

Investigation Of The Impact Of Some Abattoir Activities On Air Quality

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Abstract: *The air quality of selected of abattoir in Port Harcourt metropolis was assessed by measuring Nitrogen dioxide (NO₂), Volatile Organic Compounds (VOC), Methane (CH₄), Carbon Dioxide (CO₂), Sulphur Dioxide (SO₂), Carbon monoxide (CO), Hydrogen Sulphide (H₂S). The measurement of the concentration of these gases in the air was carried out using in-situ air quality meter. It was observed that the range of the level for NO₂ was with 0.066 to 0.134ppm. VOC in the atmosphere recorded highest in station one, point one (3315PPM) which are above the marginal VOC concentration between 500 – 1000 is marginal. The CH₄ observed in the study area was lower than the regulatory limit (695 to 698ppm), CO₂ concentrations between 350-1000PPM is typical within the indoor space and when the level gets to between 1000 – 2000, CO, SO₂, H₂S gas in the study area was not within the detectable limit in the ambient air.*

This study shows that the fuel use within abattoirs could impact on the volatile organic compounds concentration or the air quality and that adequate measures should be employed to improve on the operations

Keywords: *Air quality, Abattoirs, wastes, pollution, contaminants, roasting of hides, slaughtering, Biological oxygen demand (BOD)*

I. INTRODUCTION

One of the demerits of development and migration to urban areas include rise in economic, industrial, social, agricultural activities, etc.). There has to be an effective and efficient service and facility that will be able to take care of the demands of urbanization in order for it to succeed. These facilities include schools, hospitals, markets, health centres, churches, banks, gas stations, and utility services such a water services, good roads, good health care, electricity, etc. Among the agricultural activities is the rearing of animals for the purpose of food especially man's consumption. The development has led to urbanization and increase in food consumption as a result of the teeming population. This has led to an increase in food production as well as livestock

rearing so as to be able to cater for, the teeming populace (Adeyemo, 2002). One of such places that cater to the demands for livestock primarily for consumption in the urbanized areas is the abattoirs. They cater to the increasing demand for meat and other by-products on a large scale.

An abattoir is a place designed statutorily and designated by approving bodies for the slaughtering of animals, processing, preserving and storing of meat and by-products of livestock for human consumption (Alonge, 1991). They are also commonly called slaughterhouses and are places where livestock especially animals like cattle, sheep, pigs, goats, etc. are slaughtered or butchered for food (Collins English dictionary). It can also be known as any assigned place used for the butchering of animals primarily as meat for man's consumption. It does not include any place that is situated on a

farmland (Abattoir Acts, 1998). Slaughtering animals for food for a household or community dates as far back as civilization and so public abattoirs dates back to as far as Roman civilization. In France, it dated back to the 15th and 16th centuries when public facilities were provided for its citizens. History also has it that according to the Italian law of 1890, where the inhabitants were more than 6,000, a public abattoir had to be built. Countries like the Netherlands, Romania, Sweden, Denmark, and Norway were not left out (Jode Loverdo et al., 1906). Battoirs are said to play key roles in cattle and sheep buying from farms and processing them into meat in the United Kingdom. In 2001, about 360 red meat abattoirs were licensed as opposed to 900 in 1990 (Forster, 2005). From the foregoing, abattoirs are needed as a primary source of meat production on a large scale, especially in urbanized areas.

The abattoir is a facility where meat is processed for the supply of protein. A number of operations take place at a typical abattoir in Nigeria, ranging from the temporary storage of the animals before processing to the slaughtering of the animal and to washing, cutting, roasting of the skin, etc. The processing of meat in most abattoir is crude and constitute a health and environmental hazards, both in the area of hygiene of the operation and the disposal of the waste generated. These wastes include solid (bone, dung, etc) liquid (blood, semen, etc) and gaseous materials.

