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Grinding Machine Operator's Noise Exposure Levels at Refinery Road Market, Effurun Delta State, Nigeria

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***Abstract*—** *One of the human activities that generate continuous noise is the use of grinding machines to grind materials for human consumption. Mostly these grinding machines are operating in market places. This research became necessary so as to evaluate the operator's noise exposure level while working at the Grinding machine. The noise level measurements were taken three different times on the same day for 30 days in July 2016. The periods of measurements were; in the morning (7:30 am - 8:00 am), at the peak of commercial activity (12:30 pm - 1:00 pm) and towards the close of commercial activity (5:30 pm - 6:00 pm). The measurements were obtained at 1 m from operator of the grinding machine in the market on week days (Mondays to Fridays) with exception of Saturday and Sundays. The average daily noise level of measured was 97.45 (dBA), the dose calculated was 270.75 % and TWA of 97.18 (dBA). The operator of a grinding machine is exposed to about 97.18 (dBA) of noise for 6 to 7 hours every day. This value is very high above the standard daily allowable OSHA exposure limit. This value exceeded the lower exposure action value in the Republic of Ireland (80 dBA). Hearing impairment may result. This result also exceeded the general guidelines for noise level according to International Finance Corporation – World Bank Group, (2007). This value (97.18 dBA) is considered as very high risk, hence the operator of the grinding machine should be wearing a hearing protector of SNR 25 – 35 and must be given training about hearing damage and protection. Regular monitoring of the noise levels must be carried out to ensure they have not increased.*

***Keywords*—** *Noise; Grinding Machine; Effurun; Operator.*

I. INTRODUCTION

In present day Nigeria, noise has become part and parcel of every human activity, hence its damaging effects on man is not receiving appropriate attention. One of the human activities that generate continuous noise is the use of grinding machines to grind materials for human consumption. Mostly these grinding machines are operating in market places. Refinery Road Market as the name implies is situated along Refinery road, in Effurun Delta State, Nigeria. It serves mostly the elites living around the area for its convenience in terms of access road and proximity.

Noise and vibration are both fluctuations in the pressure of air (or other media) which affect the human body. Vibrations that are detected by the human ear are classified as sound. We use the term 'noise' to indicate unwanted sound. Noise and vibration can harm workers when they occur at high levels, or continue for a long time [1].

Noise-induced hearing loss can be temporary or permanent. Temporary hearing loss results from short-term exposures to noise, with normal hearing returning after period of rest. Generally, prolonged exposure to high noise levels over a period of time gradually causes permanent damage [1].

In major cities, noise exposure levels vary between day and night, higher during the day and lower at night. The night time exposure levels serve as a recovery time for those who are exposed to high noise value during the day [2].

Exposure to high levels of noise can cause permanent hearing loss. Neither surgery nor a hearing aid can help correct this type of hearing loss. Short term exposure to loud noise can also cause a temporary change in hearing (your ears may feel stuffed up) or a ringing in your ears (tinnitus). These short-term problems may go away within a few minutes or hours after leaving the noise. However, repeated exposures to loud noise can lead to permanent tinnitus and/or hearing loss. Loud noise can create physical and psychological stress, reduce productivity, interfere with communication and concentration, and contribute to workplace accidents and injuries by making it difficult to hear warning signals. The effects of noise induced hearing loss can be profound, limiting your ability to hear high frequency sounds, understand speech, and seriously impairing your ability to communicate [1].

Long-term exposure to environmental noise may result in cardiovascular diseases such as high blood pressure, heart disease and stroke, annoyance; sleep disturbance, decreased school performance, besides hearing problems [3]. High level noise exposure in women during the development period of faetus is a stressor that may increase the risk of implantation failure, dysregulation of placentation or decrease of blood flow into the uterine [4].

