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Comparison of Carbon Monoxide Concentrations with Set Standards: A case study of Port-Harcourtmetropolis, Nigeria.

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ABSTRACT
This study is concerned with the measurement of carbon monoxide (CO)concentrations in air at some selected traffic junctions in Port-Harcourt metropolis. TSI portable digital gas detector was employed in measuring the CO concentration in part per million. Port Harcourt is located at the coastal region of Nigeria. Its geographical coordinates are $4^0 47' 21''$ North, $6^0 59' 55''$East and 15.83metres above sea level. Seven sampling points were selected for the study. The weekly mean for the period (March/June, 2015) ranged between 36.07±2.6ppm and 14.3±0.7ppm. This shows that the measured weekly mean CO concentrations of all the sampling sites for the periods under study are higher than Nigeria Federal Environmental Protection Agency (FEPA, 10ppm), World Health Organization (WHO, 10ppm), and United States Environmental Protection Agency (USEPA, 9ppm) set limits. This means, every person within this environment (traffic congested junctions) are being exposed on daily basis to this poisonous gas (carbon monoxide). Exposure to high levels of CO has long been known to adversely affect central nervous system (CNS), with symptoms following acute CO poisoning including headache, dizziness, cognitive difficulties, lack of concentration, and death. Hence the need to introduce effective control measures ; such as charges on old vehicles that give out thick smoke, good road network, efficient transport system, and the use of alternative source of fuel.

Keywords: *Comparison, Carbon monoxide Concentration, SetStandards, Case Study.*

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I. INTRODUCTION

The problem of air pollution is a global problem since the advent of industrial revolution. This problem is more serious in industrialized and many traffic congested citiesall over the worldand Port-Harcourtmetropolis in particular. The Clean Air Act (CAA) of 1970 identified six common air pollutants of concern and establishes maximum allowable standards.These pollutants are called criteria pollutantsof which Carbon monoxide;a colourless, odourless, and poisonous gas is one of them. The remaining five criteria pollutants are nitrogen dioxide, ozone, lead, particulate matter, and sulphurdioxide. According to Rajia & Mathew (2011), it is a product of incomplete combustion of organic matter with insufficient oxygen supply to enable complete combustion to carbon dioxide (CO_2) and is often produced in domestic or industrial settings. It is motor vehicle exhaust, which contributes the most CO emissions nationwide.

According toIndian Department of Environmental Management (IDEM, 2014), high concentrations of CO generally occur in areas with high traffic congestion. Carbon monoxide is highly less dense than air; it is toxic to humans when encountered in concentration above 35ppm.

Carbon monoxide Poisoning is common, resulting in more than 50,000 emergency department visits per year in the United States (Weaver, 2009). Over 600 million people globally are exposed to hazardous level of traffic generated pollutants. Pollution due to traffic constitute up to 90 -95% of the CO levels, 80 – 90% of NO_x, hydrocarbons and particulate matter in the world, posing a serious threat to human health (Savile, 1993).

There is also report of increase in hospitalization, emergency room attendance and decrease lung function due to exposure to carbon monoxide (CO),and other criteria pollutants-nitrogen oxides (NO_x),inhale particles (measured as PM_{10}), photochemical oxidants (measured as ozone) and sulphur dioxide (SO_2)(Oguntunde et al, 2014).Robert (2015), states that the available environment laws designed to curb air pollution in Nigeria are not given the desired enforcement by government agencies responsible for the protection of the environment. Where defaulting companies or polluters are penalized, is always a paltry sum of money that is imposed on them as fines.

Air Quality: Nigeria Scenario

In Nigeria, much attention is given to pollution emanating from industries and pollution from oil companies, with little concern for damage or pollution caused by mobile transportation sources (Faboya, 1997; Iyoha, 2002; Magbagbeola, 2001). Air Quality monitoring in some areas of Federal Capital Territory (FCT) in 2013 by the National Environmental Standards and Regulations Enforcement Agency (NESREA) showed high levels of gaseous emission (CO, SO_2, NO, NO_2), PM_{10} noise pollution in the areas that had high concentrations of vehicular activities and road construction (NESREA, 2013).

