Original Research Article
Investigation of Noise Pollution from Different Petrol Generators in Nigeria

ABSTRACT

Irregular and epileptic power supply in Nigerian, Africa and some other parts of the globe has made electric power generators the primary source of power for domestic and commercial purposes in such places. These generators produce noise pollution to the environment. Thus, a petrol generator muffler cabinet was produced to curb noise pollution. Sequel to proffering solution to noise pollution from petrol generators, this study investigated the noise pollution at varying distances from five different capacity gasoline generators of varying ages representing the range of petrol generator for both domestic and commercial uses in Nigeria. Five petrol generators of varying capacities 2, 3, 6, 10 and 14 kilo Volt Ampere (kVA), and age 1, 2, 3, 4, 5 years respectively were used for the experiment. The sound level from the generators were measured at varying distances of 0, 5, 10, 15 and 20 m respectively using a digital sound level meter. Two-way Analysis of Variance (ANOVA) was used to test the difference between generators of different ages at the varying distances at ($\alpha = 0.05$). The noise intensity decreased as distance from the generators increased. The lowest noise was recorded for the generators at age 1, and increased as the age of the generators increased. For the capacity of generators tested, the noise level produced by 1 year old generators at distances 0-20 m from the generator ranged from 60.9-83 dB for 2 kVA generator; 60.2-84.1 dB for 3 kVA generator; 64.7-86 dB for 6 kVA generator; 66.52-88.02 dB for 10 kVA generator; 70-91.8 dB for 14 kVA generator respectively. The mean noise from the range of (60.9-96.68 dB) observed in this study are above the World Health Organization specified noise limits of 30 and 70 decibels for both indoor and outdoor cases respectively.

Keywords: Electricity; electric generators; petrol generators; noise; noise pollution

1. INTRODUCTION

Mechanical power required in supplying most of global energy needed for global industrialization and motorization is supplied by fossil fuels [22]. Most of the earth's energy comes in form of mechanical or electrical energy. The socio-economic development and the standard of living of any nation is a function of their energy generation capacity. The development and standard of living of developed nations is a function of their per capita power consumption. This is evident with countries such as the United States of America, Australia, Germany and Japan with high per capita power consumption and countries like Bangladesh, Cambodia, Nigeria and Myanmar with low per capita power consumption [10]. Nigeria as a country is highly blessed with abundant natural resources required for electricity generation. These resources include crude oil, coal, tar sands, natural gas, wind, hydro, solar radiation, numerous biofuel sources, as well as othersources of energy such as niobium and nuclear [13; 24]. According to [5], only 45% of Nigerians have access to electricity supply. This access is both unstable and unreliable [5; 18] due to inadequate generation and incessant collapse of grid. Thus, to satisfy their energy need, Nigerians have resulted to the use of gasoline and diesel generators to augment for their power needs both for domestic and commercial purposes. This, development is accompanied with both

