FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 7 No. 5, October, 2023, pp 176 - 180
DOI: https://doi.org/10.33003/fjs-2023-0705-2010

DETERMINATION OF EMISSIONS FROM PROTOTYPE ENGINE FOR GENERATION OF POWER FROM EXHAUST GAS OF GASOLINE GENERATOR

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ABSTRACT

The capacity to produce power from the gases emitted from the exhaust of gasoline generator is a remarkable and admirable accomplishment. But using the prototype engine to provide this power leads to obstruction in the exhaust gas flow line, which tends to affect exhaust gas emissions. Regarding this, emissions from the prototype engine and the lone or sole generator in this research were assessed at various generator speeds and loads. The study found that the emissions of carbon monoxide, carbon dioxide and hydrocarbon from the sole generator were 4.72 %, 4.36 %, and 76 ppm, respectively, while those from the prototype engine were 4.81 %, 4.41 %, and 88 ppm. This was at the minimum generator speed of 1000 rpm and load of 1200 W. The prototype engine's carbon monoxide, carbon dioxide and hydrocarbon emissions were 2.51 %, 4.97 %, and 34 ppm, respectively, while the sole generator's carbon monoxide, carbon dioxide and hydrocarbon emissions were 2.39 %, 4.89 %, and 32 ppm respectively, at the maximum generator speed of 5000 rpm and load of 2800 W. At minimum generator speed of 1000 rpm and load of 1200 W, the carbon monoxide, carbon dioxide and hydrocarbon emissions are, however, slightly higher in the prototype engine than the sole generator by 9%, 5 %, and 12 ppm respectively, and at maximum generator speed of 5000 rpm and load of 2800 W, the carbon monoxide, carbon dioxide and hydrocarbon emissions are, respectively, slightly higher in the prototype engine than the sole generator by 12 %, 8 %, and 2 ppm.

Keywords: Emissions, exhaust gas, generator, load, prototype engine , speed, sole generator

INTRODUCTION

According to Piotr et al. (2015), petrol is constituted of complex hydrocarbons and mixed components. All of the combustible materials oxidise throughout the burning process in the gasoline engine's combustion chamber (also known as the internal combustion engine), and they leave the engine's combustion chamber under pressure and heat through the exhaust. The main components of the exhaust gases are H_2O, CO_2, N_2, O_2, CO and H_2 (Martin et al., 2012). Other minor components contain smoke, HC, SOx, NOx, aldehydes, organic acids, and other oxidation products generated from the fuel and lubricant in trace levels. (Nkwaoda et al, 2016).

The atmosphere is generally polluted by the exhaust gas emissions from petrol engines and internal combustion engines fueled by petroleum fuels. According to Ukemenam (2014) as stated by Hassan et al. (2021), exposure to air pollution is a significant issue in most part of Nigeria, particularly in the urban areas where ineffective burning of energy has led to the accumulation of numerous indoor air contaminants.

In order to find out how aware the users of fossil fuel generators were of the associated environmental deterioration, Mbamali et al. (2012) assessed the related risks to human health, the environment, and society. This was done in the Kaduna metropolis of Nigeria.

The study was conducted primarily through a field research in which Kaduna's city was divided into twelve groups and an organised set of questions was given out using a purposeful sample method. Their findings revealed, among other things, that there was widespread use of generators (89.9% of households); users were aware of and "agreed" that there are environmental risks which include noise and air pollution, heat generation, dangers to living things, and structural flaws. Health risks which include hearing loss (occurring with a frequency of 67.2%), insomnia (occurring with a frequency of 60.5%), choking sensations (occurring with a percentage of 55.4%), and deafness (occurring with a frequency of 60.5%).

According to Sharaf (2013), many initiatives are being taken to lessen the air pollution caused by petrol and diesel engines, and emission controls are also being put into place in the USA and a few Indian areas. According to his findings, a thorough examination of energy use and pollutants revealed that alternative power systems still lag far behind traditional ones. Future cars will use less gasoline thanks to continued improvements in petrol and diesel engines, which might reduce consumption by 40% or more. This will thus lower CO2 emissions, a gas that causes the greenhouse effect.

