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Noise Levels and Noisiness of some Power Generators in Federal College of Education Environs, Pankshin, Plateau State Nigeria

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Abstract
This research was on determination of noise levels and noisiness in noys of some power generators and comparing the results to international noise regulatory bodies permissible noise limits. Measurement of sound pressure levels from different generators rated 650 watts to 5.0kilo watts was carried out using sound level meter SL 4010 EUROLAB. The corresponding noisiness was determined using a noy chart 150 507 using the representative frequencies of a complex sound. The measured sound pressure levels ranged from 76 &BA to 97 dBA. The noisiness ranged from 45.20noys to 189.06 noys. The noise levels were higher than the international proposal for noise limit of 45 dBA aquivalent to 5.6 noy daytime and 40dBA equivalent to 3.4noys evening time. The noise levels were above the occupational safety and Health Administration (OSHA) exposure permissible noise limit of 80dBA equivalent to 63noys and also higher than the world Health Organization (WHO) exposure permissible noise limit of 90dBA equivalent to 120.3noys.
Keywords: noise level, noisiness, noy, power generators.

INTRODUCTION

The research into noise levels and the degree of unwantedness of sound in our society cannot be over emphasized.

In everyday live, we have to tolerate high levels of noise such as traffic, busy streets and shops in our workplaces and homes.

Noise causes hearing damage and hearing loss. It interferes with work tasks, speech communication and interferes with sleep. Annoyance and irritation are consequences of prolonged exposure to noisy environment. Noise causes stress reaction and lowers morale. It also cause fatigue and interferes with concentration (Parvathi & Navaneetha 2003). The National Environmental

Standards and Regulation Enforcement Agency (NESREA) has now made noise a criminal offence punishable by imprisonment or fine or both. In recent years workers and consumers have begun to demand quieter environments and quieter products and several new proposals for noise limits have been introduced into standardization and regulatory processes. For example, the maximum environmental noise limits are 80dBA for noise tolerant area (industrial area), 60dBA general office area, for general business area, 70dBA (Lenovo 2010). The international proposal for noise assessment with respect to community response suggests the following basic noise limits; daytime 45dBA; evening 40dBA and night 30dBA (Bentley, Murphy & Dudley 1977). Occupational safety and Health Administration (OSHA) recommends exposure noise limit of 80dBA (Dennis 2007). The World Health Origination (WHO) maximum permissible noise limit of 90dB is recommended (Anomohancan et al. 2008).

Para portable generators are used very commonly in shops, offices and homes today in order to supply power during power Holdings Company of Nigeria (PHCN) shut down. These generators emit high levels of noise in addition to noxious gas emission. The noise may be generated by aerodynamic effects or due to force that result from combustion process or may result from mechanical excitation by rotating engine components (Parvathi, Navaneetha and Gopalakrishaa 2003). The commonly measurable characteristics of sound from a source (generator) are sound pressure level, sound power level, its frequency and time duration (Kinsler et al. 1982). Sound pressure level is the logarithmic measure of sound pressure relative to the reference sound pressure. It is calculated by taking the logarithm of the ration of the sound pressures to the base ten (Nelkon & Parker 1970).

The researchers became concerned about the way these generators' noise could affect the well-being of customers or passerby considering that generator noise is one of the major contributions to environmental noise pollution.

The research was aimed at investigating whether these noises from the generators are high or not and to compare with international nose standards.

The research work was carried out in Federal College of Education environs in Pankshin LGA of Plateau State.

Seventeen (17) commonly used portable generators of power output rate ranging from 650 watts to 5.0kw were used in the research. The types of generator make were: GI ELEPAQ Generator Sv 3500 E2 2.5kw,

G2 JINLING Generator JL 2800 2.5kw, G3 TIGER Generator TG 1000 650 watt, G4 GASOLINE Generator LL3GF – 4A 2.8kw, G5 SUMEC Generator SPG 2500 2.0kw,G6 TIGER Generator TG 950 650w, G7 JINLING Generator JL 6600 5.0kw, G8 PARSUN Generator 1900 Dx 950w, G9 Sz Generator TG 1150 650w, GIO RITO Generator RT 1000 650w, G11 JINLING Generator JL 3600 2.5kw, G12 DUMEK DG 1000 650w, G13 TIGER Generator 2.3kw, G14 SUMEC FRMANSPG 3000E2 2.5kw, G15 POWER Generator SV 2940E 2.4kw, G16 KING CRAFT KC 3000AE 2.5kw and G17 SUMEC F-RMAN SPS 2900 2.0kw.

Good frequency analysis of the generator noise could lead to the correct selection of hearing protection device to be used or for the development of noise control engineering (Wikipedia 2010). It will also be useful to engineers in generation noise mitigation and environmental noise reduction.

THE ESSENTIALS OF NOISE LEVELS

Noise is simply any unwanted sound.

