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Environmental Noise Assessment of Fuelless and Gasoline Power Generating Set

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Abstract- Noise pollution which is an unwanted sound is one of the most dangerous environmental pollution because it usually leads to damage of auditory and even leads to stress for human in most cases. This research work investigate environmental noise produce by fuelless power generating set and gasoline power generating set of the same capacity (1KVA). The materials used for this research work includes, 1KVA Gasoline Generating set, 1KVA Fuelless Generating set, Extech sound meter, meter rule, load box, multimeter and stop watch. Extech Instrument Sound Level Meter and meter rule was used to determine the sound performance of the electrical machines. The result of the research revealed that the sound performance analysis for fuelless Power generating set is within the allowable range set (38.4dB) by Occupational Safety and Health Administration (OSHA) Federal Safety regulations (2007) compared to gasoline power generating set with 66.5dB. In wrapping up the investigation on the fuelless and gasoline generating set in terms of noise assessment, the analysis has clearly revealed that fuelless generating set noise is better than gasoline power generator of the same capacity.

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I. Introduction

Maini (1998) has discovered that the fuelless engine usually runs very smooth and quiet and the best part of the design is that it is free from air pollution, since there is no emission of dangerous gas like Carbon monoxide (CO), carbon-dioxide (CO_2), etc. The speed are adjustable or can be built to run at one speed with engine which does not run on any type of gasoline, oil or other combustible fuel. The free electrical energy produced by the fuelless generators is replaced back into the motor and reused by the motor. While a power generator is a device that converts mechanical energy to electrical energy for use in an external circuit.

Joseph (1997) has observed that noise is a hazard that human being expose to every day without consideration. It can cause physical problems such as permanent hearing loss, as well as psychological traumas, like stress. More and more requirements by regulating bodies, like OSHA (Occupational Safety and Health Administration), are being applied to every facet of daily life in order to reduce noise pollution. There are two general methods which can be used to achieve the required noise levels; active and passive noise control. Active noise control (ANC) is specific in its application. It works well for the control of low frequency noise sources. ANC requires state-of-the-art electronic hardware and precise computer software. Today it remains one of the more expensive forms of noise control, often requiring large amounts of engineering time and costly control systems. The most cost effective and widely used form of noise suppression is still passive noise control. Passive control is achieved by the use of barriers, enclosures or some type of acoustical material. Barriers are large panels that interrupt the direct "line of sight" from the noise source to the receiver (Oldham and Hilarby, 1991).

Dennis (2007) has cited by Adewumi (2014) has described sound has what the human ear hears while noise is simply unwanted sound. Sound is produced by vibrating objects and reaches the listener's ear as pressure waves in the air or other media. Sound is technically a variation in pressure in the region adjacent to the ear. When the amount of sound becomes uncomfortable or annoying, it means that the variations in air pressure near the ear have reached too high an amplitude. The human ear has such a wide dynamic range that the decibel (dB) scale was devised to express sound levels. The dB scale is logarithmic because the ratio between the softest sound the ear can detect and the loudest sound it can experience without damage is roughly a million to one or 1:106.

Cummins (2007) has clearly revealed sources of generator set noise. Six major noise sources from generator set was discussed;

i. *Engine noise* – This is mainly caused by mechanical and combustion forces and typically ranges from 100 dB(A) to 121 dB(A), measured at one meter, depending on the size of the engine.

ii. *Cooling fan noise* – This results from the sound of air being moved at high speed across the engine and through the radiator. Its level ranges from 100 dB(A) to 105 (A) dB at one meter.

iii. *Alternator noise* – This is caused by cooling air and brush friction and ranges from approximately 80 dB(A) to 90 dB(A) at one meter.

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iv. *Induction noise* – This is caused by fluctuations in current in the alternator windings that give rise to mechanical noise that ranges from 80 dB(A) to 90 dB(A) at one meter.

v. *Engine exhaust* – Without an exhaust silencer, this ranges from 120 dB(A) to 130 dB(A) or more and is usually reduced by a minimum of 15 dB(A) with a standard silencer.

vi. Structural/mechanical noise – This is caused by mechanical vibration of various structural parts and components that is radiated as sound.