In as much as they are needed for meat production and processing and also for by-products such as hides and skin, they are key sources of environmental pollution of water, air and land as a result of processes like bleeding, dressing, hide removal, removal of internal organs, cuttings and boning, etc. This is because they contain high amounts of liquid wastes, organic solids, and fats and generate large quantities of solid wastes and wastewater with biological oxygen demand (BOD) and offensive odour (World bank, 1998; Alonge, 1991; Osibanjo and Adie, 2007). Effluents such as blood, hair, fat, bones, etc are peculiar to the abattoir and according to NNEP 2000, are potential disease carriers and as such are regarded as waste from industries. Due to the complex nature of abattoir wastewater, they can be a source of danger to the environment

The abattoir operation impacts directly and indirectly on human health in so many ways; the wrongful processing technique which contaminates the meat directly like in the deposition on carcinogenic compounds on the roasted skin which is consumed in Nigeria directly causing ingestion of harmful compounds and when waste from the abattoir washes off into the soil and water, that will also indirectly impact on human health. According to Akinro et al., (2009), pollution in abattoirs is majorly due to poor hygiene and not adhering to good hygiene and manufacturing practice. The wastes generated are not properly disposed and are allowed to litter around the abattoirs and with time, are decomposed and washed away into open drainages, rivers and streams and introduce pathogens into surface water along with surplus nutrients and also leech into underlying aquifers and contaminate wells that are manually dug (Abiola 1995; Chukwu, 2008; Adeyemo et al., 2009). Another way of contaminating the meat is the disposing of effluents directly into streams and other water bodies (without prior treatment) by some abattoir operators who also use same water sources to

wash the meat. There is a need for sensitization on the demerits of such practices. Also digging of shallow wells should be discouraged because they draw polluted water from surrounding waters especially around abattoirs (Singh & Neelam, 2011).

Of all the media being polluted, the concern of this work is limited to air pollution. The source of air pollution from abattoirs is primarily from the roasting of hides and skin which is what this work seeks to address. Air pollution has to do with the change in the components of air physically, biologically and chemically either indoors or outdoors. It can be as a result of dust, smoke or harmful gases. According to conserve energy future (2019), any substance that holds the capacity to be an impediment to the well-being of the atmosphere or living things that live in it is termed an air pollutant. It can be visible or invisible. Living beings on earth are sustained by collective gases that form the atmosphere, therefore any decrease or increase in the percentage of these gases can cause an imbalance and affect lives' survival. These pollutants cause the covering caste of the sun (ozone layer) to deplete and cause an imbalance in the gases which is one of the biggest threats facing the world's survival today. The air is contaminated by a direct result of processes e.g. SO₂ emissions (primary pollutants) from factories and also by intertwining and reactions of primary pollutants (secondary pollutants) e.g. smog.

Plates 1.1 -1.4 show the pictures of the various activities involved in the abattoirs. Plate 1.1. shows the picture of cattle in storage awaiting slaughtering. They are kept here temporarily and slaughtered as the need arise based on the demand of the day or week as the case may be. Plate 1.2. is the skinning of the slaughtered animal in order to get the hide (Kanda in local parlance). Plate 1. 3 shows the actual roasting of the hides in order to remove hair. This is a major source of air pollution as various poisonous gases are emitted into the atmosphere, thereby reducing the quality of air. Plate 1.4 is a wash tub where the hides are washed after roasting. These waters are contaminated from the pollutants in the hides that were roasted. As the water is allowed to run off after washing, they seep into the soil and water bodies and contaminate them.



Plate 1.1: Cattle in temporary storage



Plate 1.2: Cutting of animal skin



Plate 1.3: Roasting of animal skin



Plate 1.4: Washing operation at the abattoir

A. CLASSIFICATION OF WASTE FROM ABATTOIR OPERATION

a. SOLID WASTE

A number of solid wastes are generated at the abattoir including (Ezeoha & Ugwuishiwu, 2011; Fearon et al, 2014);

- ✓ Animal horns, hooves, and bones, Paunch manure (Undigested materials), Hairs, Plant fragments and whole grain, Dead bodies/carcass, aborted Fetus, Feaces/Dung.

b. LIQUID WASTE

The wastewater from the abattoir is generally classified as a heavy organic load with high Chemical oxygen demand (COD) and Biological Oxygen demand (BOD). The COD has recorded for abattoir effluent has been reported to be within 15,000 to 375, 000mg/l and BOD with the range of 700 to 60,000mg/l (Ezeoha & Ugwuishiwu, 2011; Adewumi, et al., 2016). The liquid waste load is due to the following;

- ✓ Wash water, dissolved faeces, urine, blood and blood plasma, Gut content, Semen and other gastro fluids

c. GAS WASTE

The emission from the abattoir is a problem. One of it is due to the objectionable odour from putrefying animal remains and other waste associated with compounds like amines, sulfuric molecules, and ammonia (Omole and Ogbiye, 2013).