A study by [5] revealed that exposure to excessive noise for a short period of time may produce a loss of heavy sensitivity. Continuous noise exposure over a long period of time (years) is more damaging than interrupted exposure to noise, which permits the ear to have a rest and possible recovery period. A study to investigate occupational noise in a textile plants in northern India conducted by [6] demonstrated the presence of gross occupational noise exposure in both the plants and he believes that occupation noise exposure and the related effects in India is a widespread problem. Noise at levels that do not damage hearing can have other adverse health effects. This can arise when noise chronically interferes with concentration and communication. Persistent noise stress can increase the risk of fatigue and cardiovascular disorders including high blood pressure and heart disease. Although safe levels to guard against these effects have not yet been fully determined, as a guide, the risk of adverse health effects can be minimized by keeping noise levels below: 50 dB(A) where

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work is being carried out that requires high concentration or effortless conversation. And 70 dB(A) where more routine work is being carried out that requires speed or attentiveness or where it is important to carry on conversations.

A noise exposure value of 80 (dBA) is called the lower exposure actions value. If this level of exposure is reached or exceeded, a detailed noise risk assessment must be carried out. If the noise exposure value is 85 (dBA), it is called the upper exposure action value and at this point if this value is exceeded, organization and or technical measures must be put in place. For a noise exposure value of 87 (dBA) (exposure limit value), this noise level must not be exceeded and immediate action must be taken to reduce the noise levels [7].

Most of the operators of grinding machines in market places do not feel there is any harm in working with those machines besides the risk of getting injured by the rotating parts. They are used to the noise generated by those machines and as result they see nothing wrong with it. This research became necessary so as to evaluate the operator's noise exposure level while working at the Grinding machine.

II. THEORY

TWA and Dose % are different representations of the same number, which the OSHA action levels are based on. These action levels are 85 dB (or 50%) and 90 dB (or 100%). If a worker is moving in an environment with different sources of noise, it is desirable to attach a noise dosimeter to the worker at the start of the day and allowed to monitor the real noise exposure. The function of the dosimeter is to provide TWA and the Dose % reading without subjecting someone to any manual calculations [8].

The Time Weighted Average is calculated using the high noise levels measured that a worker is subjected throughout the normal working day together the amount of time that the worker is exposed to them.

First calculate the Noise Dose as:

$$\boldsymbol{D}(\%)=100\left(\frac{\boldsymbol{C}_1}{\boldsymbol{T}_1}+\frac{\boldsymbol{C}_2}{\boldsymbol{T}_2}+\frac{\boldsymbol{C}_3}{\boldsymbol{T}_3}+\ldots\ldots+\frac{\boldsymbol{C}_n}{\boldsymbol{T}_n}\right) \quad (1)$$

For n = 1, Equation (1) becomes;

$$Noise\,Dose\,D(\%)=100\frac{C}{T} \quad (2)$$

Where C is the total length of the work-day in hours (8h), T is the reference duration corresponding to measured A-weighted sound level, L (dBA). T could be read off a standard table or calculated using the equation below:

$$T_n=\left(\frac{8}{2^{(L-90)/5}}\right) \quad (3)$$

L is the measured sound level

The value of T can easily be read off a look up table

TABLE I. T duration look up table.

L (dB)	T	L (dB)	T	L (dB)	T	L (dB)	T
80	32.00	90	8.00	100	2.00	110	0.50
81	27.90	91	7.00	101	1.70	111	0.44
82	24.30	92	6.10	102	1.50	112	0.38
83	21.10	93	5.30	103	1.30	113	0.33
84	18.40	94	4.60	104	1.10	114	0.29
85	16.00	95	4.00	105	1.00	115	0.25
86	13.90	96	3.50	106	0.87	116	0.22
87	12.10	97	3.00	107	0.76	117	0.19
88	10.60	98	2.60	108	0.66	118	0.16
89	9.20	99	2.30	109	0.57	119	0.14

Source: [8]

The moment D (%) is calculated the TWA8 can be calculated;

$$TWA=16.61Log_{10}\left(\frac{D}{100}\right)+90 \quad (4)$$

Where,

TWA_8 is the 8 hour Time Weighted Average Sound Level D is the Dose % as calculated above (or measured with a dosimeter) and Log10 is the Logarithm to base 10. TWA_8 can simply be looked up in table.