In order to determine the spectrum of applications for this strategy, Abd-Allal (2002) evaluated the ability of exhaust gas recirculation (EGR) to reduce these exhaust gas pollutants, particularly NOX emissions. The researcher conducted a comprehensive analysis of the effects of EGR on the emissions and performance of diesel engines, spark ignition engines, and dual fuel engines. Adding EGR to the diesel engine's air flow rate turned out to be a more advantageous usage of EGR in diesel engines than dislodging some of the input air, according to his research. He continued by stating that considerable reductions in NO concentrations were achieved in spark ignition engines with 10% to 25% EGR, and that doing so might make it possible to considerably reduce exhaust NOX emissions. EGR, however, also slowed down combustion, making it more difficult to maintain constant combustion. With increasing EGR, the brake-specific fuel consumption fell while the burn time and brake mean effective pressure remained constant. reduced pumping effort, reduced heat loss through the cylinder walls, and less dissociation of the high temperature burned gases all helped to reduce fuel consumption as EGR increased. According to his final assessment, greater intake charge temperatures and the reburning of unburned fuel in the recirculated gas boosted the thermal efficiency of dual fuel engines with hot EGR. Both NOX and smoke were simultaneously reduced to almost nothing at high natural gas percentages. Cooled EGR had a lower thermal efficiency than hot EGR, but it allowed for less NOX emissions. He came to the conclusion that increasing exhaust emissions through the use of EGR was the most effective strategy. According to Merkisz and Siedlecki (2017), exhaust gas after treatment systems have been a feature of automobiles for many years and have helped to lessen their negative effects on the environment and people. the majority of them to reduce or oxidise hazardous pollutants. They therefore stated that there was a discernible decrease in emissivity for carbon monoxide for both cold and hot systems in the evaluation of the after treatment system's impact on the exhaust emissions of upgraded diesel engines. Despite different engine loads during the test, the carbon monoxide emissions were practically cut in half, demonstrating the great efficiency of the post treatment system. Due to the high temperature of the oxidation reactor, a significantly inferior result was obtained for the hot exhaust system. According to the data, there were no appreciable variations in emissivity between the various operating points for cold and hot systems. The oxidation reactor was primarily responsible for the decrease in emissions. According to their findings, the first measurement point exhibits the greatest variations between systems at various temperature states, allowing system heating to be considered as an efficient means of lowering emissions.

Domenico et al. (2017) looked at how an exhaust gas recirculation (EGR) system affected the performance and emissions of a stationary, direct-injection diesel engine utilising diesel oil containing 7% biodiesel (B7). During tests in a 49-kW diesel power generator with the modified EGR system, engine performance and emissions were evaluated for various loads and EGR settings. Their investigation revealed that data, particularly at high engine loads, indicated decreased peak cylinder pressure and fuel conversion efficiency when compared to the engine operating without the EGR system in its original configuration. The use of EGR has conflicting impacts on carbon dioxide (CO2), carbon monoxide (CO), and total hydrocarbons (THC) emissions, generally increasing them depending on the load and EGR rate. EGR was commonly used to reduce nitrogen oxide (NOX) emissions, with a maximum decrease of approximately 30%. At high loads, they noticed that employing EGR typically resulted in greater CO2, CO, and THC emissions. It was found that 7.5% EGR was adequate to simultaneously reduce CO, THC, and NOX emissions at low and moderate loads without significantly affecting CO2 emissions or engine performance. Wei et al. (2012) found that an engine with hot EGR can increase the efficiency of fuel conversion and combustion by heating the intake charge using the high exhaust gas temperature, but an engine with cooled EGR enhances the volumetric effectiveness and intake mass per volume.

Zubair (2022) created a prototype engine that was installed in the exhaust pipe of a petrol or petrol generator to generate energy. However, this prototype engine is obstructing the exhaust fumes flow, and the obstructive effect on the exhaust fumes flow could result in low or high emissions. Therefore, the goal of this research is to evaluate the emissions from the sole generator and the prototype engine at various speeds and loads in order to determine the effects the prototype engine has on emissions.