economic and environmental consequences. Noise pollution is one of the factors listed amongst the major disadvantages of internal combustion (IC) engines [15] in addition to low power production efficiency, high heat loss and air pollution. The pressure wave that results from alternating air pressure pulses of high and low pressure is known as sound.Noise is defined as an undesirable or an unwanted sound. Pressure waves are produced in the IC engine by the recurrent opening and closing of the exhaust valve. As a result, the sound wave is created by the high pressure of exhaust gases being transformed to low pressure through pressure pulses. These pressure pulses form the noise that is produced from the engine. Electricity generators are normally accompanied with vibrations and noise, which poses environmental, social and health challenges to man and animal [30]. Vibration and noise from electricity generators is a global problem. However, the Nigerian experience is enormous as a result of irregular and epileptic power supply, making electric power generators the primary source of power for domestic and commercial purposes [13; 31; 3]. According to [19], there has been a steady increase in the rate of importation of electric power generator over the years. [5] estimated the importation of about 60 million generators of varying sizes in Nigeria, used massively in offices, business premises, homes, schools, churches and others. The intense cases are shopping or commercial centers, where several units are operating simultaneously to run businesses. According to [1], sound is a productan objectvibrating in open airand emittingpressure waves into the air. Thedecibel (dB) scale defines the level of sound from 80 to 100 dB as (very loud), 100 to 125 dB(uncomfortable) and 140 dB (threshold ofpain). Unmuffled gasoline and diesel engines produces exhaust noise in the range of 85-100 and 100-125 decibel (dB) respectively. The human ear can tolerate a noise up to 80-100 dB, however, noise above 100 dB creates pain and discomfort, and can also lead to deafness [27]. The level of sound that is healthy for the human ear ranges from 0 to about 140 dB. 0 dB being a serene level for the ear, as the sound level exceeds 100 dB, it will become sensationally loud to the ear, and about the threshold of 140 dB the sound level will become painful noise to the ear. The sound or noise level of 80 dB is averagely normal for the human ear [19]. According to the Nigeria Environmental Protection Agency (EPA), the acceptable threshold of noise level is 70-75 dB, at above 90 dB hearing impairment sets in [19]. Protracted exposure to excessive sound above 85 dB is potentially hazardous. Generally, the sound level and total period of exposure are two significant interrelate factors in evaluating the impact of sound in any situation [14; 21].

Plant growth and development can be adversely affected by noise pollution. Photosynthetic process can be disrupted by high decibels leading to reduced plant production [12]. According to [6], stress from induced noise can deter seed germination and thus affect plant production processes. Some species of plant also depend on definite acoustic signals for seed pollination, excessive noise can disrupt this process, leading to interruptions in ecological interactions and biodiversity. A wide variety of animal species are adversely affected by noise pollution. Loud noises can disrupt natural habitats and behaviours of wildlife, causing altered migration patterns, changes in feeding and breeding habits, and increased stress levels. Excessive noise can disrupt conveyance vital signals to animals that rely on acoustic communication for mating, territorial defense, or parental care [8].

According to [16], noise levels above the 70-75 dB recommended World Health Organization's (WHO) threshold can be linked to conditions such as hypertension, aberrant foetal development, intense emotions, and inappropriate behaviour. Such noise levels have also been reported tocause instantaneous hearing impairment as well as complaints and friction among neighbours. Excessiveenvironmental noise may lead to heart-related issues. According to studies, high decibel sound has been linked to a sharp increase in blood pressure, since it narrows blood vessels and interferes with blood flow. The quantity of heartbeats per minute, or heart rate, likewise rises. These were demonstrated in a study where children living in noisy environments had heart rates that were higher than those of children living in less noisy environments[7].

The increase in dependency on electricitygenerators in Nigeria has led to spike in noise pollution both in homes and business places which has a damaging impact on the environment; human, animal and plant health. Effects of noise on humans include; irritation,interference with communication, distraction or loss of concentration, insomnia and high bloodpressure. Noise-Induced Hearing Loss (NIHL), a progressive and seemingly undetectable decrease in hearing sensitivity, can be brought on by prolonged exposure to less powerful yet harmful sounds [16; 20]. The range of noise level of a normal electric generator is between 80-105 dB at 6.4 m. This noise level fall into very loud to uncomfortably loud level with respect tosensitivity of human ears. This makes electrical generators a source of noise pollutionto the environment**.** In the United States, for instance, laws and regulations usually permit noise levels in residential homes to not exceed 67 dB, and in industrial locations not exceed 72 dB [29].

Most of the previous researches on noise pollution from petrol generators were focussed on questioner responses from users and noise pollution assessment of clustered generators [4; 23; 2]. Sequel to proffering solution to noise pollution from petrol generators, this study investigated the noise pollution at varying distances from five different capacity gasoline generators of varying ages representing the range of petrol generator for both domestic and commercial uses in Nigeria.