Presently, there are no coordinated continuous assessments of local air quality undertaken by the Federal Ministry of Environment or any other government body tasked with pollution control in the city (Olowoporoku, 2011). It is stated that world motor vehicle population growth reached 700million in the year 2000 (Ghose et al, 20004). This has resulted in exponential increase in motor fuel consumption and the corresponding rise in carbon monoxide emission and other criteria pollutants. Similarly, Gobo eta l, (2012) stated that CO, CH_4, VOC were high and exceeded permissible limit of 10ppm in Okrika-Rivers state as a result of the automobiles and industrial activities around the area. The highest mean level of CO was given as 12.7ppm. Akinyemi & Usikalu (2013) research work showed that CO concentration emitted by trucks was (289.64ppm). This is far beyond the FEPA set standards for CO in comparison to other sources. Results from a study conducted in Enugu Metropolis showed that concentrations of CO were higher in traffic congested areas than the regulatory standards. The levels of CO concentrations obtained in the study ranged from 8.6 -35.1ppm (Nwadiogbu et al, 2013).

According to Okunola et al (2012), pollutans from mobile transportation is on the rise due to increase in per capital vehicle ownership, thus resulting in high congestion on Nigeria city roads and increase in the concentration of pollutants in the air, consequently, increasing health risks for human population. More so, study on CO concentration in Nigeria is relatively scarce compared with the volume of studies carried out in the developed world. TheFederalEnvironmental Protection Agency (FEPA) allowed daily average limit for CO is 10ppm (FEPA, 1991).

Olamijulo and Ana (2013) recorded $38.6 \pm 22.2ppm$ of CO concentration in two selected local government areas of South Western Nigeria. The value exceeds the FEPA and WHO guideline limit of 10ppm for CO. In a related development, a research study by Ojo and Awokola, (2012), their findings indicated that CO was in the range of 1.79- 51.38ppm which is above the permissible limit of USEPA ambient air quality standards.

A study of probability models in monitoring environmental pollution in Nigeria established the fact that carbon monoxide concentration in Lagos State exceeds the Lagos State Environmental Protection Agency (LASEPA) and the Federal Environmental Protection Agency (FEPA) Standards with probabilities 0.300819 and 0.231621 respectively (Oguntunde et al, 2014).

In 2007, a World Health Organization (WHO) funded project on vehicular monitoring emission in Lagos undertaken by Lagos Metropolitan Area Transport Authority (LAMATA) has shown that the concentration of pollutants (such nitrogen oxides, sulphur dioxide, particulates and carbon monoxide exceeded the WHO guidelines at most locations in Lagos. Similarly, studies conducted in Kaduna, Abuja, Ibadan, Ado Ekiti and Calabar also showed that pollutant concentrations in these cities are more than the stipulatedlimits by Federal Environmental Protection Agency (FEPA) (OlowoPoroku, 2011). Musa and Evuti, (2012) showed CO concentrations of three sampling locations in FCT-Abuja as; Tukpedi (17.33ppm), Kuje (9.33ppm), and Paseli (10.22ppm). The CO concentration of 17.33ppm was well above the FEPA and USEPA set standards.

More so, research findings from Lagos metropolitan Area Authority (LAMATA) showed that the concentrations of NO, SO_2 and CO exceeded the WHO guidelines at most location for in Situ measurement and 24-hour exposure (Taiwo, 2008). Similarly, the mean range of 14.8 - 28.3ppm ofCOconcentrations was obtained at several road junctions in Benin City (Ukpebor et al, 2009). Ukpebor et al (2009) stated that intervention programmes and policies for CO control and abatement are difficult to formulate, because available information on atmospheric (outdoor and indoor) levels of CO are rather scanty.However, the newly established National Environmental Standard and Regulations Enforcement Agency (NESREA), has outlined the vision of ensuring a cleaner and healthier environment for all Nigerians.

II. THE STUDY AREA

Port Harcourt is the capital of Rivers State. It is located at the coastal region of Nigeria. Its geographical coordinates are $4^0 47' 21''$ North, $6^0 59' 55''$ East and 15.83 meters elevation above sea level. The presence of oil and gas companies has resulted in the influx of people into the city on daily basis and a corresponding increase in traffic and emission of carbon monoxide (CO) and other Criteria Pollutants. This informs the choice of Port-Harcourt metropolis for the study.

