gas analyzer were used to measure the amount of gas products. These process include varying the engine speed while keeping the load constant and also varying the load with constant speed, the process is repeated for four times to estimate each value of gas emission. The results obtained showed that NO_2 emission is three times that of NO emitted, likewise CO is four times the amount of HC emitted. Therefore, it can be concluded that the amount of gas emission depends on the engine speed and the percentage of engine loading.*

Keywords: *Emission, Two Stoke Engine, Engine Loading, Engine Speed, Exhaust, Hazard*

INTRODUCTION

Internal combustion engines (ICEs) are engines which operate by burning fuel inside the cylinder engine, a process in which the burning of fuel occurs in a confined space called a combustion chamber. This reaction of a fuel with an oxidizer creates gases of high temperature and pressure which are permitted to expand within combustion engine in which combustion occurs intermitted such as four-stroke and two-stroke engines. These advantages for two-stroke cycle engines, such as light weight, simple construction, less components, cheap to produce and the ability to pack almost twice the power-density than that of a four-stroke engine same specification. This makes them different from other ICE types (Ishibashi, 2000; Mahmoudzadel *et al.,* 2007). Various substantial research works were carried out to tackle two-stroke engines main limitations, which is high level of unburned hydrocarbons emissions, generated by unstable running operation combined with incomplete combustion, especially at light load (Asai *et al.,* 2012). Cycle-to-cycle variation at low and mid-load has long been known as one of the drawbacks in two-stroke cycle engines. This cyclic variation is ascribe to lower average charge temperature of the cylinder, as at low-speed and low-load, the amount of energy released per each combustion cycle is too low to maintain the next combustion cycle temperature to be continued without misfiring (Duret, 1993; Mahmoudzadel *et al.,* 2007). Two stroke engines are commonly used in high power, hand held application, the overall light weight and light-weight spinning part gives important operational and even safety advantages. Power is being achieved in two stroke motorcycle in this way: Intake and exhaust occurs at the bottom dead center, some forms of pressure is needed, and fuel air mixture compressed and ignited and the piston is pushed downward by the exhaust gases. The process of pistons moving downward by the exhaust gases is different from other engines. Piston part is the simplest of the design, all functions are controlled solely by the piston covering and uncovering the ports as it moves up and down in the cylinder. A fundamental difference from typical four stroke engine is that the crankcase is sealed and formed part of the induction process in gasoline.

Studies have shown that the rates at which motorcycles are being overloaded with passengers and goods have adverse effect on the percentage of the flue gases being emitted. Although the combustion gases are being emitted like Nitrogen oxide, water vapour except with pre-carbon fuel, carbon dioxide(CO_2),except with hydrogen as fuel, there is a relatively small part of it which is undesirable these include toxic substances such as carbon monoxide(CO),hydrocarbon(HC),Nitrogen oxides(NO_2),Ozone(O_3), partly unburnt fuel and particulate matter (Heywood, 1988). Seth (2003) explained that exhaust gas emission in an internal combustion engine can be controlled by different method (i.e. by modifying the engine design, treating the exhaust gas and by fuel modification), the analysis showed that a change in engine design like changing inlet and outlet valve opening time would control the gas emission. Some vehicles operate in cold (low temperatures) or insufficiently heated engines over relatively short intervals leading to the source of its significant emissions in unfavorable weather conditions in which the concentration of the exhaust gases can be very high. In order to define exactly the amount of exhaust gaseous pollutants emitted by vehicles, it is necessary to specify two sets of data (data concerning exhaust pollutants produced in these conditions).This approach means determining individual conditions, these type of solutions can be attempted on the micro scale, but it is important to take into consideration the condition of motion (including ambient temperature and engine temperature). Motorcycle is a major means of transportation within urban towns in Nigeria. This experimental analysis is aimed at comparing the composition of each constituent element of exhaust flue gases when performing fuel characteristic tests and during exhaust gas measurement on a typical two-stroke engine.