MATERIALS AND METHOD

Materials

The following supplies and machinery were used to conduct the research: The experimental engine developed by Zubair (2022) fitted with gasoline generator, 20 litres of gasoline, Gas Analyser manufactured in Ahmedabad, India by NAMAN Automotive Solutions. Model no = NAMTECH-GA 954, and a Stopwatch

Method

The gasoline generator (sole generator) which is depicted in plate 1 was run at speeds of 1000, 2000, 3000, 4000 and 5000 rpm while being loaded at 1200, 1600, 2000, 2400, and 2800W, respectively. The probe of a digital analyzer was inserted into the exhaust tail pipe to measure emissions at various speeds and loads.

Plate 1: Experimental set-up for running sole generator.

After that, the sole generator was disassembled as indicated in plate 2, the prototype engine was attached to the gasoline generator's exhaust line as shown in plate 3, and it was made to run at a variety of speeds(1000, 2000, 3000, 4000 and 5000rpm) and loads(1200, 1600, 2000,2400 and 2800W) while the emissions were also recorded.

Plate 2: Dismantling and replacement of the exhaust system with the prototype engine

Plate 3: Experimental set-up for running the prototype engine developed by Zubair(2022)

In any case, all measurements were made for a total of thirty minutes during a five-minute interval, with average results taken into consideration.

RESULTS AND DISCUSSION

The variation of emissions from sole generator and experimental or prototype engine with generator speed is depicted in figure 1.

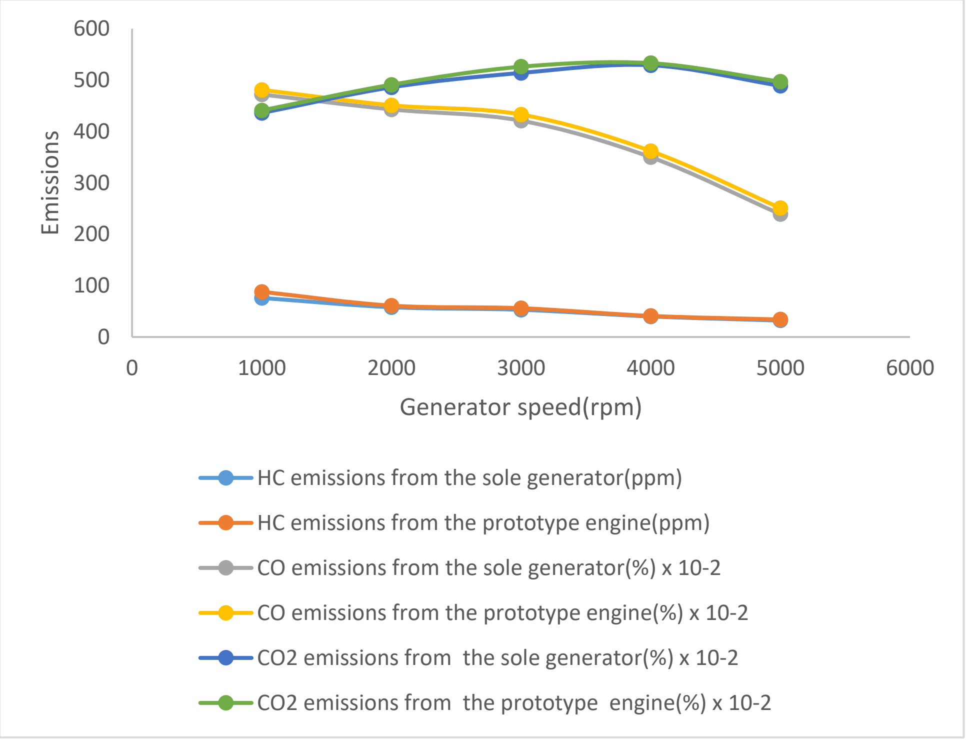

Figure 1: Variation of emissions from the sole generator and the prototype engine with generator speed

Figure 1 shows that for both the prototype engine and the sole generator, carbon dioxide (CO2) increased as generator speed increased, but carbon monoxide (CO) and hydrocarbon (HC) dropped. This tendency and the trend of the results found by Ali and Mohamad (2017) are comparable.