The majority of the gaseous effluent from the abattoir in Nigeria is the emissions from the roasting of hides and skin and the burning of bones, hooves, and horns of animals. The fuel used for this operation ranges from used automobile tyres, plastics waste to firewood and condemn oil.

The gaseous emission from these activities includes various air pollutants; Sulfur dioxides (SO₂), Carbon dioxide (CO₂), Carbon monoxide (CO), Nitrogen dioxide (NO₂), Hydrogen sulphide (H₂S), Ammonia (NH₃), Lead, Volatile Organic compounds (VOC), Ground-level Ozone (O₃) particulate matters etc (Ezeoha & Ugwuishiwu, 2011).

S/N	Waste classification	Phase	Reference
1	Paunch Content Bones Horns Faecal components	Solid	Mohammad et al., 2007; Adewumi et al, 2016
2	Dissolved solids Blood Gut contents Urine Wash water	Liquid	Bello & Oyedemi, 2009
3	Manure Intestinal content Hairs Horns Hooves Gallbladders Trimming Internal organs Bones condemned carcasses or body parts	Solid	Tamenech & Tamirat (2017)
4	Urine Blood Wastewater	Liquid	Tamenech & Tamirat (2017)
5	Odor and emissions Flue gas from roasting fuel	Gas	Tamenech & Tamirat (2017)

Table 1.1: Review of the classification of Abattoir waste

B. HEALTH IMPACT OF AIR POLLUTANTS

According to research by Obiri-Danso et al., (2008), goats and hides of cattle roasted with tyres contain high levels of heavy metals residues that made consumption of such goats and hides unsafe. When tyres are ignited and burn, the smoke from it is said to contain potential dangerous substances such that as it cools, poisonous substances like benzene is produced which when ingested, inhaled or touched, cause dizziness, giddiness, headaches, nausea, weakness, respiratory irritation, skin and eye irritation which is capable of incapacitating the victim. Edwards, (1979) suggested that although abattoirs can be situated in rural, urban and designated sites, the siting all have merits and demerits. He suggested that it is far better to site abattoirs in rural areas because the merits are much higher than when abattoirs are sited elsewhere. He is of the opinion that the abattoirs sited in rural areas should be built on gentle sloping lands that are firm, away from residential areas, factories and buildings, town boundaries and would be town boundaries. Since abattoirs provide for the slaughtering of animals, it should be done properly by trained personnel and in hygienic conditions and suitable buildings especially in the developing countries of the world where it is done in unsuitable places and by untrained personnel that does not take cognizance of the principles of hygiene (Edwards,1979).

The wastes generated by abattoirs affects the environment and creates environmental pollution with its attendant problems. The problem is more of the management of the wastes and operation of the abattoirs rather than the size of the abattoir or number of animals slaughtered or wastes generated. If these wastes are not properly managed via proper practices of management, they affect water, land, and quality of air. These wastes in as much as can be valuable to plants, when washed off into streams can reduce water quality and biological oxygen demand (BOD) of aquatic lives thereby endangering them (Raymond, 1977). Abattoir effluents and wastes can cause high levels of minerals to be concentrated in water bodies, contribute to diseases and health risk (Cooper et al., 1979; Carolyn et al, 1985, Sangodoyin et al., 1992; Encarta, 2005 and Oyedemi, 2000).

