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Fabrication of an Acoustic Enclosure for a Portable Generator

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Abstract-The use of generating set is a necessity in a power-starved economy like Nigeria. The excessive noise emanating from the use of these generators has serious impact on human health. The effectiveness of an acoustic enclosure developed for a 650 W rated portable generator is reported in this study. Result from the performance evaluation of the acoustic enclosure showed that the sound pressure level reduce from 65.2 to 58.6(6.6 dB), 63.1 to 56.1(7 dB), 59.7 to 53.7(6 dB), 58.2 to 53.3(4.9 dB), 58.1 to 52.9 (5.2 dB) 0.5 m, 1.0 m, 2.0 m, 3.0 m, 4.0 m respectively from the generator.

Keywords- *Acoustic, Enclosure, Portable, Generator, Fabrication*

I. INTRODUCTION

Noise is an unwanted sound adjudged to be unpleasant, loud and disruptive to hearing [1]. Medical evidences has linked sound levels in excess of 60-70 dB above ambient as pollution which can lead to health risk [2]. Exposure to high noise levels can result in a temporary or a permanent hearing loss, it can also result to mental and nervous discomforts, loss of working efficiency and increased risk of hazard [3]. Sound power level and sound pressure levels are usually expressed in decibels.

The development of the human society has led to more sound sources giving higher and higher noise levels. Noise is one of the most widely and frequently experienced problems of the industrial working environment in which machines such as generator is a major contributor. Also, epileptic power supply in developing countries like Nigeria has led to the emergence of the use of portable engine driven generators which are used for alternative electric power supplying in shops, greenhouses, offices, homes in cities and most rural communities. However, the noise inherence in the use of these generators is very inconvenient to nearby people.

The use of portable generators is on the increase because of the numerous advantages it offers such as its mobility due to the small size and ease of operation, however, it is usually mounted in open frames and does not come with a sound proof enclosure thereby producing a high level of noise during operation. Portable generators are mostly single phase are employed in homes, offices and shops for powering appliances requiring low power inputs such as electric bulbs, computers, television sets and other small appliances [4].

Noise control can be achieved using either active or passive means of reducing sound emissions, often based on personal comfort, environmental considerations or legal compliance. Effective noise control focuses on reducing the noise from noise generating sources such as generators. There are four basic principle employed in noise control:

i. Sound insulation which serves to prevent transmission of noise by the introduction of a mass barrier. Common materials have high-density properties such as brick, thick glass, concrete and metal.

ii. Sound absorption consist of a porous material which acts as a ‘noise sponge’ by converting the sound energy into heat within the materials includes decoupled lead-based tiles, open cell foams and fiberglass.

iii. Vibration damping is applicable for large vibrating surfaces. The damping mechanism works by extracting the vibration energy from the thin sheet and dissipating it as heat. A common material is sound deadened steel.

iv. Vibration isolation is preventing transmission of vibration energy from a source to a receiver by introducing a flexible element or a physical break. Common vibration isolators are springs, rubber mounts and cork.

Over the years, several investigators have used various sound dampening technologies to attenuate the noise produced from generating sets.

The major noise sources of noise in an engine driven generator set (petrol start and kerosene run) has been identified [5]. They first separated the combustion and mechanical noise and found that their contribution was almost equal. They also performed sound intensity measurement to identify major noise sources in the generator set when the exhaust was ducted away. The results of these measurement indicated that the main sources of noise in the generator set are: cooling fan cover, silencer shell, silencer cover and engine crank case.

An investigation was carried out to determine the feasibility of producing a simple, effective design for enclosing portable generators [6]. The investigation followed the theories for insertion loss of a close fitting enclosure. System behavior was examined and effects of the material stiffness, density and source-to-enclosure distance on the insertion loss and effectiveness of the enclosure were evaluated.

Craik and Smith [7] employed the Statistical Energy Analysis (SEA) to model the transmission of sound through a double leaf lightweight partition. They concluded that the best SEA model is dependent on the range of frequency considered and the method of construction.

Parvathi and Navaneetha [8] performed experimental studies on the assessment and control of indoor and near-field noise levels due to the operation of a portable power generator. Noise control was studied employing anti vibration mounts (made up of rubber, coir, polyurethane foam, thermocole, wool-felt and sand bed) and enclosures (made up of cardboard, thermocole and a sandwich of cardboard and thermocole). Among the anti-vibration mounts used in the study, the maximum noise reduction was due to the sand beds of 32mm thickness (containing sand particle size 0.5 mm) which reduced overall noise by 10 dB(A).

The sound intensity method was used for the determination of the field transmission loss data for some wall elements such as window and doors [9]. They found out that the methods used showed good agreement with the conventional methods used in laboratory test procedures.

Craik [10] also presented a model for the determination of the coupling loss factor which is used in the prediction of sound transmission through lightweight double walls.