Anyway, the prototype engine's CO, CO_2, and HC emissions are marginally greater than the sole generator by 9%, 5% and 12ppm respectively at minimum generator speed of 1000rpm and by 12%, 8% and 2ppm at maximum generator speed of 5000rpm. The slight higher emissions experienced by the prototype engine may have been caused by the inclusion of the turbine in the exhaust line, which functions as a partial stopper and is comparable to that of Fatona (2015), who constructed an exhaust and added three tiers of cascade stoppers in it.

The variation of emissions from the exhausts of sole generator and the experimental or prototype engine with generator load is depicted in figure 2.

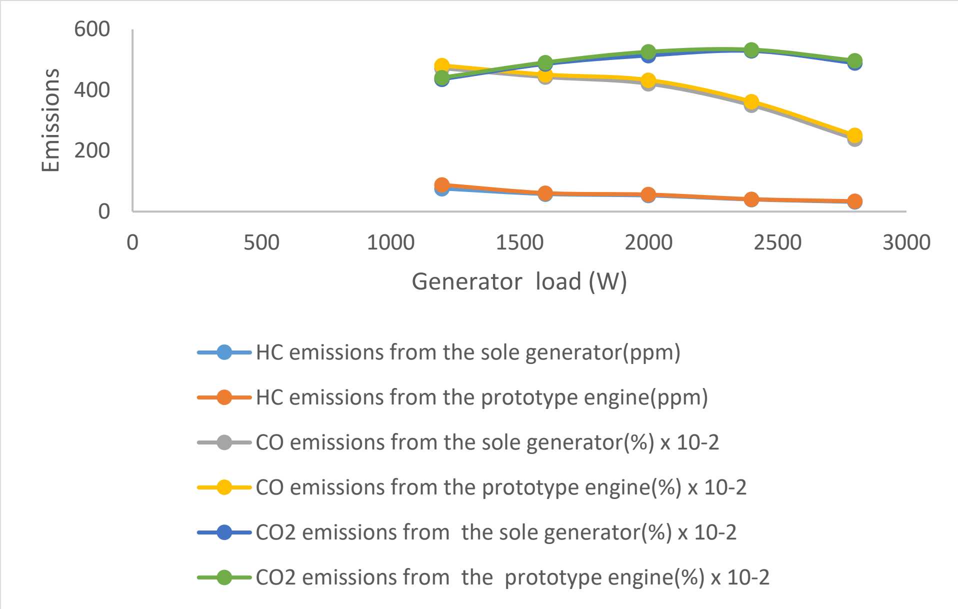

Figure 2: Variation of emissions from the exhausts of sole generator and the prototype engine with generator load

As the generator load increased, CO and HC emissions fell while CO2 emissions rose. This finding is consistent with Wang et al.(2021) discovery. At a minimum load of 1200W, the prototype engine emits 4.81%, 4.41%, and 88ppm of CO, CO2, and HC, compared to 4.72%, 4.36%, and 76ppm from the sole generator. At the minimal generator load of 1200W, the emissions of CO, CO2, and HC from the prototype engine are 9%, 5%, and 12 ppm higher than those from the sole generator, respectively. At a maximum load of 2800W, the sole generator released 2.39% of CO, 4.89% of CO2, and 32 ppm of HC, whereas the prototype engine released 2.51% of CO, 4.97% of CO2, and 34 ppm of HC. At the generator's maximum load of 2800W, the prototype engine's CO, CO2 and HC emissions are 12%, 8%, and 2 ppm higher than the sole generator's.

CONCLUSION

It is a commendable and respectable feat to be able to produce electricity from petrol generator exhaust fumes or gas, which is often wasted and tends to pollute the environment. The prototype engine's use to generate this power, however, causes obstruction in the exhaust gas flow line, which generally has an impact on exhaust gas emissions. With respect to this, emissions from the prototype engine and the lone generator in this study were evaluated at varying generator speed and load. It can be concluded from the research findings that for both the prototype engine and the sole generator, CO_2 emissions rise while CO and HC emissions fall as generator speed and load increase. The emissions are slightly higher in the prototype engine than the sole generator irrespective of the generator speed and load.

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