MIT (2015) has identified that the ear has three main parts. They are called the outer, middle, and inner ears. The *outer ear* consists of the organ on the side of our heads that we usually call simply "the ear". (The scientifically accurate name for this structure is the pinna.) Also included in the outer ear is the ear canal. This is the hollow tube that leads from the pinna into the head. It terminates in the eardrum which is technically known as the tympanic membrane. The purpose of the external ear is to transmit sounds from the outside world into the more internal parts of the auditory system. While one can simply think of the pinna and ear canal as a simple funnel for collecting sounds, in reality they perform some important functions. The pinna has various ridges and folds that act to reflect and absorb certain frequency components of the sound wave . Because the pinna is not circularly symmetric, sounds which come from different directions will have slightly different spectral characteristics. (This means that certain frequencies will be slightly louder or softer depending on the direction they enter the ear.) As a result, sounds which come from above our heads seem slightly different than sounds coming from below. This allows us to localize (pinpoint the direction of) a sound source. We therefore immediately look up when someone calls us from an upper story window.

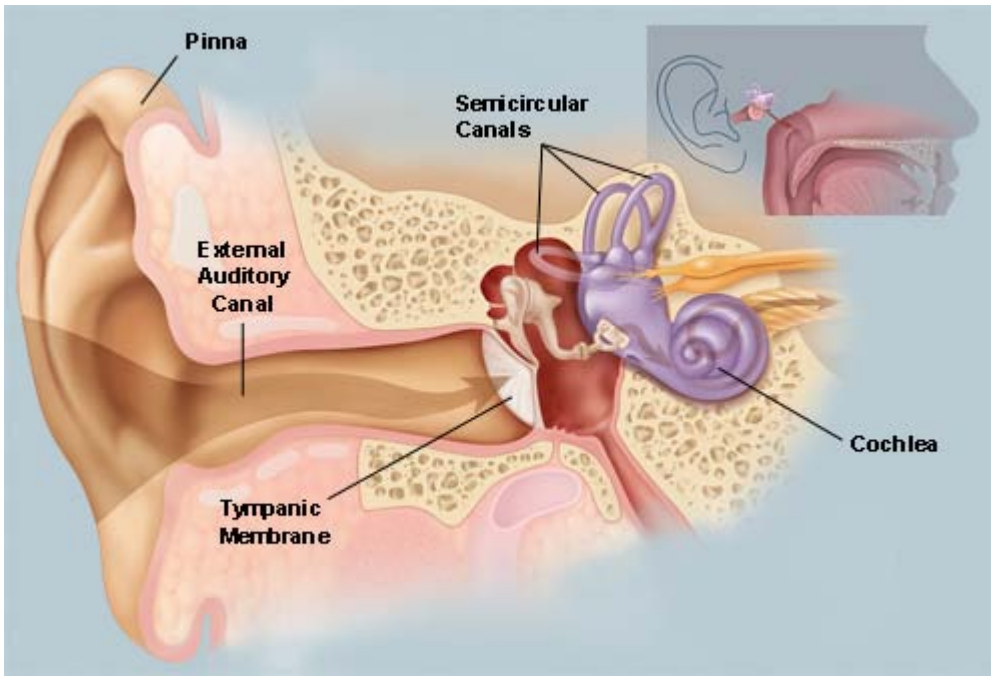


Figure 1 : Human Ear (Source: WebMD 2014)

Barry (2015) has discovered that the dynamic range of the auditory system, which is the interval between the softest and loudest sounds that the ear can hear, is more than 120 decibels. The decibel is the log of the ratio of two quantities multiplied by 10. This means that the ear can hear sounds whose strength lies anywhere within a range of over 12 orders of magnitude. The ear is sensitive enough that it can detect sounds which are so weak that the air molecules move less than the diameter of an atom! But yet it is also able to handle much louder sounds without overloading and saturating ("maxing out") which would cause undesirable distortion. This is accomplished by means of an automatic gain control system (AGC) which attenuates the response to louder sounds.

II. Materials

The materials used for this research work includes, 1KVA Gasoline Generating set, 1KVA Fuel less Generating set, Extech sound meter, meter rule, load box, multimeter and stop watch.

1KVA Fuelless Power Generating Set

1KVA TIGMAX Gasoline Generating Set

III. Methods

Extech Instrument Sound Level Meter and meter rule was used to determine the sound performance of both fuel less and gasoline generating set (1KVA). Five different runs were set for distance of 5m, 10m and 15m respectively. The result of the sound are stated below in Table 1 -4.

