# DETERMINATION OF SOUND LEVEL OF PROTOTYPE ENGINE FOR GENERATION OF POWER FROM EXHAUST GAS OF GASOLINE GENERATOR

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## ABSTRACT

The ability to produce energy from gasoline generator exhaust gas, which is commonly wasted and has a tendency to contaminate the environment, is an admirable and constructive accomplishment. However, using the prototype engine to produce this power results in the gasoline generator adding another component, which will change the sound level. In this regard, the prototype engine's and the sole generator's sound levels in this study were assessed at various generator speeds and loads. The research revealed that the prototype engine's and the sole generator's respective sound levels were 73 and 78dB at the minimum generator speed of 1000rpm and load of 1200W. The sound levels of the sole generator and the prototype engine were 86 and 91dB, respectively, at the maximum generator speed of 5000rpm and load of 2800W. However, regardless of the gasoline generator speeds and loads, the sound levels of the prototype engine are within the permissible tolerance limit of 90-98dB as mentioned in the literature.

***Keywords:*** *Generator, Sole generator, prototype engine, sound level*

## 1. INTRODUCTION

Generators emit a lot of noise when they are running, and when this noise is excessive, it can have negative effects on the ears, including hearing loss, cardiovascular effects, sleep disturbances, and overall lower quality of life for those around (Abraham, 2003). According to Oke *et al.* (2014) generators make a significant contribution to ambient noise. The noise may be caused by aerodynamic effects, combustion process forces, or mechanical stimulation of spinning or reciprocating engine components (Hultgren, 2011) as stated by Oke *et al.* (2014), An experimental examination of the noise levels of diesel-powered generators in the nation was presented by Giwa *et al* (2019). It was intended to disseminate knowledge regarding the noise pollutants associated with diesel-powered generators in order to aid in policy development and raise public awareness of potential health problems. So they hired 105 diesel-fuelled generators in the Sango area of Ogun State, Nigeria, ranging in age and installed capacity from 0.5 to 14 years and 10 to 500 kVA, respectively. Standard measuring devices were used to measure the noise levels at a distance of 1 m from the diesel-powered generators, and they recorded noise levels between 72.6 and 115.6 dB. They said that the noise level is far greater than recommended on average and across the board. Ibhadode *et al*. (2019) measured the noise levels of electric power generators in seven (7) important cities in north-central Nigeria: Abuja, Makurdi, Lokoja, Ilorin, Lafia, Minna, and Jos. They selected ten (10) top generator brands that manufactured fifty (50) popular kinds of electric power generators that were imported into and operated in the study area. Through field measurements and computation, they employed the CR811C Noise Metre to determine the Perceived Noise Level (Lm), Sound Pressure Level (LP), and Sound Power Level (SWL) of each of the fifty electric-power generator models twelve times. Their findings showed that the majority of the tested electric power generator types employed (operated) in the research area (80%), two-thirds (66%) and less than half (42%) did not meet three (3) international noise emission limits, such as LP values greater than 85db, 87db and 90db . In two business communities in Ibadan, Yusuf et al. (2020) evaluated the awareness and perspective of generator users towards the noise-induced health risks connected with generator use. So they conducted a comparative cross-sectional study in the Agbowo and Ajibode neighbourhoods of Ibadan, which have high and low generator use, respectively. Surveys were given to all 515 generator users in both villages (Agbowo: 304, Ajibode: 211). According to their findings, Agbowo had a mean knowledge and perception score of 11.4 ±4.9 and 4.3±2.1, while Ajibode had 13.9±3.8 and 4.1±2.2 (p <0.05). Agbowo had a greater percentage of knowledgeable generator users (53.3%) than Ajibode (44.5%) did. In both business districts, the majority of respondents (Agbowo: 82.9% and Ajibode: 86.7%) acknowledged that noise from electric generators was a source of noise that may impair hearing, but none were aware of the sound level that could do so. In Agbowo and Ajibode, respectively, the percentage of respondents with a negative perception was 51.3% and 82% (p 0.05). Comparatively few respondents (Agbowo: 7.7%; Ajibode: 5.0%) considered noise-induced hearing loss to be a severe health issue. Only 11.5% and 6.6% of the people in Agbowo and Ajibode, respectively, wanted to quit their occupation despite the fact that 80.3% and 26.1% of them thought their workplace was noisy (p <0.05).