2. MATERIALS AND METHODS

2.1 Experimental procedure

Five petrol generators of varying capacities 2, 3, 6, 10 and 14 kilo Volt Ampere (kVA), and age 1, 2, 3, 4, 5 years respectively were used for the experiment. The sound level from the generators were measured at varying distances of 0, 5, 10, 15 and 20 m respectively using a digital sound level meter model UT353. The experiments were carried out in three replications. Two-way Analysis of Variance (ANOVA) was used to test the difference between generators of different ages at the varying distances at ($\alpha = 0.05$).

3. RESULTS AND DISCUSSION

The results of the estimated marginal mean of sound intensity generated from the various generators at varying distances and years are presented in Figs 1-5. The model relationship of sound loudness from generator capacities against age and distance is as shown in Table 1. The two-way (ANOVA) relationship at ($\alpha = 0.5$) between the ages of generators and distances from the generator and sound level is shown in Table 2.

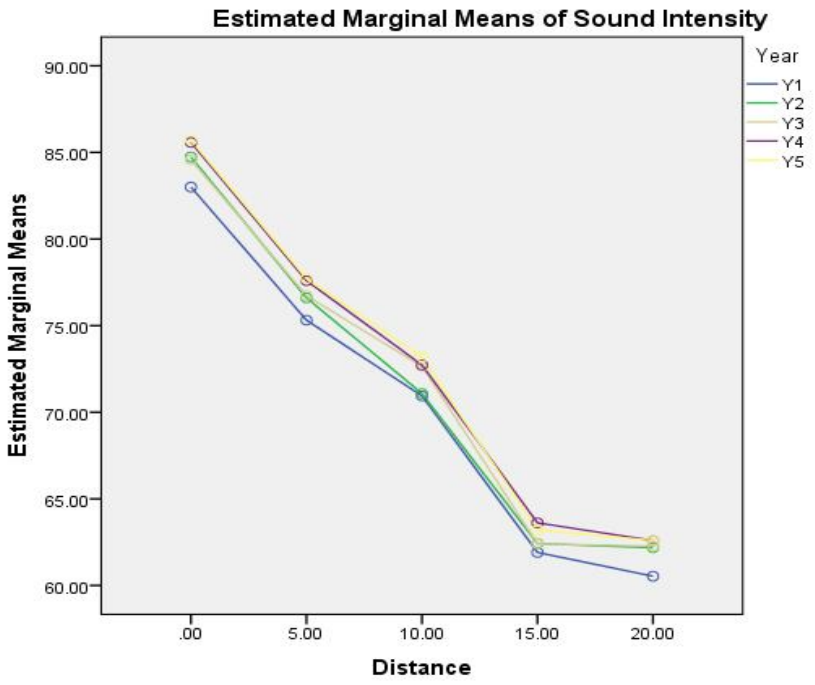

Fig. 1. Estimated marginal mean of sound intensity generated from 2 kVA generator set at different distances and years

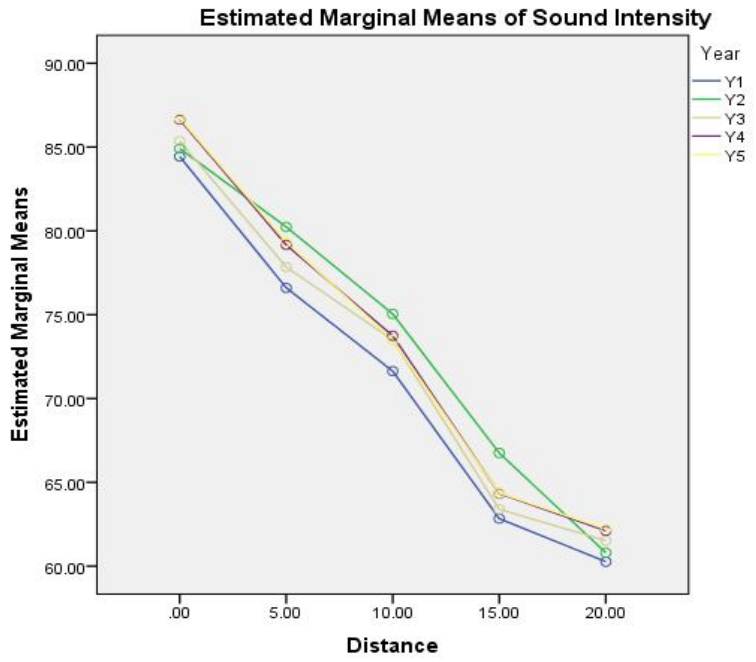

Fig. 2. Estimated marginal mean of sound intensity generated from 3 kVA generator set at different distances and years