III. MATERIALS AND METHODOLOGY

The sound level meter was set to the 'A' weighting at which the frequency response of the meter is similar to the response of the human ear. 'A' weighting is commonly used for environmental or hearing conservation programs. 'C' weighting is a much flatter response and is suitable for the sound level analysis of machines, engines, etc. "A" or "C" icons will appear in the display [9].

The noise level measurements were taken three different times on the same day for 30 days in July 2016. The periods of measurements were; in the morning (7:30 am - 8:00 am), at the peak of commercial activity (12:30 pm - 1:00 pm) and towards the close of commercial activity (5:30 pm - 6:00 pm). The measurements were obtained at 1 m from the operator of the grinding machine within the market on week days (Mondays to Fridays) with exception of Saturday and Sundays.

IV. RESULTS AND DISCUSSION

The weekly measured noise levels are presented in table II to table VI below. Each week has five days measured noise levels (Mondays to Fridays). From the field values of noise levels, the Dose (%) for each day was calculated using equations (3) and (2). The values of T in equation (2) can also be obtained using the look up table I, and the dose (%) can be calculated using equation (2). The values for the dose were used to calculate the equivalent Time-weighted Average using equation (4).

TABLE II. Noise levels, dose and time weighted average values week 1.

Days	Morning Exposure (dBA)	Afternoon Exposure (dBA)	Evening Exposure (dBA)	Daily Average (dBA)	Dose (%)	TWA (dBA)
Monday	93.10	98.20	97.60	96.30	209.60	95.34
Tuesday	92.60	99.30	100.80	97.57	249.90	96.60
Wednesday	95.20	100.30	101.90	99.13	310.20	98.20
Thursday	96.30	95.60	98.10	96.67	220.60	95.70
Friday	93.50	100.10	96.20	96.60	218.50	95.60
Average	94.14	98.70	98.92	**97.25**		

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TABLE III. Noise levels, dose and time weighted average values week 2.

Days	Morning Exposure (dBA)	Afternoon Exposure (dBA)	Evening Exposure (dBA)	Daily Average (dBA)	Dose (%)	TWA (dBA)
Monday	90.50	99.50	97.30	95.77	194.70	94.80
Tuesday	95.30	101.30	98.40	98.33	277.70	97.40
Wednesday	96.30	95.10	96.20	95.87	197.40	94.90
Thursday	93.50	100.50	97.60	97.20	237.40	96.20
Friday	93.10	98.10	99.50	96.90	227.70	95.90
Average	93.74	98.90	97.80	**96.81**		

TABLE IV. Noise levels, dose and time weighted average values week 3.

Days	Morning Exposure (dBA)	Afternoon Exposure (dBA)	Evening Exposure (dBA)	Daily Average (dBA)	Dose (%)	TWA (dBA)
Monday	93.50	99.50	98.60	97.20	237.40	96.20
Tuesday	94.20	100.30	100.50	98.33	277.70	97.40
Wednesday	95.30	96.50	99.20	97.00	230.90	96.00
Thursday	94.30	98.30	97.10	96.57	217.60	95.60
Friday	96.50	100.10	100.40	99.00	304.70	98.00
Average	94.76	98.94	99.16	**97.62**		

TABLE V. Noise levels, dose and time weighted average values week 4.

Days	Morning Exposure (dBA)	Afternoon Exposure (dBA)	Evening Exposure (dBA)	Daily Average (dBA)	Dose (%)	TWA (dBA)
Monday	96.10	95.10	106.70	**99.30**	317.60	98.30
Tuesday	95.80	96.90	102.10	**98.27**	275.40	97.30
Wednesday	95.70	102.70	98.50	**98.97**	303.40	98.00
Thursday	96.50	100.40	97.90	**98.27**	275.40	97.30
Friday	97.70	99.60	98.90	**98.73**	293.50	97.80
Average	**96.36**	**98.94**	**100.82**	**98.71**		

TABLE VI. Noise levels, dose and time weighted average values week 5.