Aya and Nwite (2016) carried out a study on the implication of goat roasting with tyre. It was found out that scrap tyres contain 45.49%, 40%, 0.23% and 1.17% composition for carbon black, Zinc, wax and sulphur materials which could pose health threats. They found out that high concentrations of heavy metals residue above the maximum permissible level of lead (Pb), zinc (Zn), copper (Cu) and iron (Fe) washed into the soil, water bodies and air causing contaminations. They suggested that appropriate laws should be made and enforced to stop butchers in Ebonyi state from using tyres as roasting materials and scraped soot be properly disposed to avoid water, soil contamination with heavy metals. Olawani et al., (2017) in their research on the effect of proximity of abattoirs to residential areas found out that abattoirs polluted the environment and had the tendency to affect the health of the residents around the said area. They discovered that the more distant the abattoirs are situated from surrounding residential areas, the lesser the environmental effect and health risk to residents. Conversely, the reverse is the case. It was recommended that adequate provisions be

made for efficient and effective disposal of wastes in abattoirs and that the siting of residential buildings be regulated so that they are far from abattoirs.

Weli et al. (2016) conducted a study to assess the occurrence of heart diseases related to the air quality of abattoirs in Port Harcourt. They obtained demographic and socio-economic characteristics (no of years, frequency to the hospital) of respondents via the use of questionnaires. Handheld multi meter was used to collect gases such as NO₂, SO₂, H₂S, CH₄, CO, PM_{2.5} and PM₁₀ at distances of 0, 20m, 50m, 100m, and 200m. The targeted population were workers in the roasting section and were diagnosed for symptoms of ischemic heart disease. They found out that a positive correlation occurred between the disease occurrence and concentration of pollutant during exposure, age, and duration in the job but varied from location to location. They recommended that the workers at abattoirs be subjected to periodic epidemiological and air quality assessment.

There are various health hazards associated with air pollutants that are released by the fuel used in the processing of the animal products at the abattoir. The hazards and impacts of various emission on human health are shown in Table 1.2.

S/N	Air Pollutant	Health effect
1	Particulate matter PM _{2.5} to PM ₁₀	Cardiovascular Disease
		Decreased lung function
		Exacerbation of allergic symptoms
		Increased respiratory symptoms
		Developmental defects in children
2	Ozone	Inflammation of the lining of the lungs
		Wheezing
		Reduced Lung function
		Respiratory symptoms (eg cough)
		Chest pain and Burning in the chest
		Shortness of breath
		Aggravated respiratory illnesses (Asthma, emphysema, and Bronchitis)
3	Sulfur Dioxide	Premature mortality
		Wheezing and Chest tightness
		Shortness of breath
4	Nitrogen Dioxide	Increased respiratory symptoms in children
		Respiratory symptoms (eg cough)
5	Lead	Respiratory symptoms (eg cough)
		impaired development of the central nervous system in young children (neurodevelopmental effect)
6	Carbon Monoxide	Reduces capacity of blood to carry oxygen

		Chest pain (angina)
		Chronic obstructive pulmonary disease
		Anaemia and Diabetes
7	Volatile Organic Compounds	Kidney damage
		Throat, Nose and Eye irritation
		Nausea, Headache, and loss of coordination
		Damage of central nervous system
		Fatigue and dizziness
8	Ammonia	Throat, Nose and Eye irritation
		Unconsciousness
		Wheezing and Shortness of breath
		Coughing
9	Carbon Dioxide	Asphyxiant
		Unconsciousness and Strenuous exertion
10	Hydrogen Sulfide	Nausea, Fatigue, annoyance, and headache
		Bronchial restriction
		Eye irritation
		Memory loss and dizziness

Table 1.2: Pollutants and their human effect

Port Harcourt is witnessing black soot deposits on indoor and outdoor material surfaces which has been linked to releases associated with burning of tyres and wrongful crude oil refining technique among other culprits. The use of used tyres and plastics as fuel in the roasting of animal skin doesn't only impact on the meat product quality but also on the environment by releasing criteria pollutants into the environment.

The research is aimed at investigating the impact of abattoir activity on ambient air quality. The area of study will be major abattoir in Port Harcourt metropolis in the Niger Delta region of Nigeria.