Noisiness is the degree of unwantedness of sound perceived as being noisy. The unit of noisiness is the noy. One noy is defined as the noisiness of 1000HZ tone at a sound pressure level of 40dB (Gracey and Associate, 2011). Expression for noisiness is $N(K) = n(ik) + 0.3 \{(\sum_{i=1}^{k} n(ik)) - n(ik)\}$ (Federal Aviation Resolution 2002).

N(k) = Total noisiness in the K band, n(ik) = maximum value of noisiness in the k band and 0.30 = constant for k octave band.

When the amount of sound becomes uncomfortable or annoying, it means that the vibration in air pressure near the ear has reached too high amplitude (Dennis 2007).

The acoustical characteristics of speech, sound as well as those of music and noise may be measured with considerable precision by the use of standard acoustical instrumentation which includes microphone, frequency analyzer etc. The result of such measurements may be expressed in terms of precise physical parameters including frequency, power, pressure level etc (Kinsler et al.1982).

Sound Pressure Level

Sound pressure level of a sound source especially the A-weighted sound pressure level relates to what our ears hear. Sound pressure levels vary substantially with distance from source and also diminish as a result of intervening obstacles and barriers, air absorption and wind (Wikipedia 2010). Sound pressure level (SPL) is a logarithmic measure of sound pressure relative to the sound pressure $= 20\log_{10}(p/po)$

Where $Po = 2x10^{-5} N/m^2$

In terms of sound power, sound pressure level (SPL) = $10\log w \times 10^{-4\pi r2}/10^{-12}$

$= (10\log_{10} w + 120) - 10\log_{10} 4\pi r^2$

$= Lw - 20\log_{10} r - 11$ (for absorbent ground)

$SPL = Lw - 20\log_{10} r - 8$ (for non- absorbent ground) (Smith, Peters & Owen 1998)

Sound power level Lw can also be expressed as $Lw = SPL + 10\log_{10} S$

Where S = area $= 4\pi r^2$ (sphere) $= 2\pi r^2$ (hemisphere) (National instrument, 2010)

In order to characterize a particular noise, the sound pressure level must be measured at different frequencies. The noise level is specified in terms of the octave frequency bands in the audible frequency range (20Hz – 20 kHz). Measuring noise level without specifying any frequency usually takes into consideration the representative frequencies to analyze the noise. The representative frequencies covering the range of importance to complex sound (music, speech and noise) are 12Hz, 250Hz, 500Hz, 1000Hz, 2000Hz and 4000Hz which fall into the octave band frequencies (Kinsler et al. 1982).

Sound Level Meter

A sound level meter consists of a sensitive microphone, an amplifier, frequency weighing networks and an indicating meter calibrated to read decibel (kinsler et al. 1982)

The frequency weighting network designated A, is commonly used as it reflects closely to human hearing (Bentley, Murphy & Dudley 1977). The linear decibel reading can be converted to read on the A-scale by using the relative response correction data. These corrections are added to the linear readings of the SPLs at a particular frequency, to obtain the readings on the A-scale (Smith, Peters & Owen 1998).

The A-weighted sound level meters give their readings in dBA, directly.

Adding Sound Pressure Level and Averaging Sound Pressure Level.

Sound pressure levels can be added logarithmically by using their differences and the corresponding corrections. The corrections are added to the highest of the SPLs being added.

A formula was established to average a number of sound pressure level (SPL) given as

$L_{AV} = 10\log_{10}(10^{L1/10} + 10^{L2/10} + \ldots\ldots + 10^{Ln/10}) - 10\log_{10} n$

= sum of decibels $- 10\log_{10} n$ (Smith et al 1998)

Where n = number of different SPL in dB
L_{AV} = average of SPL in dB, L1, L2…. Ln is first, second to the nth SPL in dB respectively.

MATERIALS AND METHODS

Sound levels of the generators were measured using the sound level meter types, SL4010 EUROLAB which has a frequency range of 31.5Hz – 8 kHz. The measuring level ranges from 30 – 130dBA, accuracy of ±1.5dBA with A and C frequency weighting. 'A' is a scale use for general sound level measurements. It corresponds to the response of the ear. 'C' is a scale use for measurement of low frequency noise.
Measurement of generator noise level was carried out where there were no other generators running. Where it was observed that another nearby generator was running, the owner was requested to switch it off. Other noises nearby were also put off. The generators whose levels were investigated (in an unloaded or loading condition) were placed on the ground in an open field. For each generator, the reading position was at 1m distance from it.

The procedure for the measurement using the sound level meter was commenced with the installation of the 9 volt battery and the power of the meter turned on.