Days	Morning Exposure (dBA)	Afternoon Exposure (dBA)	Evening Exposure (dBA)	Daily Average (dBA)	Dose (%)	TWA (dBA)
Monday	95.50	98.60	98.30	**97.47**	246.50	96.50
Tuesday	96.30	96.00	100.20	**97.50**	247.50	96.50
Wednesday	94.50	98.20	97.50	**96.73**	222.40	95.80
Thursday	95.60	97.60	99.00	**97.40**	244.10	96.40
Friday	92.50	95.50	98.50	**95.50**	187.60	94.50
Average	**94.88**	**97.18**	**98.70**	**96.92**		

TABLE VII. Noise levels, dose and time weighted average values week 6.

Days	Morning Exposure (dBA)	Afternoon Exposure (dBA)	Evening Exposure (dBA)	Daily Average (dBA)	Dose (%)	TWA (dBA)
Monday	93.00	96.50	98.50	**96.00**	201.00	95.00
Tuesday	95.40	94.00	101.50	**96.97**	230.00	96.00
Wednesday	97.20	96.00	99.00	**97.40**	244.10	96.40
Thursday	96.00	98.50	98.80	**97.77**	256.90	96.80
Friday	98.50	97.00	100.50	**98.67**	291.10	97.70
Average	**96.02**	**96.40**	**99.66**	**97.36**		

TABLE VIII. Average weekly noise levels, dose and time weighted average for 30 days.

	L-Average (dBA)	Dose (%)	TWA (dBA)
WEEK1	97.25	271.31	97.20
WEEK2	96.81	198.33	94.94
WEEK3	97.62	270.28	97.17
WEEK4	98.71	305.24	98.05
WEEK5	96.92	233.53	96.12
WEEK6	97.36	271.00	97.19
AVERAGE	97.45		

The highest noise levels measured in the morning was in week 4 with average value of 96.36 (dBA) while the lowest noise levels measured on the morning was in week 2 with average noise level of 93.74 (dBA). The highest noise levels measured in the afternoon was in week 4 with average value of 98.94 (dBA) while the lowest noise levels measured on the morning was in week 6 with average noise level of 96.40 (dBA). The highest noise levels measured in the evening was in week 4 with average value of 100.82 (dBA) while the lowest noise levels measured on the morning was in week 2 with average noise level of 97.80 (dBA). These results fall within the generator noise levels of 94 dB recorded in some areas. The results exceeded the recommended noise level of 90dB for an 8 hour exposure by OSHA, hence people around these areas are already being ignorantly affected by these sources of noise investigated by [10].

The average daily noise level of 97.45 (dBA) from table VIII was used to calculate dose of 270.75 % and TWA of 97.18 (dBA) using equations (2) and (4). These values exceeded the OSHA action levels of 85 dB (or 50% Dose) and 90 dB (or 100% Dose). The operator of the grinding machine should be wearing a hearing protector of SNR 25 – 35 and must be given training about hearing damage and protection. Regular monitoring of the noise levels must be carried out to ensure they have not increased. The studies conducted on noise from portable generators and its effects on human health in institutional environment by [11], revealed a mean noise level in the indoor and outdoor environment as 60.26±8.45dB

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and 58.15±4.53dB respectively. This noise levels from electric generator exceeded WHO limit.

The result obtained by [12] revealed areas were defined thus; High risk [80-90 dB (A)], medium risk [70-80 dB (A)] and low risk [60-70 dB (A)] respectively. The highest mean noise levels in Agbowo (93.7 dB) and Ajibode (90.3 dB) and the enclosed location had the highest mean noise level (98.7dBA) as compared to road side location in Ajibode (81.7dBA). These values correlated well with the values obtained in this research work.

V. CONCLUSION

The operator of a grinding machine is exposed to about 97.18 (dBA) of noise for 6 to 7 hours every day. This value is very high above the standard daily allowable OSHA exposure limit. This value exceeded the lower exposure action value in the Republic of Ireland (80 dBA), hence, a detailed risk assessment must be completed for the entire. Hearing impairment may result. This result also exceeded the general guidelines for noise level according to [13].

This value (97.18 dBA) is considered as very high risk, hence the operator of the grinding machine should be wearing a hearing protector of SNR 25 – 35 and must be given training about hearing damage and protection. Regular monitoring of the noise levels must be carried out to ensure they have not increased.

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