According to 2006 Nigerian Census, Port Harcourt has a population of 1,382,592 and covered about $360km^2$ (140sq miles). Port-Harcourt features a tropical monsoon climate with lengthy and heavy rainy seasons and very short dry seasons. Only the months of December and January truly qualifies as dry season months in the city.

The Harmattan, which climatically influences many cities in West Africa, is less pronounced in Port Harcourt. Port Harcourt's heaviest precipitation occurs during September with an average of 367mm of rain. December on average is the driest month of the year; with an average rainfall of 20mm. Temperature throughout the year in the city is relatively constant, showing little variation throughout the course of the year. Average temperature is typically between $25^0C – 28^oC$ in the city.

SAMPLING SITES

The sampling sites include Ada-George, Rumuokwuta, First Artillery, Mgbuoba, Rumuola, Eliozu andRumuokoro Junctions. Figure 1 shows map of Port Harcourt Metropolis.

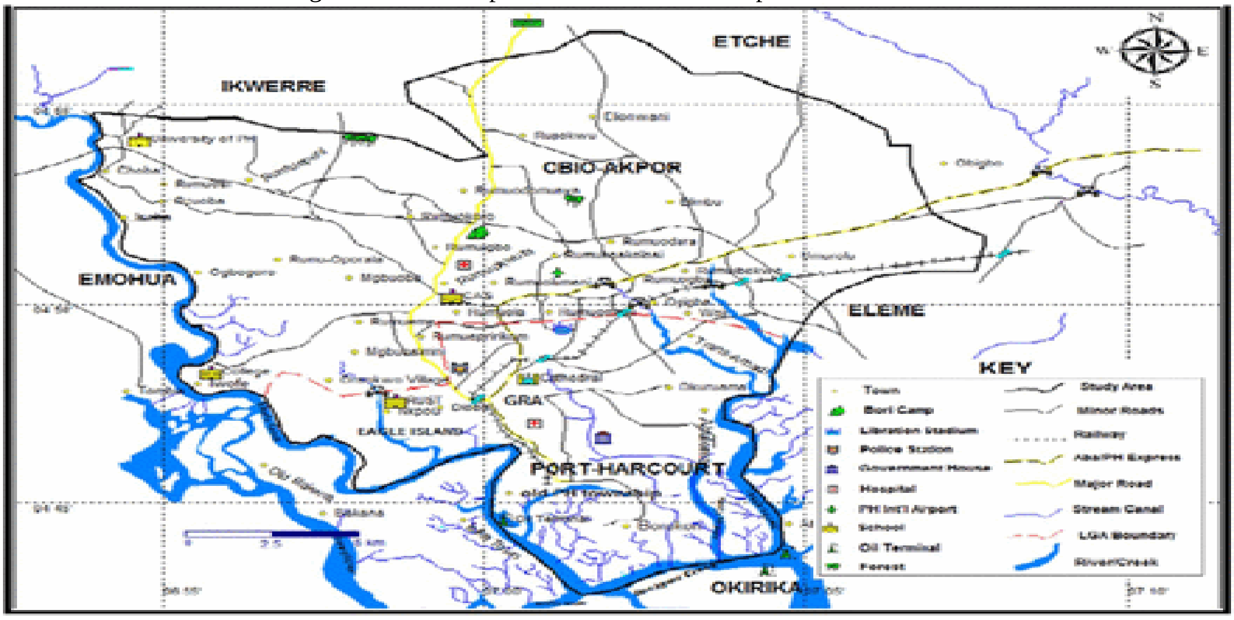

Fig 1: Map of Port Harcourt metropolis.
***Source**:* Adapted from GoogleEarth (2012)

III. MATERIALS AND METHODS

TSI portable digital gas detector was employed for CO data collection. This device measures CO in part per million (ppm) and with a very high precision. This is shown in figure 2.

Fig. 2: TSIportabledigital gas detector

The instrument was used to measure CO concentrations at theseven sampling points at an elevation of 2.5 meters above the earth's surface. The readings were taken morning and evening at 10 minutes interval for 1 hour at each sampling site. The morning segment runs from 6am - 1pm, while the evening segment runs from 4pm to 11 pm for three weeks in the months of March and June, 2015.