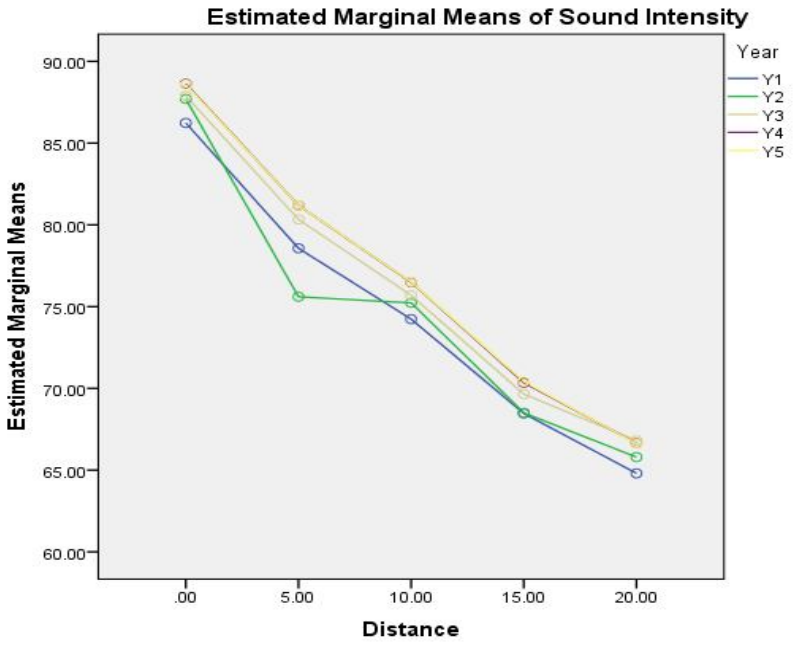

Fig. 3. Estimated marginal mean of sound intensity generated from 6 kVA generator set at different distances and years

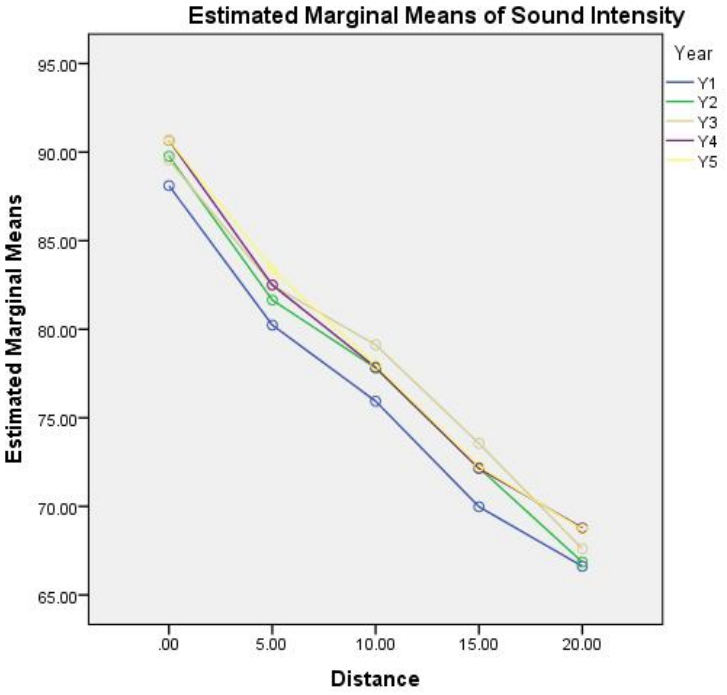

Fig. 4. Estimated marginal mean of sound intensity generated from 10 kVA generator set at different distances and years

