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Full Length Research Paper

Concentrations of green house gases (GHGs) around tankfarms and petroleum tankers depots, Lagos, Nigeria

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Air pollution generated through combustion of fossil fuels presents difficult environmental challenge to societies as it could degrade the environment and affect human health and quality of life. Road transportation is a prominent pollutant contributor especially in urban areas. Smokes from exhausts of petroleum tankers generate harmful gases into the atmosphere. The paper is on the level of concentration of generated gases by petroleum products tankfarms along the main Apapa-Oshodi Expressway Lagos, Nigeria. It assesses the levels of noise, NO_2, CO and SO_2 around six (6) bus stops through direct field measurements over 6 months, lasting February and July 2010. The field data are correlated with existing regulatory standards of Federal Ministry of Environment with a view to identify the areas high concentration. The surrounding land uses are characterized to identify the source points. The results show that noise level is low in almost all the stations measured. NO_2 is nil within the axis. SO_2 is recorded at the bus stop sited around the foot of a bridge. High concentrations of CO are reported around bus stops proximate to the marketing depots and garages for imported fairly-used vehicles. The implications of the findings for sustainable environment are discussed in the conclusion.

Key words: Green house gases (GHGs), emissions, petroleum depots, tankers, Nigeria.

INTRODUCTION

Pollution is the introduction of substances or energy into the air, water or soil environment, directly or indirectly by man, thereby having deleterious effects to such an extent that it will endanger human health, amenities or eco-system resources (Kummer, 2004). To Odigure (1998), air pollution is the presence of one or more gaseous or particulate contaminants in the outdoor or indoor atmosphere in such quantities, characteristics or duration that can be injurious to human, plant or animal life or to property. Climate change results from the altera-tion in the balance between incoming and outgoing radiation elements in the atmosphere over a considerable period of time (IPCC, 1992). It results from changes in the quality of air over a period (Bond, 1972).

The change has attracted more interests than any other environmental concerns since about the last 2 decades. Earliest interest in air pollution dates back to about 1881 when some catastrophes were recorded through trapped smog and sulphur-laden fog respectively in Chicago and Cincinnati (El Fadel, 2000). Ever since, the effects on the economies and socio-politics of many economies had been on the increase both directly and otherwise.

At the forefront of the activities are the Intergovern-mental Panel on Climate Change (IPCC) and the UN Framework Convention on Climate Change (UNFCCC). Recently, many other interested stakeholders are being formed locally, nationally and regionally. They include governmental and non-governmental organizations as well as some community based organizations.

The major chemical compounds of green house gases (GHGs) leading to global warming and climate change include carbon monoxide (CO), hydrocarbons (HC), nitrogen oxide (NO), nitrogen dioxide (NO_2), suspended particulate matter (SPM) particulates, sulphur dioxide (SO_2), and photochemical oxidants. Fu (2001) and Goyal (2006) argued that in order of significance, they originate from anthropogenic stationary and mobile sources including: (i) industrial activities such as energy plants,