The meter level was put on slow and the A – weighting was selected. The desired level was put to 'low' for level range 30 – 100dB and was put to 'high' for level range 60 – 130dB and the level meter's microphone was pointed at the generator and held steadily and as far away from the body. The sound pressure level displayed was record. The 'maximum hold' mode was selected to capture the maximum noise level and was also recorded. As precautions taken during the experiments, no measurements were done near any hard reflecting object or in the presence of aircraft noise and other environmental noise. The experiments were not carried out in rainy and windy conditions. The measurements were repeated to confirm that noise level had remained unchanged, and where there were changes, averaging was made.
The Noy chart IS0507 was used to determine the corresponding noisiness in noys of the sound pressure levels. The frequencies 125Hz, 250Hz, 500Jz, 1000Hz, 2000Hz and 4000Hz were used as the representative frequencies for complex sound.

RESULTS

SOUND PRESSURE LEVELS AND NOISINESS
Measurements of sound pressure levels were done using the sound level meter type; SL 4010 EUROLAB. The sound pressure levels at 1m distances from the generators were measured and noisiness determined. The results are shown in the table below.

NOISINESS (NOY) AT VARIOUS FREQUENCIES

S/N	Generator type	Usage period (months)	Average Sound Pressure Level (dBA)						Total Noisiness (Noy)
				125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	
1	G1	6	81	11.50	15.00	17.50	18.20	30.00	35.00	62.66
2	G2	12	94	28.70	36.60	44.00	46.00	76.60	92.00	161.57
3	G3	12	82	12.00	16.25	18.30	19.50	32.00	40.00	69.40
4	G4	24	88	17.90	22.50	28.00	28.80	48.00	60.00	83.04
5	G5	2	87	16.40	21.20	25.60	26.60	44.00	51.00	91.14
6	G6	12	76	7.50	10.60	12.60	12.70	22.20	25.50	45.20
7	G7	12	93	26.60	32.70	40.00	42.20	70.00	80.00	143.45
8	G8	12	88	17.90	22.50	28.00	28.80	48.00	60.00	83.04
9	G9	12	82	12.00	16.25	18.30	19.50	32.00	40.00	69.40
10	G10	12	78	8.90	12.50	14.10	14.40	25.00	29.50	51.97
11	G11	12	86	16.60	19.30	23.70	26.20	42.00	48.00	86.34
12	G12	12	81	11.50	15.00	17.50	18.20	30.00	35.00	62.66
13	G13	36	97	53.00	44.00	52.50	53.70	90.00	106.50	189.06
14	G14	24	91	23.10	28.70	35.00	37.00	60.00	69.20	124.34
15	G15	36	94	28.70	36.60	44.00	46.00	76.60	92.00	161.57
16	G16	6	87	16.40	21.20	25.60	26.60	44.00	51.00	91.14
17	G17	2	86	16.60	19.30	23.70	26.20	42.00	48.00	86.34

DISCUSSION

The result shows that the noise levels ranges from 76dBA to 97dBA. It could be observed that generators with longer period of usage have relatively higher noise levels. For instance generator G13 which has been in used for thirteen months has high noise level of 97dBA. Variation of noise level can depend on type of generator make for instance generators type G9 and G12 both 650 watts has noise levels of 82dBA and 81dBA respectively.

The noise levels and corresponding noisiness are linearly dependent. Comparing these noise levels from the result, we can see that the noise levels are higher than the international noise regulatory bodies permissible noise limits. For example, the noise levels are higher than permissible noise limit of 45dBA equivalent to 5.6noys daytime and 40dBA equivalent to 3.4noys evening time. The noise levels are also higher than the occupational safety and Health Administration noise limit of 80dBA equivalent to 63noys and higher than the world Health Organization (WHO) exposure permissible noise limit of 90dBA equivalent to 120.3noys. These high noise levels can lead to negative impact on the society as it may cause annoyance and reduce concentration on work tasks. It can cause hearing loss in individuals and can interfere with speech communication.

CONCLUSION

Power Generator noise is a major contributor to environmental noise pollution. Measurement of generator noise with sound level meter SL 4010 EUROLAB were carried out in Federal College of Education environs Pankshin, Plateau State, Nigeria. The generators under research ranged from 650 watts to 5.0 kilowatts. The sound pressure levels measured were from 76dBA to 97dBA. The noise level were higher than the international noise regulatory bodies permissible noise limits, as mentioned in the discussion above.

Noy chart ISO507 was used in noisiness measurement giving a minimum and maximum value of 45.20 noys and 189.06 noys. And the general variation is due to type of generator make and period of usage of the generators.

RECOMMENDATIONS

The knowledge of power generators noise level is to help us reduce these noises and by that, we can reduce noise pollution in our environments. Therefore we will recommend that

(i) Usage of old and unserviceable generators should be discouraged.
(ii) Certain type of generator make that emits high noise level should be discourage
(iii) The to be buyers should be guided appropriately on how to buy low noise generators
(iv) Power generators should be kept in sound absorbent location to reduce the noise.
(v) The relevant agency responsible for the control of these noises like the National environmental standard and Regulation Enforcement Agency (NESREA) should take active measures to enforce relevant laws on environmental noise reduction seriously.

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