Sound Performance Analysis Result

Table 1 : Sound Performance at distance of 5 meters apart

Trial	Distance from property line (m)	Time (Sec)	Fuel less Noise level (dB)	Gasoline Noise (dB)
1	5	60	50.9	66.9
2	5	120	50.5	66.5
3	5	180	49.2	66.4
4	5	240	50.6	66.5
5	5	300	50.7	66.4
		Mean	50.38dB	66.54dB

Source: Field Work (2015)

Table 2 : Sound Performance at distance of 10 meters apart

Trial	Distance from property line (m)	Time (Sec)	Fuel less Noise level (dB)	Gasoline Noise (dB)
1	10	60	44.5	63.5
2	10	120	43.9	62.9
3	10	180	44.2	63.1
4	10	240	43.6	62.4
5	10	300	44.2	62.5
		Mean	44.08dB	62.88dB

Source: Field Work (2015)

Table 3 : Sound Performance at distance of 15 meters apart

Trial	Distance from property line (m)	Time (Sec)	Fuel-less Noise level (dB)	Gasoline Noise (dB)
1	15	60	37.1	54.5
2	15	120	38.3	55.2
3	15	180	38.8	54.3
4	15	240	38.5	54.4
5	15	300	39.3	55.2
		Mean	38.4dB	54.72dB

Source: Field Work (2015)

Table 4 : Mean Noise Level Performance for Fuel less and Gasoline Generating Set

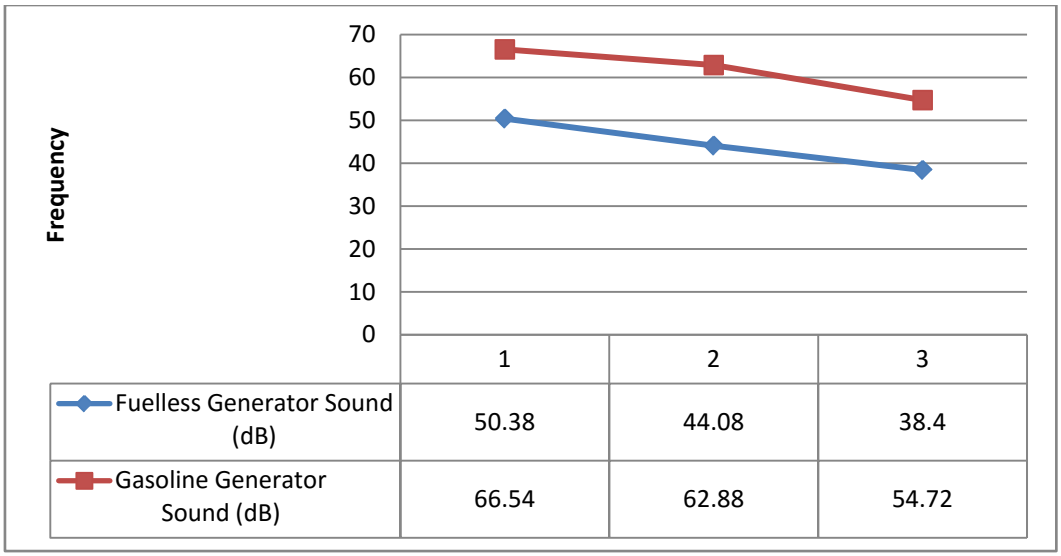
Trials	Time (Sec.)	Distance (Meter)	Fuel-less Sound (dB)	Gasoline Sound (dB)
5	300	5	50.38	66.54
5	300	10	44.08	62.88
5	300	15	38.4	54.72

Source: Field Work (2015)

IV. Discussion

The above Table 4 revealed that in terms of sound performance fuel less generator is better than gasoline generating set as the noise level ranges from 38.4dB at distance of 15meters away from the building to 50.38dB which is still in range of quite to moderately loud as reported by Dennis (2007). While that of gasoline generating set ranges from 54.72dB to 66.5dB which is moderately loud according to typical noise level chart by Dennis (2007).

According to Occupational Safety and Health Administration (OSHA) Federal Safety regulations (2007) as cited in Dennis (2007) explained sound as what the human ear hears; noise is simply unwanted sound. Sound is produced by vibrating objects and reaches the listener's ear as pressure waves in the air or other media. Sound is technically a variation in pressure in the region adjacent to the ear. When the amount of sound becomes uncomfortable or annoying, it means that the variations in air pressure near the ear have reached too high amplitude. With maximum noise levels permitted at a property line that range from 52 dB(A) to 72 dB(A), depending on location and zoning, and untreated generator set noise levels that approach 100 dB(A) or more, it is clear that generator set noise mitigation will be a subject of great importance.



	1	2	3
Fuelless Generator Sound (dB)	50.38	44.08	38.4
Gasoline Generator Sound (dB)	66.54	62.88	54.72

Figure 2 : Noise level variation between fuel less Generating set and Gasoline type

V. Conclusion

In wrapping up the investigation on the fuel less and gasoline generating set in terms of noise assessment, the analysis has clearly revealed that fuel less generating set noise is better than gasoline power generator of the same capacity. It was also discovered that both of the power generating set must be place at distance of 15m away from the user in order not to have any health related issues like ear defect, blood related diseases among others, due to the environmental issues associated.

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