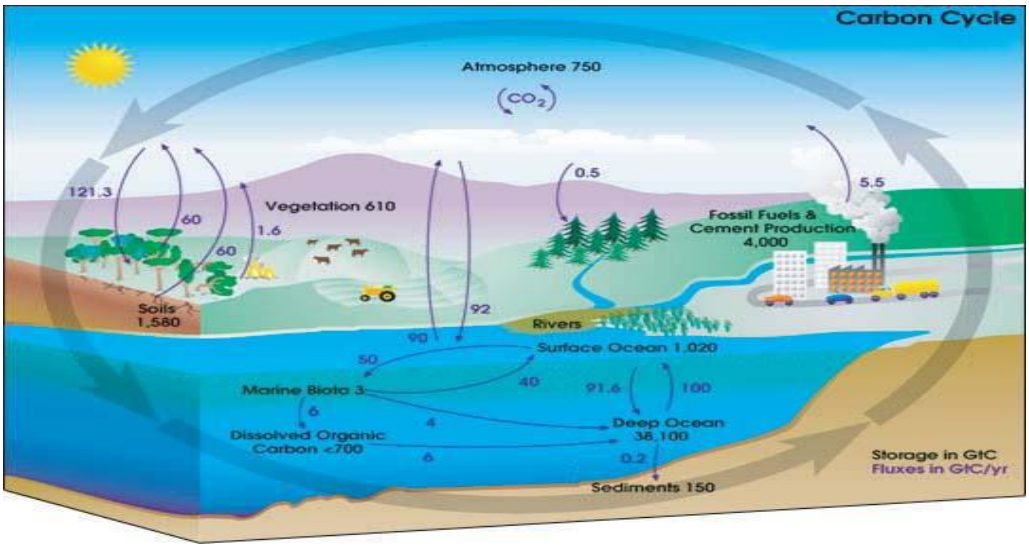


Figure 1. The major pools and fluxes of GHGs (in gigatons of carbon) (FAO, 2004).

chemical, cement and atomic units (ii) transportation of all modes, (iii) dwelling areas via aerosols in household utensils and waste disposal system and (iv) accidents including leakages, forest fires and tankers mishaps. A few natural sources are in form of organic decomposition, wild fires and volcanic activities (Figure 1).

Most GHGs in urban areas are from burning of fossil fuels such as coal, oil and gas; industrial processes and transportation. In the rural areas are farming, deforestation and fuelwood burning for cooking. Aghedo et al. (2007) established that majority of the harmful air pollutants reside in the troposphere (less than 15 km from the surface).

The series of health impacts of high concentration of GHGs reviewed by Tanimowo (2000), Elvingson and Christer (2004), Bernstein et al. (2008) and ALA (2010) include slight feel of stress and discomfort to ailments such as asthma and cancer, birth defects and genetic mutations as well as premature deaths. The environmental effects of elevated smog, acid rains and ultraviolet radiation are established by Bond (1972), Miller and George (2002) and Efe (2008). Arstrup (2006) identified the implications on climate change through ozone layer depletion including absorption and reflection of incoming shortwave radiation from the sun and long-wave radiation from the surface of the earth and the atmosphere.

Oil and gas production is the backbone of the Nigeria economy. It contributes over 90% of the national foreign exchange earnings and about 20% to the GDP (OTAL, 2010). Investments in the exploration, transportation, distribution and products marketing had been on the increase in recent times. For example, over 300 marketers were licensed in the country as at 2001 (NNPC, 2002) and rose to about 8,000 in 2009. Much of the crude productions are exported and the finished products imported. In view of its advantaged ports facilities, Apapa area is a main operations zone for the receipt and distribution by the marketers.

All the processes of the oil and gas sector contribute to GHG emission (Orubu, 2004). The distribution chain is dependent heavy duty diesel-powered vehicles which Beecham (1993) noted to be accounting for about a third of GHG emissions and a quarter of particulates on the American highways. Yet they were only about 2% of the total number of vehicles on the roads.

There is hardly any systematic measurement of the air quality in Nigeria. The efforts the Department of Petroleum Resources and the Federal Ministry of Environment are limited to uncoordinated occasional assessments of emissions from stationary sources around main oil and gas projects and over short durations.

The study aimed at analyzing the level of gaseous concentrations around some selected depots at Apapa and the main route of the tankers conveying the products to marketers. The following analyses were shown: (i) it reviews the main land uses around the bus stops in the axis with emphasis on petroleum-related activities, (ii) assesses the levels of noise, CO, SO_2 and temperature around the bus stops and their surroundings; and (iii) examines the extent to which the determined values are suitable for human environment based on existing regulatory standards and limits.