II. METHODOLOGY

Field data gathering covered three different abattoirs in Port Harcourt Metropolis. Controls were taken 5km away from the influence of the abattoir. Three Air quality stations were taken at strategic points with reference to the wind direction. The air quality monitoring meter was an in-situ meter that reads off the values of each parameter measured and also the coordinates at that point was read off.

AIR POLLUTION INDICATORS/SAMPLED CLIMATE PARAMETERS

The Parameters Studied include:

- ✓ Nitrogen Dioxide (NO₂);
- ✓ Carbon Monoxide (CO);
- ✓ Sulphur Dioxide (SO₂);

- ✓ Hydrogen Sulphide (H₂S);
- ✓ Carbon Dioxide (CO₂);
- ✓ Methane (CH₄);
- ✓ Ammonia (NH₃);
- ✓ Volatile Organic Compounds (VOCs)and;
- ✓ Determination of Locations.

Air samples were collected at a height of about 2 meters above the ground level at the sampling point. For most of the pollution indicators, the measurement was carried out using pre-calibrated hand-held meters (passive samplers) which record in-situ levels of the pollutants; viz:

- ✓ Air quality was determined with the aid of two automatic reading digital air samples for determination of Oxides of Nitrogen (NO₂), Sulphur dioxide (SO₂), Carbon Monoxide (CO), Ammonia (NH₃), Hydrogen Sulphide (H₂S), Methane (CH₄) and Volatile Organics (VO). Reading automatically appears on the screen in parts per million (ppm) or µg/m³ using the equipment labelled A in fig2.2

The coordinates of points and locations were determined using Gemini GPS meter labelled B in figure 2.2.

FIELD SAMPLING EQUIPMENT AND MATERIALS

The equipment/meters that were utilized for field data gathering and their uses are presented in Table 2 1. and Figure 2.

Meter Alphabet	Equipment/Material	Use
A	Aeroqual 530 Portable gas analyzer	Air quality measurement
B	Gemini GPS meter	Determination of co-ordinates

Table 2.1: Field Data Collection Equipment/Materials



Figure 2: In-Situ Air Quality measurement meters

III. RESULTS AND DISCUSSIONS

NITROGEN DIOXIDE (NO₂)

Nitrogen dioxide (NO₂) is a member of the family of highly reactive gases called nitrogen oxides or oxides of nitrogen, which are produced during fuel combustion

processes. In air oxides of nitrogen will dissolve in rainwater to form acid rain. NO₂ results when fuel is combusted at high temperatures like the use of alternative fuels like car tyres, plastics that are used at the abattoir for roasting of hides and skin. The range of the Nitrogen dioxide 0.066 to 0.134ppm. While it has been noted in table 1.2 that Nitrogen dioxide has human health effects on exposure to concentrations higher than 0.5ppm, Nitrogen dioxide within the study area is below the permissible standard within the study area. At the time of the survey, the NO₂ levels in the ambient air of the study areas were both within the national air quality guideline for maximum exposure and safe exposure levels for human. The ambient concentration of this gas in the study area may increase from the use of alternative fuel for automotive engines for drilling operations. The level at the three sampling stations is shown in Figure 3. The lowest amount being at the station one, point two (0.066 PPM) and the highest recorded station three, point two (0.134PPM). The value of the control station was far lower than the value of the study area.

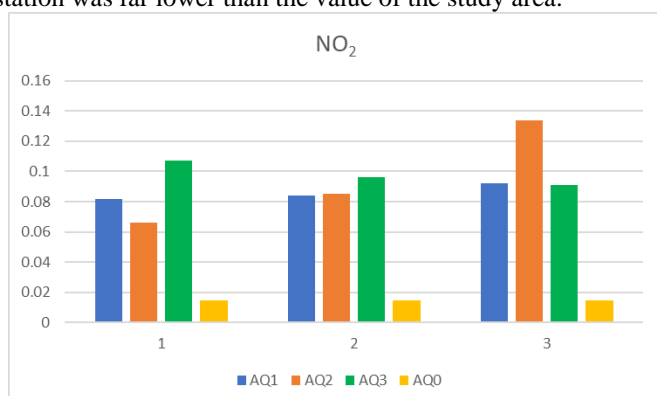


Figure 3: NO₂ Concentrations in selected Locations in Port Harcourt Abattoirs

VOLATILE ORGANIC COMPOUNDS (VOC)