According to Elanchelyan (2013), diesel generators for power are among the most crucial pieces of machinery used in the construction industry. They are frequently utilised in groups and are situated close to the work area. These generators emit noise at a considerably greater level than is acceptable. However, the construction crew made very little attempt to prevent or reduce this noise level to a legal level. According to Musa and Enoch (2016), noise from generators has a negative impact on human health. In light of this, they created a soundproof device for portable generators with 950Watt ratings, which are very popular. After the soundproof device's performance was assessed, the generator's sound pressure level dropped. At the Centre for Environmental investigations (CES), Anna University, Parvathi and Gopalakrishnan (2003) conducted experimental investigations on the measurement and control of indoor and near-field noise levels owing to the operation of a portable power generator. Antivibration mounts (made of rubber, coir, polyurethane foam, thermocole, wool-felt, and sand bed) and enclosures (made of cardboard, thermocole, and a sandwich of cardboard and thermocole) were used in the study on noise control. They claimed that among anti-vibration mounts and enclosures, respectively, sand beds of 32 mm thickness (containing sand particle size 0.5 mm) with an air gap of 5 cm between sandwich enclosure walls were found to be the best effective in suppressing noise caused by the generator operation. According to Berberian *et al*. (2016), a group of patients who received treatment using sound generators reported positive outcomes. They examined the audiologist follow-up records of 25 adult patients who had hearing loss and tinnitus complaints. Free field audiometry with hearing aids, the Visual Analogue Scale to gauge how annoying the tinnitus is, and the Tinnitus Handicap Inventory to gauge how the condition affects quality of life both before and after therapy were all used. Their findings showed a significant improvement in hearing thresholds, a significant decrease in the level of tinnitus annoyance, a significant decrease in tinnitus, and, as a result, a significant improvement in the respondents' quality of life after using hearing aids. The use of hearing aids with sound generators is a viable resource for the treatment of tinnitus associated with mild to moderately severe hearing loss, they concluded, as a result of their study.

John and Dewan (2015) measured the noise levels and noisiness of certain power producers and compared the results to the acceptable noise limits set by international noise regulating authorities. The sound pressure values that were recorded varied from 76 &BA to 97 dBA. From 45.20 noyes to 189.06 noyes, there was noise. They discovered that the noise levels above the international proposal for noise limit of 45 dBA, or 5.6 decibels during the day, and 40 dBA, or 3.4 decibels during the evening. They noted that the noise levels were greater than both the workplace safety and Health Administration's (OSHA) exposure permissible noise standard of 80 dBA, or 63 noys, and the WHO's exposure permissible noise limit of 90 dBA, or 120.3 noys.
In the University of Technology in Iraq, Ahmed *et al*. (2020) investigated the effects of employing huge electrical generators on the environment. Based on their findings, they stated that the generators' extraordinarily high noise emissions could seriously endanger the health of university employees and students. Using a 43-item questionnaire, Azodo and Adejuyigbe (2013) evaluated the impacts of noise on residents of Obantoko, Ogun State, Nigeria. According to the findings of their analysis, residents of Obantoko are constantly exposed to generator noise, which has a negative impact on their health. These effects include hearing loss, interference with spoken communication, sleep disturbances, cardiovascular disturbances,

impaired task performance, negative social behaviour, and irritability reactions. They came to the conclusion that the harmful impacts of noise on people of Obantoko required immediate treatment. Ana *et al*. (2014) evaluated the effects of electric generator noise in the Ibadan, Nigerian business districts of Agbowo and Ajibode. They discovered that the average noise levels in Agbowo were 78.5 3.9 dBA and in Ajibode were 65.7 4.4 dBA, both of which were above the 65 dBA limit set by the World Health Organisation for outdoor commercial areas. They came to the conclusion that having a job or living in Agbowo was substantially related to having hearing loss right now (odds ratio: 6.8, 95% confidence interval: 3.4-13.7). However, they argued that it is justified to limit exposure to noise from the electric power generators that supply residences and small businesses in metropolitan areas. In Ikorudu, a city in Lagos, Nigeria, Ademola *et al*. (2014) looked into the effects of noise from diesel engine power generators utilised for production activities. They discovered that when all of the factory's generators were running at once, the ambient noise level was 30.0-152.5 dB(A), with the least contribution occurring inside the building at 70.0-84.4 dB(A) and the largest contribution occurring outside the fence line at 57.2-70.8 dB(A). Although the maximum noise level was 152.5 dB(A), they noted that the maximum noise level of 70.8 dB(A) outside of the fence line indicated compliance with the World Bank's 45 dB(A) and 55 dB(A) residential area limit while exceeding the 70 dB(A) industrial and commercial area limit. Using empirical, diagrammatic, analytical, and noise map elaboration techniques, Seutche *et al*. (2019) conducted a study on environmental noise pollution from a thermal power plant in Cameroon with the goal of suggesting the best possible safeguards for the thermal plant's surroundings against noise pollution. The study found that the population is exposed to sound levels over the alert threshold of 80 dB and above the upper limit of 50 dB. The principal sources of acoustic power levels at the geo-located motors of the plant were found to fall between 60 and 98 dB, which was said to be quite similar to the acoustic pressure levels of between 60 and 95 dB. They discovered that the levels of acoustic strength and pressure were higher than 80 dB, which is the limit of human hearing. They emphasised that this is thought to be harmful to people's health and wellbeing, highlighting the need for a deeper investigation into the relationship between sound levels from stationary sources and frequency in high-sound environments and the creation of a strategic noise map for the town of Mbalmayo and its surroundings.