THE STUDY AREA

Lagos (3°24'E, 6°27'N) was the administrative headquarters of Nigeria until the late 1980s when it was changed to a new Federal Capital Territory, Abuja. It is the smallest of 36 states of Nigeria in terms of area extent but the highest populated most industrialized and economically vibrant. Its official population 9.7 million

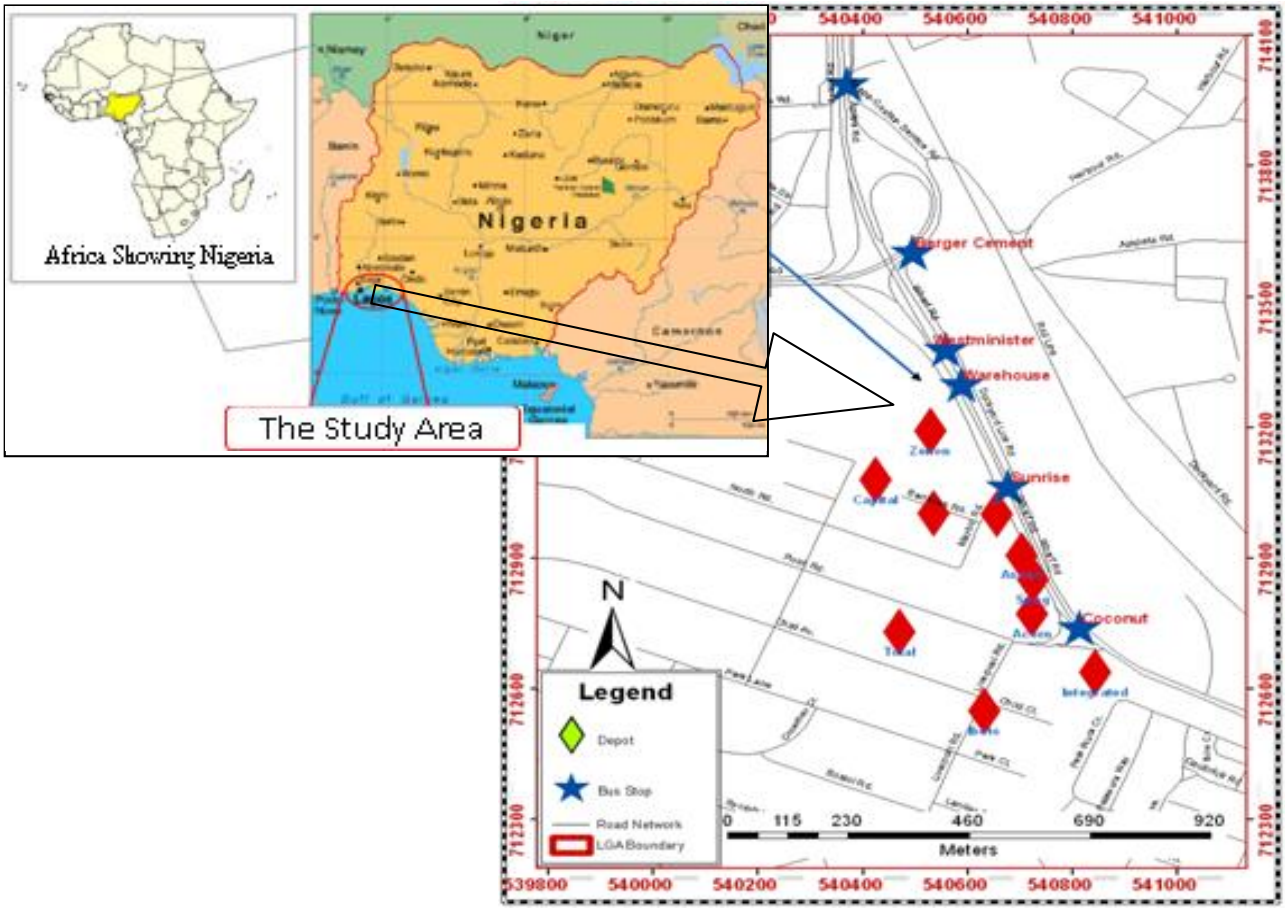


Figure 2. The sampled areas.

ranks it the second highest in Africa, after Cairo but the growth rate is highest in the continent (UN, 2008).