MATERIAL AND METHOD

The volume of exhaust gases coming out from internal combustions engines are considered as one of the prime cause of pollutions, thereby series of activities have been directed to establish prescribe standards of permissible emission level of CO, NO_X, HC and HS as well as the methods and apparatus for evaluating the emissions. The analysis of these exhaust gases require the use various factors and measuring instruments such as gas analyzer, varying the loads and speeds of the engine. Thus, during the measurement of these gases, various data were obtained and analyzed so as to interpret the final results. The sample of fuel used to power the motorcycle is first being tested and the percentage of various constituents is determined such as carbon, hydrogen and nitrogen. The weight of air, flue gases and air fuel ratio required for complete combustion was estimated. The percentage composition of exhaust flue gases were measured at predetermined speeds and loads. The two most common motorcycles used in Nigeria towns (Bajaj box and Jincheng) were considered and these motorcycled were used as model in this investigation. From the evaluation it was observed that Jincheng motorcycle is lighter in weight than that of Bajaj and thus, the former has low centre of gravity, therefore in attaining optimum stability, the load carried must be increased. Using the exhaust gas analyzer and varying the loads being applied to the machine at constant speed exhaust gas determined randomly. The loads are varied in these percentage 0%,25%,50%,75% and 100% while the exhaust product were being recorded at a particular speed.

There The speed factor for each motorcycle was calculated below:

A. Bajaj Box Motorcycle

Bore and Stroke= 53mm×45mm

Swept Volume= $AD^2L/4$

$$Swept\ Volume = \frac{\pi \times 0.053^2 \times 0.045}{4} = 9.929 \times 10^{-5} m^3$$

Compression ratio = 95:1

Maximum net power = 6.03kw at 7500rpm

B. Jincheng Motorcycle

Bore and Stroke= 50mm×50mm

$$Swept\ Volume = \frac{\pi \times 0.005^2 \times 0.5}{4} = 9.819 \times 10^{-6} m^3$$

Compression ratio = 66:1

Maximum net power = 6.03kw at 7500rpm

Also by analytical method, engine speeds were varied from 1000rpm, 2000rpm, 3000rpm, 4000rpm and 5000rpm at constant load.

RESULTS AND DISCUSSION

The results obtained from the experimental analysis are shown in the following tables below.

Table-1 HC Emission for Two-Stroke S.I Engine

Engine loading (%)	Engine Speed(RPM)				
	1000	2000	3000	4000	5000
0	2050	2270	2550	3190	3650
25	2140	2510	3150	3750	4150
50	2460	3050	1450	4250	4650
75	1950	3350	3950	4650	5250
100	3250	2850	4550	5150	6050

Table-2 CO Emission for Two-Stroke S.I Engine

Engine loading (%)	Engine Speed(RPM)				
	1000	2000	3000	4000	5000
0	9805	10400	11200	12225	13815
25	10205	11017	12035	13400	14800
50	10800	11811	13018	14600	16100
75	11811	12819	14406	15800	17808
100	12700	13510	14815	16613	19845

Table-3 NO Emission for Two-Stroke S.I Engine

Engine loading (%)	Engine Speed(RPM)				
	1000	2000	3000	4000	5000
0	410	398	395	388	382
25	460	439	425	408	397
50	548	518	497	457	436
75	610	560	528	507	487
100	760	688	638	587	537

Table-4 NO_2 Emission for Two-Stroke S.I Engine

Engine loading (%)	Engine Speed (RPM)				
	1000	2000	3000	4000	5000
0	170	157	150	142	135
25	180	165	155	146	140
50	202	172	160	152	145
75	228	195	165	156	150
100	262	210	180	170	160

Table-5 Estimation of grand Mean

Dependent Variable			95% Confidence Interval	
	Mean	Std. Error	Lower Bound	Upper Bound
CO	6802.8	52.8	6690.8	6914.79
NO	490.2	5.81	477.9	502.52
NO2	159.7	2.33	154.74	164616
HC	1782	1784	1744.17	1819.83

