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Assessment of Noise pollution from the Activities of Kaduna Refining and Petrochemical Company (KRPC) Limited, Kaduna, Nigeria

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ABSTRACT:

This paper examined the effects of noise pollution from Kaduna Refining and Petrochemical Company (KRPC), Kaduna, Nigeria. Data was collected from four areas which did not experience any disruption from October to December, 2016. Data was also collected from four control points which were free of refining activities using an integrated average sound level meter, model No. CR812B, Results showed that the four areas of refinery activities have mean values ranging from 66.0 to 107.4 dB some of which were above WHO limits of 85 dB while the control areas where no refinery activities take place have mean values ranging from 56.0 to 65.0 Db which were below WHO limits.

INTRODUCTION

Noise is an unwanted sound or sound without value that causes discomfort health hazards to the listener (Chauhan, 2011). It is the most common physical hazard in the industrial workplaces. The most common health problem due to noise exposure is Noise-Induced Hearing Loss (NIHL), an irreversible but preventable disorder (Dunn *et al*., 2005). NIHL is the second most common form of acquired hearing loss, after presbycusis (Robinowitz *et al*., 2005; Hong, 2005), and is a major concern for workers' health in different countries (Hong, 2005; WHO, 2005). Noise pollution is an act in which displeasing human or machine created sound that disrupts the activity of balance of human or animal life is introduced to the environment. It is an undesirable by product of our modern way of life. Industrialization and modernization has given rise to a new form of pollution, noise (Singh *et al*., 2004). . Noise pollution is by now recognized worldwide as a major problem for the quality of life in any urban area (Piccolo *et al*., 2005). Gradually, noise has become an important environmental pollutant and in big cities that it has been considered by the World Health Organization (WHO) to be the third most hazardous type of pollution besides air and water pollution (WHO, 2005). In line with many other environmental problems, noise pollution continues to grow and is accompanied by an increasing number of complaints from people exposed to the noise. Noise effects have various impacts on mental and physical health and disturbance in daily activities. It may affect sleep, conversation, leading to perception of annoyance and causes hearing loss, cardiovascular problems as well as affecting task performance (Jamrah*et al*., 2006; Piccolo *et al*., 2005). Worldwide about 30 million workers are exposed to hazards of

noise pollution and hearing loss due to regular exposure to sounds of 85 dB or greater out of which 9 million are estimated to be in the United States of America (Verbeek *et al.*, 2012). Occupational hearing loss is one of the most common occupational diseases. Many studies have revealed that extended exposure to noise pollution may cause auditory and non- auditory disorders, such as temporary or permanent hearing loss (Yildirim *et al*., 2007; Keipert, 2008), sleep disruption (Freedman *et al.*, 1999; Freedman et al., 2001). Vertigo, agitation, weariness, hypertension, gastro intestinal system problems (including gastric and duodenal ulcer), cardiac arrhythmia, nervous and psychic disorders are the effects of noise pollution (Van Kempen *et al*.,2002; Ising and Kruppa, 2004; Penny and Earl, 2004; Roozbahani *et al*.2009). According to the National Institute for Occupational Safety and Health (NIOSH, 2001), 49% of male miners have hearing loss by the age of 50, by the age of 60; this number goes up to 70%. Construction workers also suffer an elevated risk. A screening programme focused on construction workers employed at United State Department of Energy (USDE) facilities found 58% with significant abnormal hearing loss due to noise exposures at work (USDE, 2013). Occupational hearing loss is present in up to 33% of workers overall. Occupational exposure to noise causes 16% of adult disabling hearing loss worldwide (Verbeek *et al.*, 2012).

An oil refinery or petroleum refinery is an industrial process plant where crude oil is processed and refined into more useful products such as petroleum naphtha, gasoline, diesel fuel, asphalt base, heating oil, kerosene, and liquefied petroleum gas (Gary *et al*., 1984; Leffler, 1985 Noise pollution in a in refinery is usually caused by activities such as electrical power generation using steam or gas turbines, use of hydrogen or air compressors. There are about seven categories of refinery activities in which noise is generated: fabrication, drilling, excavation, power generation, sandblasting, jet-cleaning, soot-blowing and processing of crude oil. These activities affect the health of the workers of the refinery but also the people living in the vicinity of the refinery facility. Fabrication that can generate noise pollution involves the cutting, shearing, pressing, and riveting of metal pipes. Bugliarello *et al.,* (1976) report that "riveting a large steel structure" can produce noise levels greater than 130 dB. The second category of refinery activity, which also produces dangerous noise levels, is the activity that often produces broad-band noise that includes high levels of higher-frequency noise due to the operation of electric and pneumatic tools, such as grinders and impact wrenches (Bugliarello *et al*., 1976). Other sources of noise pollution from an oil refinery are power generation caused by turbine generators and air compressors, devices such as fans and blowers and finally, processing through different parts such as furnaces, heat

exchangers, pumps, compressors, and air and steam leaks (Bugliarello *et al.*, 1976).