Tadeu and Mateus, [11] compared the predicted values for the acoustic insulation of single and double panel walls made of glass, steel and concrete, using analytical models they developed with experimental findings. The laboratory experiments involved placing test specimens between standard chambers. They concluded that the predictive analytical solutions were in good agreement with the experimental results, except when the area of the panels is very small and the frequencies are very low. At low frequencies, the experimental results appeared to be significantly affected by the resonance effects associated with the creation of stationary waves within the acoustic chambers, and the vibration modes introduced into the dynamic system by the restriction on the movement of the panel along its boundary.

Kuku et al. [2] observed that the use of generator as alternative source of electricity power is very prevalent in the Nigerian society with little or no attention being paid to the noise emanating from these generators during use. Therefore this study is focus on the development of an acoustic enclosure to attenuate the sound produced by a portable generation which is very common in many household in Nigeria

II. MATERIALS AND METHOD

The design of an acoustic enclosure for portable generators was carried out in the department of Mechanical Engineering, Osun State University, Nigeria. The method employed in the design is the passive absorption principle. The materials used in the fabrication of the acoustic enclosure include: plywood, acoustic foam and rubber dampers. The six walls of the acoustic ensure was arranged to form a box-like shape as shown in Figure 1 below with one of the walls serving as the door. The inside of the enclosure is padded with acoustic foam. The enclosure was developed using 15 mm thick plywood with dimensions of 535×520×520 mm. An air gap layer with about 150 mm thickness was provided between the enclosure walls and the generator.

A Tiger Suzhou TG950 with specifications as shown in Table 1 below generator was put on and placed inside the acoustic enclosure and was allowed to run at moderate load, for 30 minutes and as it was running the sound pressure level was measured. The equipment used to measure sound levels was a hand-held sound level meter which measures the sound level via its built-in capacitor microphone. The sound levels were measured at distances of 0.5 m, 1.0 m, 2.0 m, 3.0 m and 4.0 m from the generator. Measurement at each distance was replicated three times, with the average value taken for each of the five different distances from the acoustic enclosure. The same procedure was repeated when the generator was operated without an acoustic enclosure.

Figure 1. The Acosutic Enclosure

TABLE I. TECHNICAL DATA OF THE PORTABLE GENERATOR

Name	Tiger Suzhou TG950
Dimension	365×335×340 mm
Dry weight	22.5 kg
Engine type	4 – Stroke, side valve, 1 cylinder
Tank capacity	4L
Engine speed	3000 r.p.m
Cooling system	Conventional air cooling
Rated A.C output	650 W

III. RESULT AND DISCUSSION

The variation in sound pressure level at various distances without the acoustic enclosure and with the acoustic enclosure is as shown in Figure 2 below.

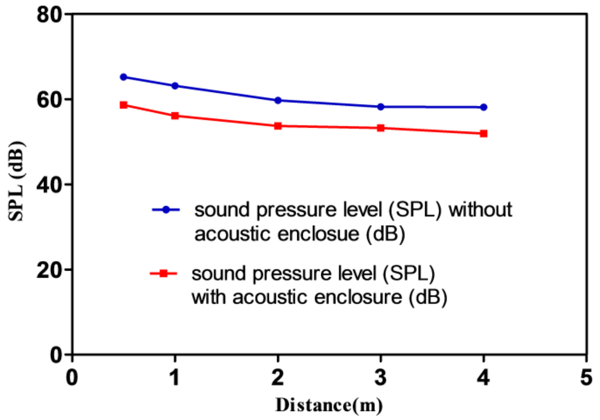

Figure 2. Variation of sound pressure level with and without acoustic enclosure at varying distance from source

As shown in the figure the sound pressure level was reducing as the distance from the sound source was increases for both the open environment and when the acoustic enclosure is used.

The sound pressure level when running the generator without the acoustic enclosure ranged from 65.2 dB at a distance of 0.5 m from the source to 58.1 dB at a distance of 4 m from the source. This sound pressure level can impart negatively on the health and comfort of people exposed to it [12]. The use of the acoustic enclosure decreased the sound pressure level to 58.6dB at 0.5 m and 52.9 at a distance of 4 m.

IV. CONCLUSION

The study reports the use of an acoustic enclosure to attenuate the sound pressure level emanating from portable generators used in many homes in developing economies like Nigeria. The acoustic enclosure was fabricated using plywood padded with acoustic foam. Result from the performance evaluation of the acoustic enclosure showed that the sound pressure level reduce from 65.2 to 58.6(6.6 dB), 63.1 to 56.1(7 dB), 59.7 to 53.7(6 dB), 58.2 to 53.3(4.9 dB), 58.1 to 52.9 (5.2 dB) 0.5 m, 1.0 m, 2.0 m, 3.0 m, 4.0 m respectively from the generator.

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