IV. RESULTS AND DISCUSSION

The results obtained from measurement of CO concentrations at the aforementioned seven sampling sites are presented in Tables 1, 2, 3, 4, 5, and 6 respectively.

Table 1: Measured CO concentration weekly mean in (ppm) at the selected sampling Sites for the morning segment of March 1st – 7th, 2015

Names of sampling site	weekly mean
Ada-George	15.93±1.6
Mgbuoba	22.07±2.5
Rumuokwuta	33.50±4.4
Rumuola	27.57±2.6
First Artillery	29.57±2.8
Eliozu	32.79±5.9
Rumuokoro	36.07±2.6

Tables 2: Measured CO concentration weekly mean in (ppm) at the selected sampling sites for the evening segment of March 1st – 7th, 2015

Names of Sampling site	Weekly mean
Ada-George	24.79
Mgbuoba	20.14
Rumuokwuta	29.57
Rumuola	25.71
First Artillery	24.21
Eliozu	27.43
Rumuokoro	34.28

Table 3: Measured CO concentration weekly mean in (ppm) at the selected sampling sites for the morning segment, June1st- 7th, 2015

Name of sampling site	Weekly mean
Ada-George	18.1±2.6
Mgbuoba	15.3±1.3
Rumuokwuta	18.8±1.5
Rumuola	20.4±1.2
First Artillery	21.3±1.2
Eliozu	16.9±1.9

Table 4: Measured CO concentration weekly mean in (ppm) at the selected sampling sites for the evening segment, June 1st – 7th, 2015

Names of sampling sites	weekly mean
Ada-George	15.0±1.8
Mgbuoba	22.4±2.3
Rumuokwuta	21.1±2.1
Rumuola	17.6±0.8
First Artillery	23.0±1.4
Eliozu	15.4±0.6
Rumuokoro	18.6±0.9

Table 5:Measured CO concentration weekly mean in (ppm) at the selected sampling sites for the morning segment, June 14th- 20th, 2015

Names of sampling sites	Weekly mean
Ada-George	16.4±0.9
Mgbuoba	19.2±2.4
Rumuokwuta	19.1±0.6
Rumuola	20.7±0.8
First Artillery	23.5±1.2
Eliozu	16.1±1.2
Rumuokoro	21.3±1.4

Table 6: Measured CO concentration weekly mean in (ppm) at the selected sampling sites for the evening segment, June 14th – 20th, 2015

Names of Sampling sites	weekly mean
Ada-George	14.3±0.7
Mgbuoba	16.5±1.2
Rumuokwuta	21.0±1.9
Rumuola	23.7±3.1
First Artillery	24.7±1.7
Eliozu	17.4±1.1
Rumuokoro	26.4±2.4

A look at Tables 1 and 2 shows that Rumuokoro sampling site has the highest weekly mean CO concentration of 36.07± 2.6ppm and 34.28±4.3ppm followed by Rumuokwuta with 33.50±4.4ppm and 29.57±1.7ppm, and Eliozu sampling site with 32.79±5.9ppm and 27.43±3.2ppm respectively.Similarly, in Tables 3 and 4,First Artillery has the highest CO concentration of 21.3±1.9ppm and 23.0±0.6ppm followed by Rumuola with 20.4±1.2 in Table 3 and Mgbuoba with 22.4±2.3 in Table 4.

More so, in Table 5, Eliozu sampling site has the highest weekly mean CO concentration of 23.5±1.2ppm followed by Rumuokoro sampling site, while in Table 6, Rumuokoro sampling site has the highest weekly mean CO concentration of 26.4±2.4ppm followed by First Artillery with 24.7±1.7ppm and Rumuola with 23.7±3.1ppm. Adageorge has the lowest weekly mean CO concentration of 14.3±0.7ppm for the entireperiod under study as shown in Table 6. Comparing the weekly mean CO concentrations between the months of March and that of Juneas shown in Tables 1and 2 ; and Tables 3, 4 ,5 and 6, it can be stated that the measured weekly mean CO concentrations in March are higher than that measured in June.This differencecould be attributed tothe some meteorological factors.