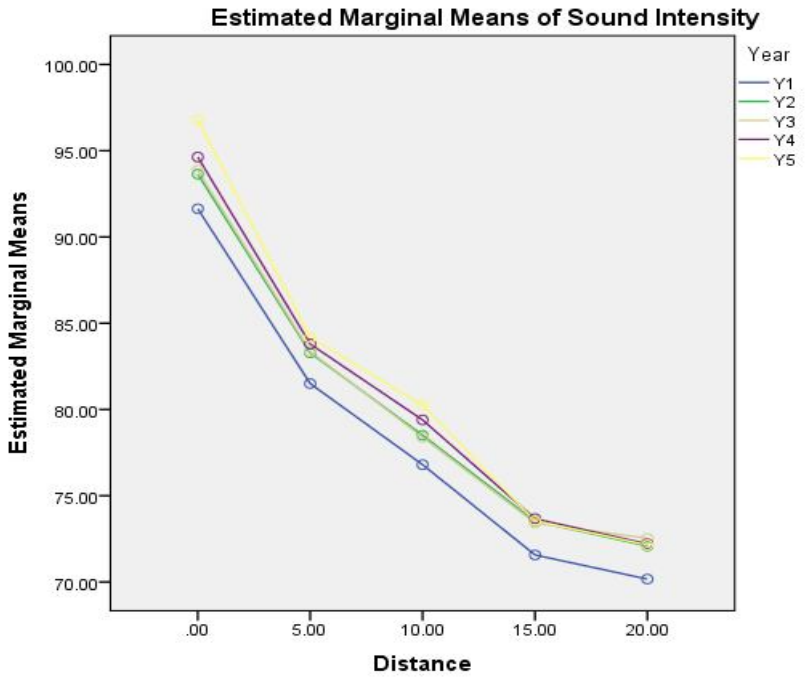

Fig. 5. Estimated marginal mean of sound intensity generated from 14 kVA generator set at different distances and years.

As shown in Figs (1-5), the noise intensity decreased as distance from the generators increased. The lowest noise was recorded for the generators at age 1, and increased as the age of the generators increased. For the capacity of generators tested, the noise level produced by 1 year old generators at distances 0-20 m from the generator ranged from 60.9-83 dB for 2 kVA generator; 60.2-84.1 dB for 3 kVA generator; 64.7-86 dB for 6 kVA generator; 66.52-88.02 dB for 10 kVA generator; 70-91.8 dB for 14 kVA generator respectively. This trend was the same for all the other generator capacities for 2-5 years. The results are within the range of 85.33 ± 1.47 dB from at 3 m distance obtained by [14]. Similarly, [4], obtained mean values of 109.86, 85.95, 83.09, 80.68 and 81.69 decibels at 1-3 m distances from generators capacities of 0.5-5.0 kVA. The noise levels observed in this study are above the World Health Organization specified noise limits of 30 and 70 decibels for both indoor and outdoor cases respectively. Exposure to excessive or repetitive noise over a long duration of time can result in loss of hearing. According to [25], exposure to sound level above the range of 70 to 75 decibels can cause high blood pressure, abnormal fetal changes, extreme emotions and behaviour. Study by [28], indicated that the degree of the effect of vibration on man and animal depends the intensity and extent of exposures. It was observed that the sound levels from the generator increases as the age of the generator increases as shown in Table 1.