Volatile Organic compounds in the atmosphere are compound that are damaging to health. These pollutants can be found in the environment as compounds of carbon accept Carbon dioxide (CO₂) and carbon monoxide (CO). The common VOCs are ethanol, Formaldehyde, acetone, benzene, and dichlorobenzene. These VOCs are released into the atmosphere comes from sources including Fuels, Woods and additives in paints and cleaning products. Health impact of these compounds includes kidney damage, throat, eyes, and nose irritation among others as shown in table 1.2. At the time of the survey, the VOC levels in the ambient air of the study areas were significant and will not be unconnected with the fuel used for the processing of the skin. The use of the plastics tyre and wood may not be unconnected with the VOC level. The lowest amount recorded was at station two, point three (1047PPM) as shown in Figure 4. The highest recorded VOC value is in station one, point one (3315PPM). While VOC concentration between 500 – 1000 is marginal, VOC between 1000 - 3000 is high. The VOC in all the study area is high above the marginal threshold limit.

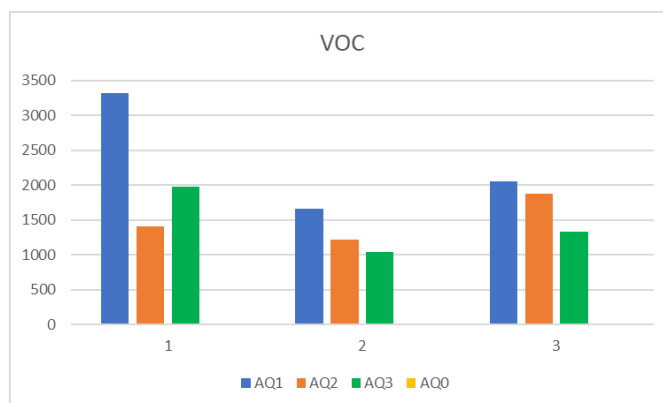


Figure 4: VOC Concentrations in selected Locations in Port Harcourt Abattoirs

METHANE (CH₄)

Methane (CH₄) is not as toxic as the other alkanes and aromatic hydrocarbon found in the atmosphere. Methane gas in the atmosphere is emitted during anthropogenic and natural processes. Methane (CH₄) vapour in the atmosphere arises from fugitive emissions, vents and incomplete combustion of fuels, particularly where the fuel to air ratios are too high and can also be as a result of burning off some alternative fuels. Methane (CH₄) is a greenhouse gas and is significantly toxic and exposure to high concentrations in the atmosphere could result in interference with oxygen intake and acute leukaemia. The Methane detected in the study area is relatively high within 695 to 698ppm, indicating that the activity does have significant methane emission level higher than the level in the control (Figure 5). The methane level within the study area is within the permissible exposure limit of 1000PPM.

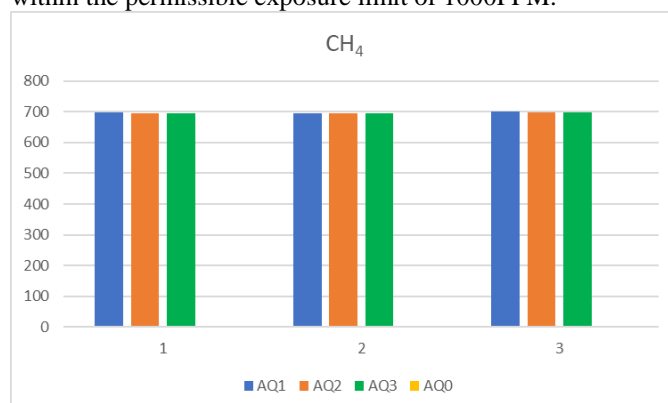


Figure 5: CH₄ Concentrations in selected Locations in Port Harcourt Abattoirs

CARBON DIOXIDE (CO₂)

Carbon dioxide (CO₂) concentrations between 350-1000PPM is typical within the indoor space and when the level gets to between 1000 – 2000 is results to poor air and subsequent drowsiness above that level of exposure (2000 – 5000), Carbon dioxide has an adverse health effect of loss of attention, slight nausea, poor concentration, sleepiness, headaches and stale The CO₂ gas in the study area is lowest station two point two while it is highest at station three point

two. The concentration is higher in the study area than in the control.