As shown in Figure 2, the study is focused on the Apapa end of the Apapa-Oshodi Expressway. The axis stretches between Berger Tokunbo/Yard and Coconut Bus stops. It accommodates large number of marketers' depots, tankfarms and tanker garages on both sides. The road is a major route for trucks conveying imported petroleum products to the hinterland. The trucks account for most of the common traffic bottlenecks in the area and generate emit pollutants significantly.

Lagos shares boundary with the Atlantic with its networks of lagoons and creeks emptying waters into the ocean through the Lagos Harbour. On the harbour are the Nigeria main Lagos, Apapa and Tin Can Island Ports. They handle most of the imported goods into the country.

Ports activities are on the increase due to brisk businesses of importation of petroleum products and 'tokunbo' household appliances such as air conditioners and refrigerators. The use of heavy-duty diesel engines trucks had been on the increase in Nigeria because the alternative railway system is dysfunctional. Automobile emissions in the area are from vehicular energy combustion and evaporation of the products.

Usually, NO_2, CO, unburned HC, particulates of lead, soot and sulfates are associated with vehicle exhausts and engines while crankcase, fuel tank and the carburetors are sources of unburned HC (Ajayi and Dosumu, 2002). Even though respective manufacturers also aims at improving the designs for environmental friendliness (Ludwig, 2007), most of the trucks on Nigerian roads are not new but products of the influx of fairly used vehicles. Majority of the trucks are more than 2 decades old.

MATERIALS AND METHODS

Data for the study were collected *in-situ* between February and July 2011 at the 6 bus stops within the defined section of the highway: Coconut, Warehouse, Westminster, Sunrise, Berger Cement and Berger Yard/Tokunbo (Figure 2). The equipments used are presented on Table 1. The measurements were taken over a total of 15 'wet' days and 15 'dry' days over the 6-month period with a view to ascertain any seasonal variation in the concentrations.

At each bus stop, the measurements were taken at 5 composite sites including the centre and some 50 m distance in the north, south, east and west cardinal directions. The purpose was to accommodate any error between the centre and the radial

Table 1. The equipments used for the *in-situ* field measurements.

Parameter	Equipment	Model
Sound / noise	Sound level meter	ExTECH 407730
SO_2 and NO_2	RAE system SO_2 and NO_2 concentration meters	ToxiRAE II
CO	CO meter	REED CO-180
Temp, RH and wind speed	Lutron LM-8000	Lutron LM-8000
Coordinates	GPS	Garmin GPSMap 76CXs

Table 2. The regulatory limits by the ministry of environment for the gases.

Parameter	Limit
NO_2	0.04 - 0.06 ppm
SO_2	0.01 - 0.1 ppm (26 - 260 g/m^3)
CO	10 – 20 ppm (11.4 - 22.8 g/m^3)
Noise	90 dB
Temperature	30°C

Table 3. The petroleum depots around the bus stops evaluated.

Bus stop	Coconut	Warehouse	Westminster
Depots	Integrated	Spog	Capital
	Acorn	Ibeto	
	Total	Aquitaine	
	Ascon		
	Zenon		
	Sahara		

distances away. Cognizance was taken of any factor that could be responsible for any observed variation between 5 sites. The values generated are analyzed statistically and correlated with the limits by the Federal Ministry of Environment shown in Table 2.

RESULTS AND DISCUSSION

The land use activities in the vicinity

The area is dominated by road transport facilities especially roads, sales of 'tokunbo' facilities such as cars and electronics, construction companies and petroleum depots and garages. The latter are dominant around Coconut, Warehouse and Westminster Bus stops (Table 3). They generate heavy traffics of commercial vehicles during peak hours and products tankers during operation periods.