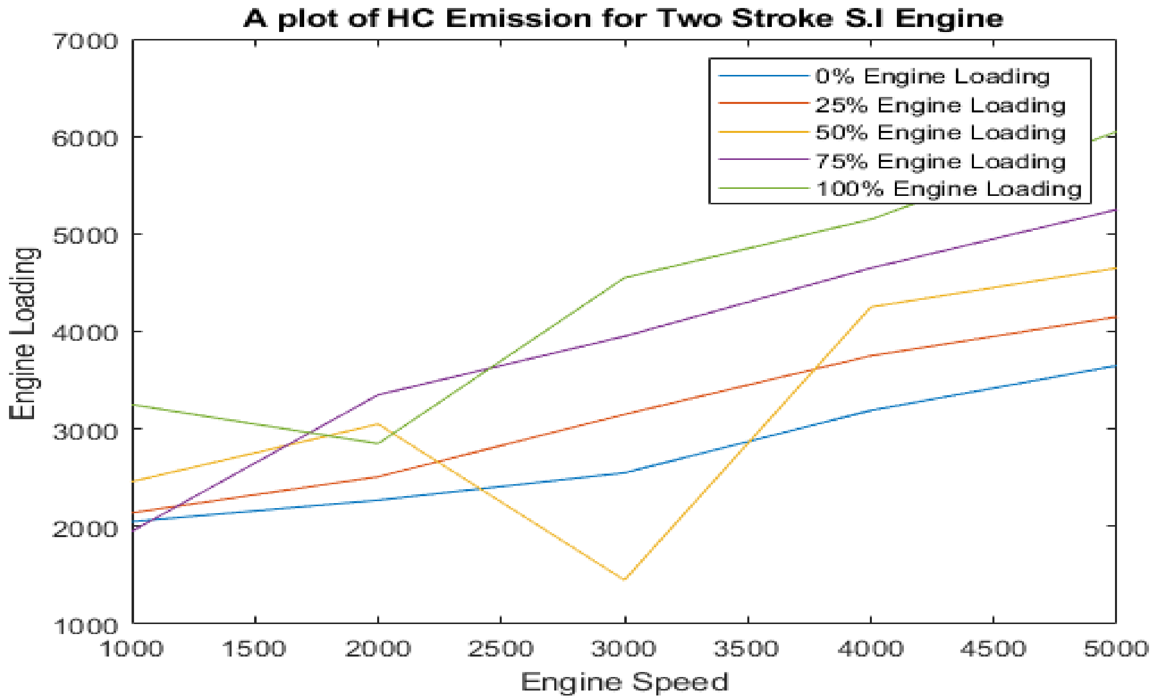

Fig 1. HC Emission for Two-Stroke S.I Engine

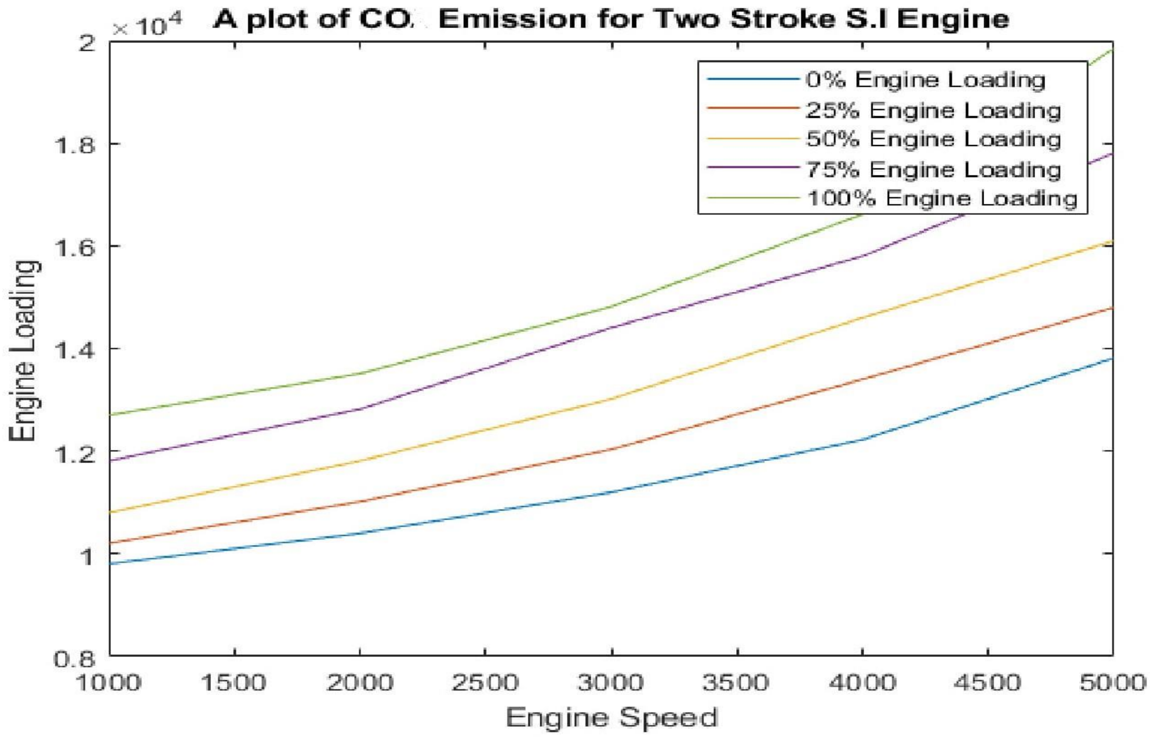

Fig 2. CO Emission for Two-Stroke S.I Engine

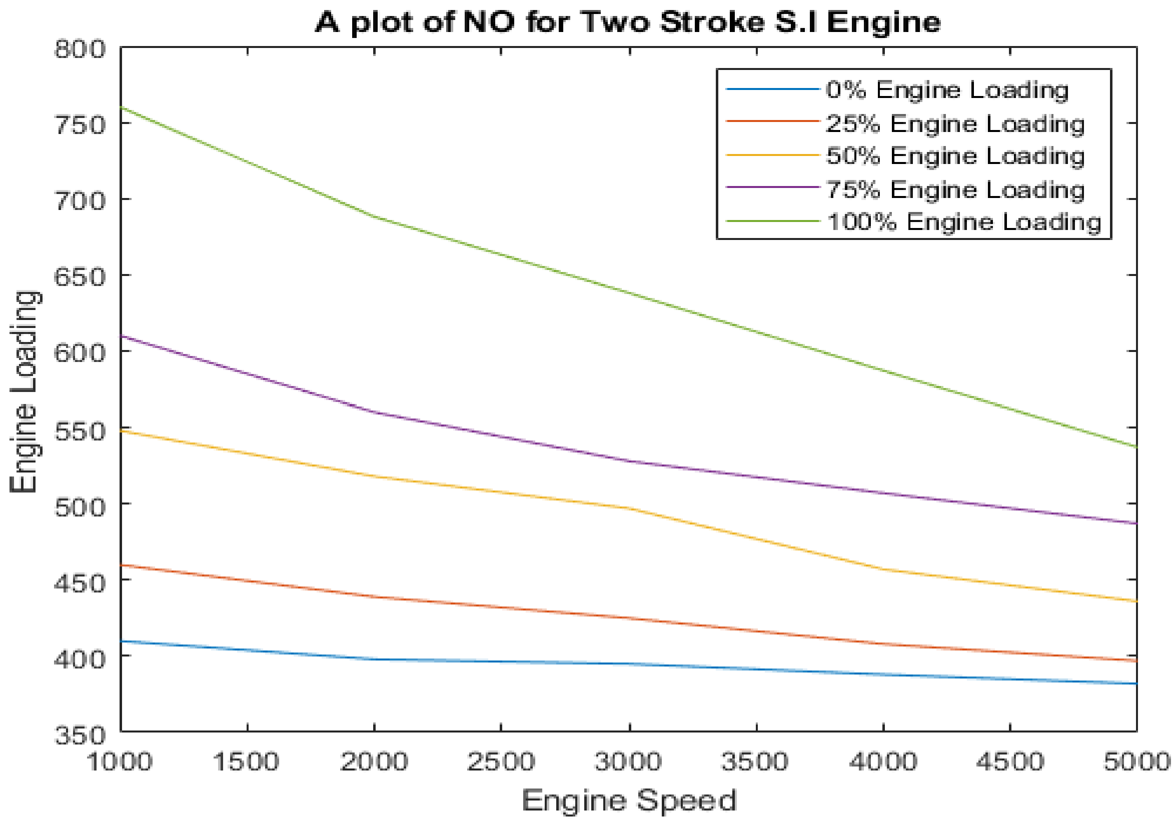

Fig 3. NO Emission for Two-Stroke S.I Engine

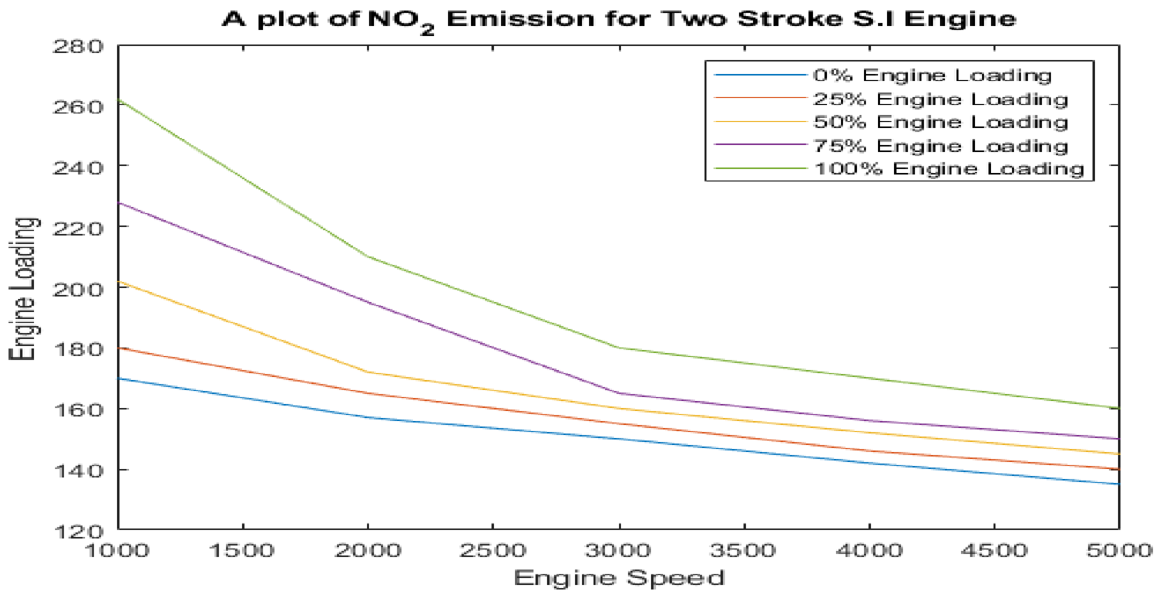

Fig 4. NO_2 Emission for Two-Stroke S.I Engine

The result obtained from the analysis shows that NO_2 emission is three times that NO form during combustion. Also the total amount of CO formed is four times that of HC during the combustion process. As the loading condition increases, there is high amount of CO emitted.NO_2 exhibited a very little significant difference in terms of increase in gas emission as the engine speed increases.