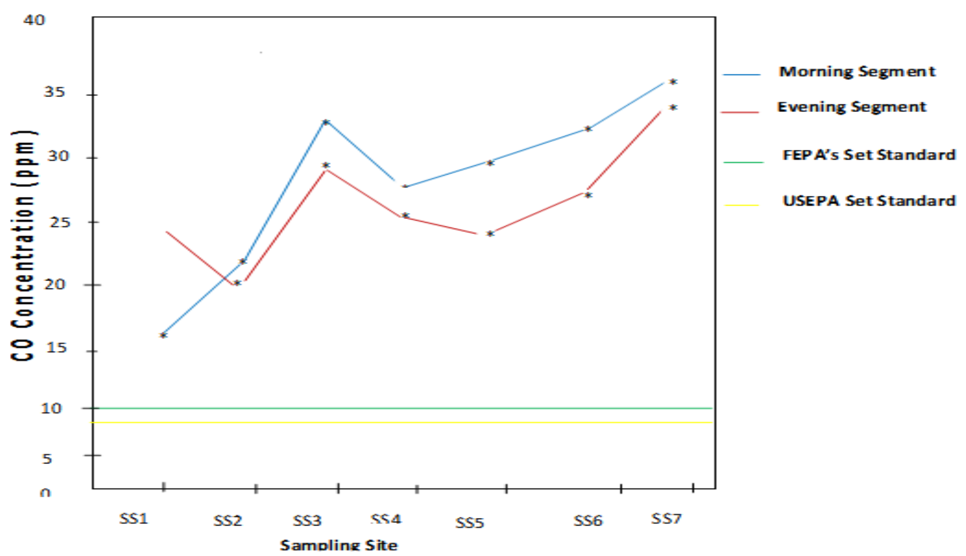

Fig. 3: Morning and evening weekly Mean CO concentration for the seven Sampling Sites of March 1st – 7th, 2015

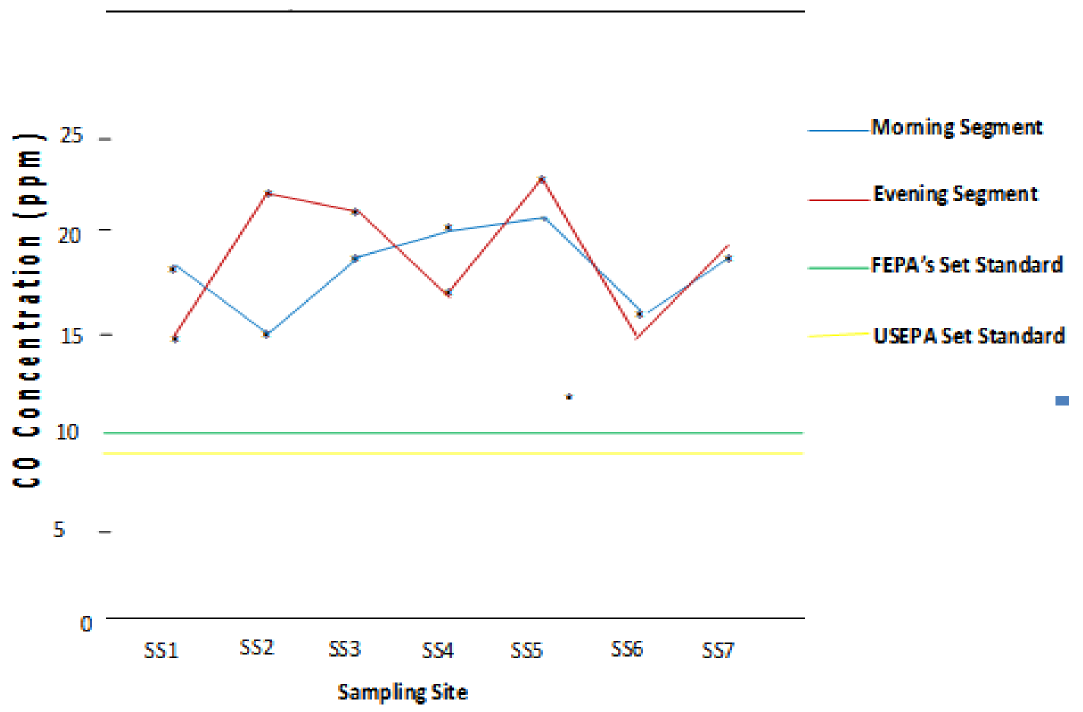

Fig. 4: Morning and evening weekly Mean CO concentration for the seven Sampling Sites June 1st – 7th, 2015