Concentration of the gases in the area

The concentrations of the gases measured are shown in Figure 3. There were no traces of NO_2 over the bus stops throughout the entire study period. SO_2 value of 0.4 ppm was recorded at Coconut bus stop on the wet day of 02 June only. The mean temperature for the period for all the measurements was 33.1°C. The minimum was 26.6°C at Coconut bus stop (02 June) and the maximum of 39.2°C at Berger Cement bus stop (11 June).

CO was 3.2 ppm for the entire period and bus stops on the average. A maximum of 14.0 ppm was recorded at around the foot of the flyover bridge at Coconut bus stop (17 April). This is assumed to be due to higher emissions from trucks as they attempt to climb the bridge. The mean noise level for all the locations was 76.4 dB. A minimum of 61.2 dB was recorded for Berger Cement bus stop (31 March), 2010 and a maximum of 103.2 dB at Sunrise bus stop (02 Febuary). These are shown in Figure 3.

Correlations of the concentrations with regulatory limits

NO_2

That there are no traces of NO_2 in the sites shows that the area conforms to regulations.

SO_2

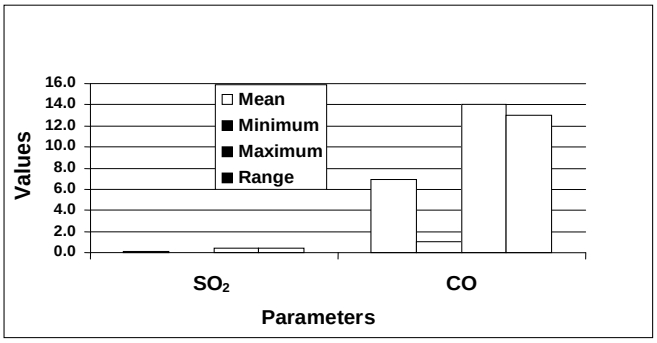
The only SO_2 value of 0.4 ppm recorded at Coconut is above the FMEnv limit of 0.01 to 0.1 ppm.

CO

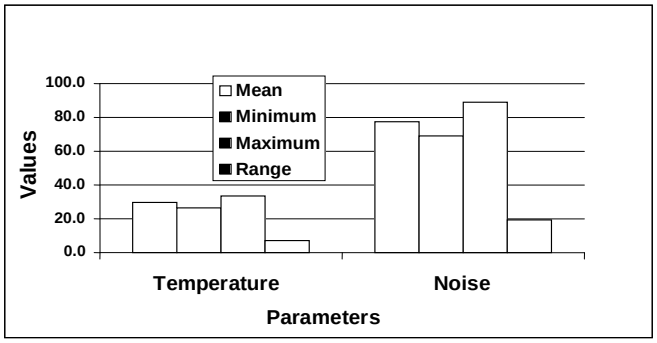
Coconut and Warehouse bus stops had maxima concentrations of 14 and 13 ppm respectively. Westminster recorded exactly the regulatory limit of 10 ppm. Nonetheless, minimum of 0 ppm are recorded at Warehouse and Westminster on a Sunday. The averages ranged between 1.7 ppm at Sunrise and 6.9 ppm at Berger. Locations with higher values are around depots, tanker parks and loading activities (Figure 4).

Noise

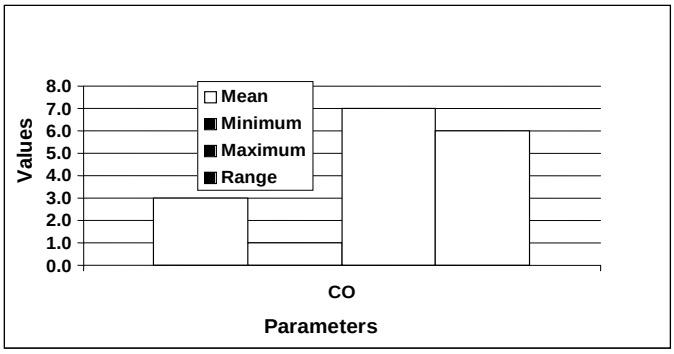
Only Sunrise bus stop recorded a maximum noise