At constant engine speed as the load increases the emission of nitrogen (IV) Oxide increase, also at constant load, as the speed increases, emission is reduced but varies at maximum loading. There is a high significant emission emitted when the engine speed is increased. At speed range of 1000rpm to 2000rpm, HC emit high emission but reduced as the speed increases from 2000rpm to 5000rpm.Hydrocarbon(HC) is the major exhaust product in the flue gas emission irrespective of the speed or load factor.

CONCLUSION

The effect of exhaust gases from two stroke spark ignition engine has been found to have a major health challenges to humans and adverse effect on its environment. The result of this analysis shows that gas emission rates depend on the engine speed and on the percentage of loading rate on two stroke spark ignition engine. The analysis summarized that CO and HC are the major exhaust gas emitted from two stroke ignition engines. Also for minimal emission of CO which have severe health hazard on human, the engine speed should be kept within the range of 1000rpm to 2000rpm and load carrying condition should be between 0% to 25%. More so, the nitrogen II oxide emitted is minimal when the engine speed is within the range of 4000rpm to 5000rpm.Therefore increased HC emission is the function of both engine speed and load carrying condition.

RECOMMENDATION

The following recommendations are suggested, the engine speed and load carrying condition should be kept within the range, and this will help to reduce the emission given out by these machines. Also cleaner power sources should be improved upon to power these machines.

CONFLICT OF INTEREST

There is no conflict of interest associated with this research work

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