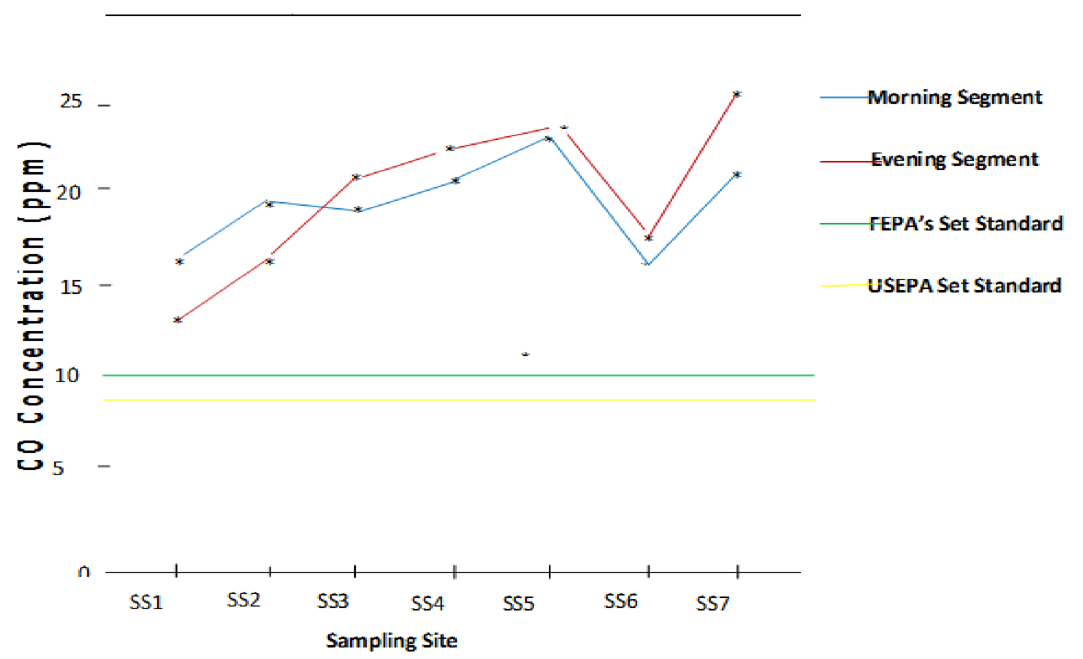

Fig. 5: Morning and evening weekly Mean CO concentration for the seven Sampling Sites June 14th – 20th, 2015

From figures 3, 4 and 5, it is clear that none of the points on the two curves with blue and brown colours touches or falls below the FEPA, WHO and USEPA lines with green and yellow colours respectively. This means that the weekly mean CO Concentrations of all the sampling sites are far above Nigeria Federal Environmental Protection Agency (FEPA) World Health Organisation (WHO) set limits of 10ppm and 9ppm of United States Environmental Protection Agency(USEPA) Set limits.

V. CONCLUSION

It is evidently clear that the weekly mean CO concentrations are far above the set standards. This means, every person within this environment (traffic congested junctions)are being exposed on daily basis to this poisonous gas (carbon monoxide). According to USEPA (2010), exposure to high levels of CO has long been known to adversely affect central nervous system (CNS), with symptoms following acute CO poisoning including headache, dizziness, cognitive difficulties, and lack of concentration. There is also evidence of ambient exposure during pregnancy having a negative effect on foetal growth (low weight babies, and other neonatal abnormalities) in epidemiology studies. CO is known to induce reduction of oxygen-carrying capacity to the body's organ (like the heart and brain) and tissue. At extremely high levels, CO can cause death. More so, climate change will become worsen, since CO has been identified as a weak and indirect contributor to radiative forcing (RF) and green house effects (Sinha & Toumi, 1996; Forster et al, 2007).Hence the need to introduce effective control measures ; such as charges on old vehicles that give out thick smoke, good road network, efficient transport system, and the use ofalternative source of fuel.

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