STUDY AREA

The study was carried out in Kaduna Refining and Petrochemical Company Limited (KRPC) which occupies an area of 2.89 Square Kilometers, in FardamaJaki Rido in Chikun Local Government Area of Kaduna state, Nigeria. The refinery was designed and constructed by Chiyoda Chemical Engineering and Construction Company (now Chiyoda Corporation) of Japan to process both imported paraffinic and Nigerian crude oils into fuels and lubes products . It has undergone design modifications to increase its refining capacity to the current 110,000 barrels daily.

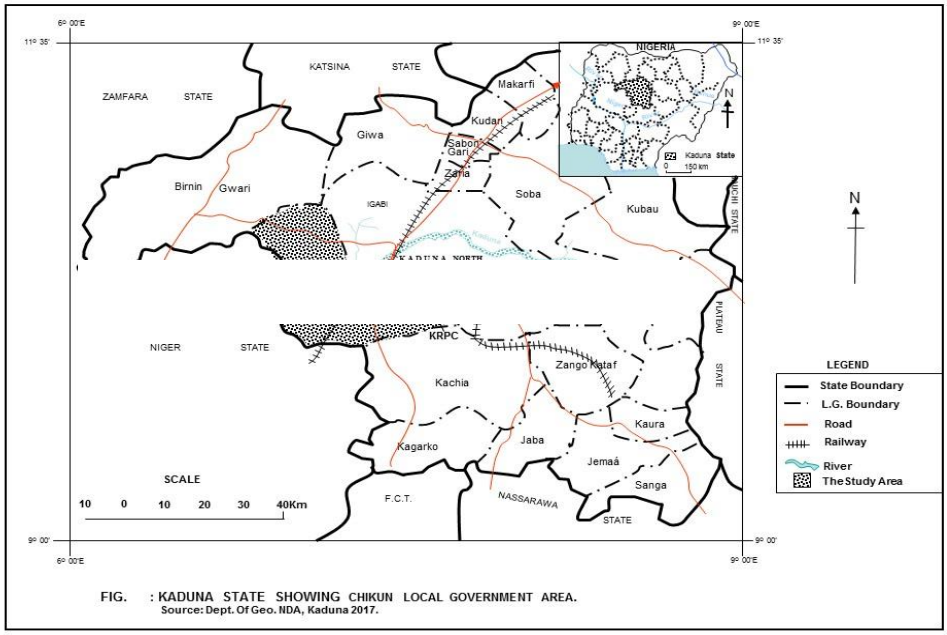

FIG. : KADUNA STATE SHOWING CHIKUN LOCAL GOVERNMENT AREA.
Source: Dept. Of Geo. NDA, Kaduna 2017.

Fig.1: Map of Kaduna State showing the Local Government Area of the Study Area (Nigeria inset)

Source: Geography Department NDA Kaduna, 2017.