In the Nigerian cigarette industry, Wang *et al*. (2020) assessed the noise danger level and its effects on technical operators of tobacco processing equipment. They found that since the company relies on electrical generators for the functioning of the machinery, the utility departments were responsible for the greatest noise mean, which was around 106.02 dB. All technical operators were exposed to extreme noise, which is significantly beyond the standard of National and International limit of 85 dB, according to the aggregate mean of noise measured from the three firms (101.89 dB, 98.63 dB, and 96.15 dB). This study demonstrated that excessive noise levels have a negative influence on the health and productivity of technical operators, who spend an average of 12 h daily on the production floor.

For usage in a home generator, Oke *et al*. (2014) created an exhaust/silencer system that can lessen exhaust noise. Both the manufactured silencer and the factory-installed silencer were used in the experiment. A noise reduction of 8.06% was achieved with the custom exhaust system, as opposed to 4.16% with the factory-installed silencer. Additionally, it was discovered that the generator used less gasoline while the manufactured exhaust system was in use. They stated that the new exhaust system will effectively replace the old system in the long term.

Zubair (2022) and Musa *et al*. (2023) developed a prototype engine that was attached to a petrol or gasoline generator's exhaust line to generate energy. It is anticipated that the prototype engine, which is an extra component to the gasoline generator, may increase noise or sound levels. As a result, the goal of this research is to determine the sound level of the prototype engine and the solitary generator at various speeds and loads.

## 2. MATERIALS AND METHOD

### 2.1 Materials and Equipment

The materials and equipment used to carry out the research include:

i. The prototype engine developed by Zubair (2022) and Musa *et al* (2023) fitted with gasoline generator.
ii. 20 litres of gasoline.
iii. Digital Sound Level Meter manufactured in Taiwan by EXTECH Instruments corporation with the following specification
Model no = 407740,
Input signal range = 30 to 130dB.
Resolution = 0.1dB,
Frequency = 31.5 to 8000Hz
iv. Stopwatch

### 2.2 Method

The gasoline generator, which is depicted in plate 1, was operated solely at speeds of 1000, 2000, 3000, 4000, and 5000rpm with loads of 1200, 1600, 2000, 2400, and 2800W, respectively. The sound level of the sole generator was measured using a sound level metre placed at a distance of one metre from the generator at the varied speed and load, following the lead of Ibhadode *et al*. (2019).

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

The solitary or sole generator was then disassembled, as shown in plate 2, and the prototype engine was attached to the gasoline generator's exhaust line, as shown in plate 3, and made to operate at the same variable speed and load. Following the work of Ibhadode *et al*. (2019), the sound level of the generator with the prototype engine was also measured in each case using a sound level metre placed one metre from the generator.

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) and Musa *et al* (2023)

In any case all the measurement were carried out for five minutes for a period of thirty minutes and average values were considered.

## 3. RESULTS AND DISCUSSION

The variation of sound level of the sole generator and the prototype engine with generator speed is shown in figure 1.