Table 1. Model relationship of sound loudness from generator capacities against age and distance

Capacity of generator (kVA)	Sound Loudness (decibel)			
	Age of Generator (year)		Distance (m)	
2	1	70.34 ± 8.70	0	84.72 ± 1.01
	2	71.40 ± 8.91	5	76.79 ± 0.92
	3	71.73 ± 8.87	10	72.12 ± 0.98
	4	72.42 ± 8.96	15	62.71 ± 0.73
	5	72.48 ± 9.10	20	62.03 ± 0.82
3	1	71.15 ± 9.20	0	85.61 ± 1.00
	2	73.54 ± 9.50	5	78.64 ± 2.00
	3	72.32 ± 9.30	10	73.48 ± 1.55
	4	73.19 ± 9.47	15	64.33 ± 2.57
	5	73.23 ± 9.48	20	61.38 ± 0.80
6	1	74.46 ± 7.81	0	87.80 ± 0.90
	2	74.57 ± 7.85	5	79.38 ± 2.19
	3	76.07 ± 7.82	10	75.63 ± 0.89
	4	76.66 ± 8.07	15	69.48 ± 0.89
	5	76.66 ± 8.05	20	66.13 ± 0.79
10	1	76.18 ± 7.87	0	89.76 ± 0.99
	2	77.65 ± 8.14	5	82.05 ± 1.11
	3	78.46 ± 7.77	10	77.74 ± 1.07
	4	78.38 ± 8.01	15	72.02 ± 1.02
	5	78.60 ± 8.12	20	67.71 ± 0.97
14	1	78.33 ± 8.04	0	94.11 ± 1.72
	2	80.21 ± 8.07	5	83.22 ± 0.96
	3	80.31 ± 8.09	10	78.67 ± 1.20
	4	80.74 ± 8.37	15	73.14 ± 0.85
	5	80.19 ± 8.20	20	71.82 ± 0.89

The values of Probability of F lower than 0.05 as shown in Table 2 indicates a significant difference in noise level of the generators as they age. The probability values are < 0.05 for all the generators 2, 3, 6, 10 and 14 kVA at age 1, 2, 3, 4 and 5 years respectively across all the distances investigated. Also, the very high of coefficient determination R^2 values > 0.9990 indicates a large significant effect.

Table 2. ANOVA effect of age of generator and distance from generator on sound loudness

Generator Capacity (kVA)	Source	Sum of Squares	df	Mean Square	F	Sig.
2	D	5546.983	4	1386.746	16720.404	0.000
	Y	46.020	4	11.505	138.720	0.000
	D * Y	6.486	16	0.405	4.887	0.000
	Error	4.147	50	0.083		
	Total	5603.636	74			
	R Squared =0.999					
3	D	6009.094	4	1502.274	645.479	0.000
	Y	56.663	4	14.166	6.087	0.000
	D * Y	33.538	16	2.096	0.901	0.573
	Error	116.369	50	2.327		
	Total	6215.663	74			
	R Squared =0.981					
	D	4353.927	4	1088.482	44631.855	0.000
	Y	72.131	4	18.033	739.412	0.000

	D * Y	36.698	16	2.294	94.047	0.000
6	Error	1.219	50	0.024		
	Total	4463.975	74			
	R Squared =1.000					
	D	4442.118	4	1110.529	24367.252	0.000
	Y	61.175	4	15.294	335.578	0.000
	D * Y	16.758	16	1.047	22.981	0.000
10	Error	2.279	50	0.046		
	Total	4522.329	74			
	R Squared =0.999					
	D	4876.314	4	1219.078	29307.587	0.000
	Y	77.591	4	19.398	466.338	0.000
	D * Y	16.482	16	1.030	24.766	0.000
14	Error	2.080	50	0.042		
	Total	4972.467	74			
	R Squared =1.000					

Note: D = Day, Y = Year

4. CONCLUSION

Investigation of noise pollution from different petrol generators of varying capacities and age was carried out. The sound levels five petrol generators of varying capacities (2-14 kVA) at age (1-5 years) at distances (0-20 m) were measured. The noise levels produced by the generators were list at year one and increased as the number of years increased. The noise level decreased as distance away from the generators increased. The mean noise from the range of (60.9-96.68 dB) observed in this study are above the World Health Organization specified noise limits of 30 and 70 decibels for both indoor and outdoor cases respectively.

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