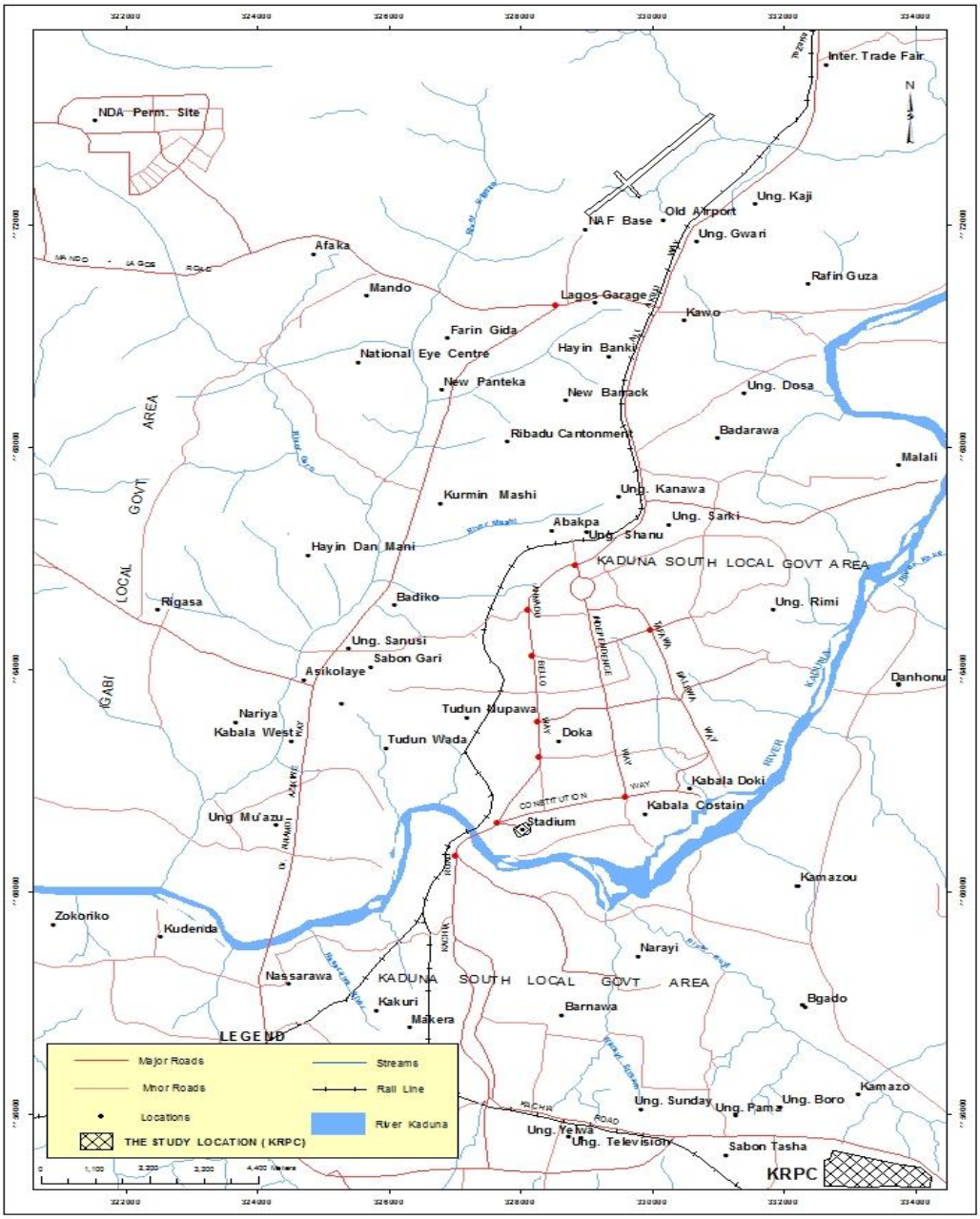

Fig.2: Map of the study area – Kaduna Refining and Petrochemical Company (KRPC).
Source: Geography Department NDA Kaduna, 2017.

METHODOLOGY

This study was restricted to four out of the many different areas in the study area - KRPC. These four areas operated smoothly without any breakdown during the research period from October to December, 2016. In addition to these areas data was also collected from the control areas where no refining activities take place. The data was obtained using an integrated average sound level meter, model No. CR812B, developed by the Cirrus Research, UK. The activities of the four areas are as stated below:

i. Area 1 is the first section in the fuel plant which takes its feed (crude oil) from the oil movement plant.
ii. Area 2 is another section of the fuel plant whose constituent units consist of Naphtha Hydro Treating unit (NHU), which takes its feed (whole naphtha) from crude distillation unit 1 to produce liquefied petroleum Gas, heavy and light naphtha, and hydrogen rich gas.
iii. Area 3 section is called the fluid catalytic cracking unit (FCCU). The feeds to area 3 are flushing oil, heavy cycle oil (HCO) and Vacuum Gas Oil (VGO).
iv. The power plant and utilities areas are saddled with the responsibility of providing safe, reliable and secured electrical power, steam, water (cooling, drinking and boiler feed), air (instrument & plant) nitrogen and so on required for the continuous operation of the process plants and other facilities in the refinery.
v. . Noise level data were also collected from other control areas. They were: Medical area (plant clinic), Warehouse, and Administrative Building.

RESULTS AND DISCUSSION

Out of the four process areas studied, Power Plant and Utilities (PPU) was found to have the highest level of noise pollution due to the high temperature and pressure associated with steam production which drives turbine generators to produce electricity.