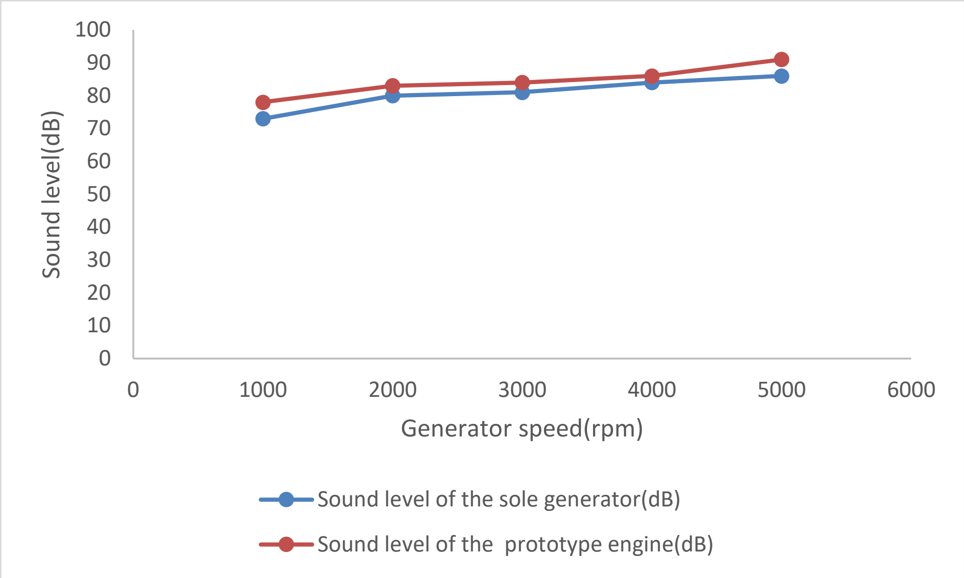


Figure 1. Variation of sound level with generator speed

Figure 1 shows that when the generator speed grew, so did the noise level of the prototype engine and the sole generator. This is consistent with Khaled's (2013) measurements of noise levels at various engine speeds at various points around the car, which showed that the noise level rose as the engine speed rose (from 750 to 4000 rpm). The sound level of the solo generator and the prototype engine were both found to be 73 dB at the lowest generator speed of 1000 rpm. The prototype engine's and the sole generator's sound levels were discovered to be 86 and 91dB, respectively, at the maximum generator speed of 5000 rpm, as shown in figure 1.

The variation of sound levels of the sole generator and the prototype engine with generator load is shown in figure 2.

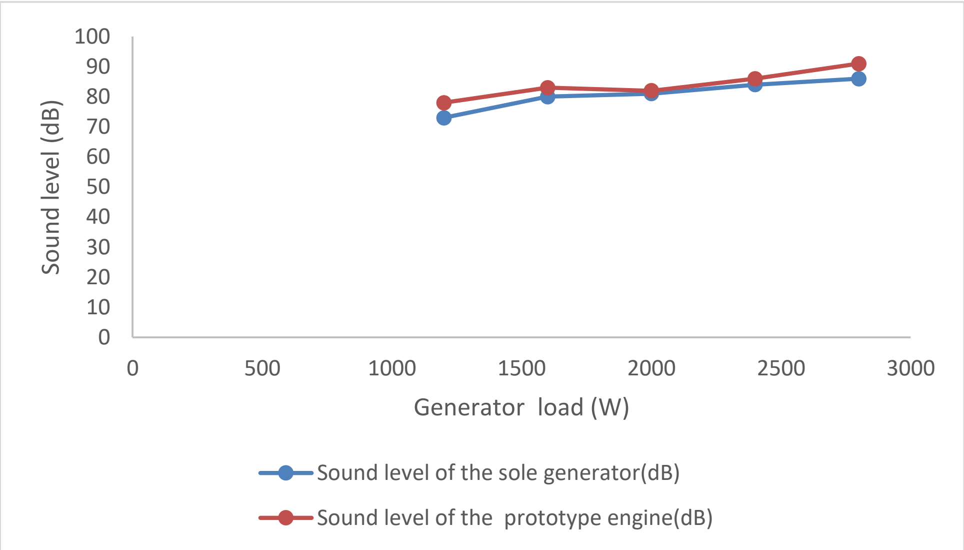


Figure 2. Variation of sound level with generator load

Figure 2 shows that when the generator load grew, both the prototype engine and the sole generator's noise level increased. The sound levels of the single and prototype generators were found to be 73 and 78dB respectively, at the generator's minimum load of 1200W. At the maximum generating load of 2800W, the sole generator's maximum sound level was measured to be 86dB, while the prototype engine's maximum sound level was measured to be 91dB.

It was discovered that the prototype engine had a 5dB louder sound than the sole generator. Fan, bearing, and sound emission from the surface are the typical sound sources of an electrical power generator, according to Elancheliyan (2013). However, the turbine is an extra component that was added to the generator in the prototype engine and its noise contribution may have accounted for 4dB. However, Elancheliyan (2013) stated acceptable tolerance limit of 90-98dB is met by the prototype engine's sound level.

## 4 CONCLUSION

The study assessed and determined data for sound emission of prototype engine that generates power from exhaust waste gas of a gasoline generator. In this regard, at various generator speeds and loads, the sound level of the prototype engine and the sole or solo or lone generator in this research was assessed. It can be concluded from the research findings that the sound level increase with increase in generator speed and load for both the sole generator and the prototype engine. However, the sound level of the prototype engine irrespective of the gasoline generator's speed and load is within the acceptable tolerance limit of 90-98dB as found in literature.

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