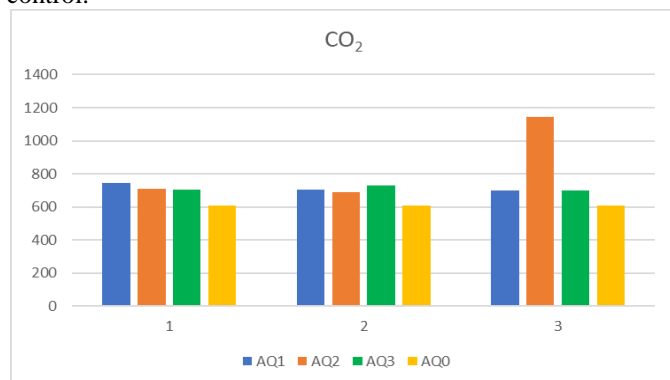


Figure 6: CO₂ Concentrations in selected Locations in Port Harcourt Abattoirs

CARBON MONOXIDE (CO)

Carbon monoxide (CO) is a colourless, odourless and tasteless gas produced by the incomplete combustion of carbonaceous materials or fossil fuels and in natural decaying organic materials – gas, oil, coal, and wood. Carbon monoxide has an adverse health effect; within concentrations of 12 – 17ppm for 8 hours and at prolonged exposure within 45 minutes to 3 hours at concentrations of 200ppm and 800ppm, CO results to reduced capacity of blood oxygen, angina and severe headache, dizziness, nausea and convulsions which might also lead to death, see table 1.2. The CO gas in the study area was not within the detectable limit in the ambient air.

SULPHUR DIOXIDE (SO₂)

Sulphur dioxide (SO₂) is a colourless gas produced from selected industrial activities, including combustion of sulphur-containing fuels, smelting, manufacture of sulphuric acid, and incineration of refuse and also from biological decay. The SO₂ gas is a known harsh irritant, causing wheezing and chest tightness aggravates the asthmatic crisis and bronchitis. Sulphur dioxide results in acid rain when sulphuric acid aerosols are formed from dissolved Sulphur dioxide which readily attacks building materials, especially those containing carbonates such as marble, limestone, and mortar. Sulphuric acid mists can also damage cotton, linen, rayon and nylon fabrics as well as paper. The Sulphur dioxide gas in the study area was not within the detectable limit in the ambient air.

HYDROGEN SULPHIDE (H₂S)

Hydrogen sulphide (H₂S) is a toxic gas that has several health impacts including, Nausea, fatigue, irritation, headache, and other effects. Hydrogen sulphide gas is odorous and corrosive gas, which is rapidly oxidised to SO₂ in the atmospheres. Exposure to Hydrogen sulphide of concentrations in excess of 500ppm can be fatal. Its non-detection in the ambient air of the study area suggests that the activity does not lead to significant emission of the gas was going on in the vicinity of the study area at the time of the survey.

IV. CONCLUSION

Investigation of the Impact of some Abattoir activities on Air Quality in Port Harcourt metropolis using in-situ air quality meter to measure pollutant gases at three major slaughterhouses. The results indicate that the processing activities of the abattoir have perceived effect on the air quality. While H₂S, CO, and SO₂ concentrations are below the detectable limit, concentrations of NO₂, CH₄ and CO within the study area are within the permissible threshold limit. The Volatile Organic Compound (VOC) concentration measured within the three stations and at all the three-point in the station is above the VOC permissible limit. This may be unconnected with a used car tyre, waste plastics, and wood used as fuel for skin processing. It is necessary to emphasize that this has health impact including kidney damage, throat, eyes, nose irritation, and damage of the central nervous system.

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