Table 1. Results of data obtained from Power Plant and Utilities (PPU) Area EA & EB

2016	October	November	December	mean
71 TG4 Local	112.60	113.00	108.00	111.2 dB(A)
Control Room	66.60	64.00	67.10	66.0 dB(A)
71 TG1	91.20	88.40	-	90.0 dB(A)
71 TG4	91.00	91.30	91.00	91.1 dB(A)
70 BO1	89.00	86.50	-	88.0 dB(A)
70 BO2	92.10	91.10	-	92.0 dB(A)

70 BO3	87.00	88.30	91.00	89.0 dB(A)
70 BO5	93.00	-	-	93.0 dB(A)
Letdown A	111.00	109.00	102.20	107.4 dB(A)
Letdown B	100.00	104.0)	101.00	102.0 dB(A)
75 KO1 A	99.00	104.4)	104.10	103.0 dB(A)
70 PMO1S	98.10	98.00	94.40	97.0 dB(A)
78 PO1/2 A/B	90.40	89.40	88.30	89.4 dB(A)

Source: Fieldwork, 2016
Unit of measurement - Decibel (dB), Threshold limit value (TLV) = 85dB **KEY**
TG = Turbine generator, **B** = Boiler, **K** = Compressor, **P** = Pump, **PM** = Motor Driven Pump **dB (A)** = Decibel Average

Table 1 shows the average level of noise obtained from PPU. 71 Turbine Generator (TG) 1 Locals recorded the highest average of 111.2 dB (A) because it is the generator where the steam produced by the boilers turns turbine blades at a very high temperature of 412 degree Celsius (^{0}C) and a pressure of 42.5 kilogram per centimeter square (Kg/cm^2) respectively to generate electricity. Some areas have high noise level while the others have less due to the nature of operational activity being carried out in such areas and the type of equipment in service. High or medium steam driven equipment tend to produce more noise because they have turbines more than their electric motor counterpart. There are different noise levels in the same area in the refinery because there are different plant equipment operating at different speed, temperatures and pressures. Workers who work in the operating areas such as area 1, 2, 3, power plant and utilities are subjected to a periodic medical checkup to ascertain their level of exposure. The noise level for the turbine locals, control room, turbine generators, boilers, letdown stations, pumps and compressors ranged from 108 - 112.6 dB(A), 66.2 - 67.1 dB(A), 88.4 - 91.3 dB(A), 86.5 - 93.0 dB(A), 100 – 111.0 dB(A), 88.3 – 98.1 dB(A) and 99.0 – 104.4 dB(A) respectively.

The average noise level for the turbine locals, control room, turbine generators, boilers, letdown, pumps and compressor during the period under review were 111.2 dB(A), 66.0 dB(A), 91.0 dB(A), 93.0 dB(A), 107.0 dB(A), 97.0 dB(A) and 103.0 dB(A) respectively as shown in Table 4.1. These values are higher than the World Health Organization (WHO) limit of 85 dB (A) which is the starting point where hearing damage risk is thought to be imminent. This noise level was found to compare favorably with the noise pollution value of above 90 dB (A) obtained by Osanrenmwinda *and* Onojoserio, (2015), noise pollution in refining and petrochemical company, Ighoroje *et al*., (2004) in selected industrial locations Sawmills, Electro-

acoustic market and food processing industrial areas in Benin City, Nigeria and above 85 dB (A) obtained by Oyedepo and Saadu (2008), in sundry processing and manufacturing industries in Ilorin metropolis, Nigeria.

The mean values of noise pollution in Areas 1, 2 and 3 are presented in Table 2.It was observed that, 10 Pump (P)17 A/B recorded the lowest value of 76.5 dB (A) because it was driven by an electric motor and was running on load. On the other hand, 10 pump (P) 04 A/B recorded the highest value of 81.4dB (A) because it was running without load and thus producing a lot of noise.

Table.2. Results of data obtained from Areas 1, 2 and 3.

Area1	October	November	December	mean
10 PO6 A/B	91.10	78.30	64.50	78.0 dB(A)
10 PO4 A/B	98.20	80.00	66.00	81.4 dB(A)
10 P 17 A/B	85.40	77.00	67.00	76.5 dB(A)
Area 2	October	November	December	mean
11 PO4 A/B	97.10	82.10	74.00	84.4 dB(A)
11PO5 A/B	94.00	81.0	107.00	94.0 dB(A)
12 P51	98.30	92.00	82.00	91.0 dB(A)
Area 3	October	November	December	mean
16 PO7 A/B	94.00	83.5	81.0	86.2 dB(A)
16 KO1 A/B	98.10	87.0	80.0	88.4dB (A)

Unit of measurement - Decibel (dB), Threshold limit value (TLV) = 85dB **KEY**
P = Pump, **dB (A)** = Average decibel, **K** = Compressor
Source: Fieldwork, 2016

The mean noise levels for all the areas were found to be above the limits of 85 dB recommended by the World Health Organization (WHO) except in two components of Area 1. This was found to compare favorably with the value of below 85 dB (A) obtained by Noweir *et al*, (2012) for food processing and dairy products and beverage industries in Saudi Arabia. On the other hand the mean levels of noise pollution in Area 2 were found to be above the WHO recommended threshold limit value (TLV) of 85db (A**).** The average noise level of the pumps under review are 84.4 dB (A), 94.0 dB (A) and 91.0 dB (A) respectively. These noise levels compare favorably with the Ambient noise levels of between 70.1 - 95.2 dB(A) obtained by Sonibare *et al*, (2004) for

eight canning industries in Kano and Onuu, in 1992 with values above 85 dB(A) in nine industrial layouts in Calabar, Nigeria.

Table 3.Results of data obtained from Control Areas

Refinery Warehouse	October	November	December	mean
Front of Warehouse	67.2	62.1	65.6	65.0dB(A)
Inside the Warehouse	62.9	63.6	63.2	63.2 dB(A)
Behind the Warehouse	56.4	58.6	57.9	57.6 dB(A)
Refinery Administration Building				
Front of the Building	63.8	68.2	58.1	63.3dB(A)
Inside the Building	55.4	58	59.5	57.6dB(A)
Behind the Building	58.2	6.1	63.6	63.0 dB(A)
Refinery Plant Clinic				
Front of Plant Clinic	57.5	59.7	56.4	58.0 dB(A)
Behind the Plant Clinic	60.1	56.8	55.1	57.3 dB(A)
Inside the Plant Clinic	55.9	54.1	58.1	56.0 dB(A)

Unit of measurement - Decibel (dB), threshold limit value (TLV) = 85Db
Key dB (A) = Average Decibel
Source: Fieldwork, 2016.

It was observed in Area 3 that Compressor 16 K01 A/B recorded the highest value of 88.4 dB(A) compared to 86.2 dB(A) obtained from 16pump (P) O7A/B. The reason is because it is a heavy duty compressor which operates at high pressure to compress hydrocarbon vapour. The noise level for pump and compressor in Area 3, which are: 16 P07 A/B and 16 K01 A/B ranged from 81.0 – 94.0 dB (A) and 80.0 – 98.1 dB (A) respectively Table 3. The average noise level varies between 86.2 dB (A) and 88.4 dB (A) respectively. These value are higher than the 85 dB (A) recommended by WHO and are found to agree with the average noise of 98.4 dB(A) obtained by Oyedepo and Saadu(2010) in study of the noise emitted by hammer mill machine from mineral-bearing rock-crushing mills in Ilorin, Nigeria. The results of noise levels in control

areas are presented in Table 3**.** These were the areas in which oil refining activities do not take place. The data from the Refinery warehouse ranged from 67.2 to 56.4 dB as shown in Table 3. In the Refinery Administrative building the mean values ranged from 57.6 to 63.3 dB while in the Refinery Plant Clinic the mean values ranged from 56.0 to 58.0 dB. These values are well below the limits recommended by the World Health Organization. They also confirmed that the assertion that these activities do cause noise pollution with implications for the health and psychological well- being of the workers.

CONCLUSION

Results of the study show that, there is considerable high amount of noise pollution in the study area. Most of the noise pollution recorded is associated with plant equipment running under high temperature, pressure, ageing and lack of sound proof protectors. As a result, most of the personnel working in these areas susceptible or prone hearing impairment.

RECOMMENDATIONS

Based on the above findings, the study therefore, recommends**:-**

i. Use of Personal protective equipment (PPE) e.g. ear muff/plug should be made compulsory for every worker and visitor going into the plants or process areas.
ii. The operational staffs who work in these plants should undergo mandatory periodic medical checkup.
iii. The locations of the plants should be refitted with sound proof materials in order to reduce the noise levels from the operations to the surrounding areas.
iv. The refinery should be operated in line with global best practices in the highly automated facility

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