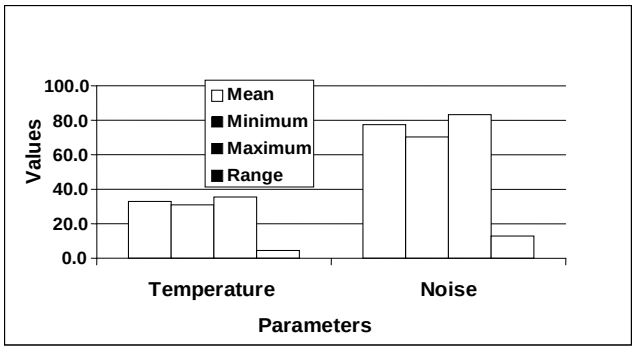
(a) CO and SO 2 for all wet days



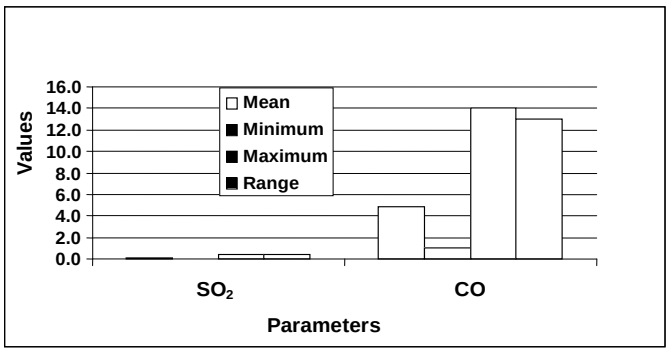
(b) Temperature and noise for all wet days



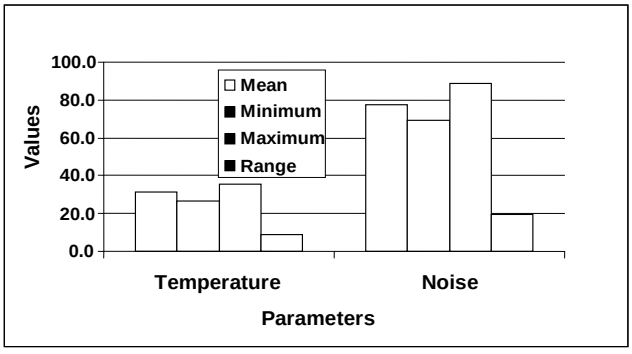
(c) CO for all dry days (Note SO_2=nil)



(d) Temperature and noise for all dry days



(e) CO and SO 2 for all days



(f) Temperature and noise for all days

Figure 3. The levels recorded for the parameters in the area over the wet and dry days.

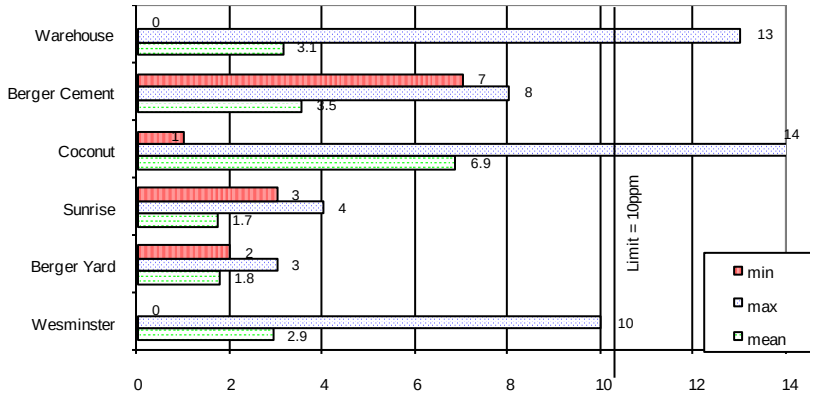


Figure 4. CO concentrations in the area.

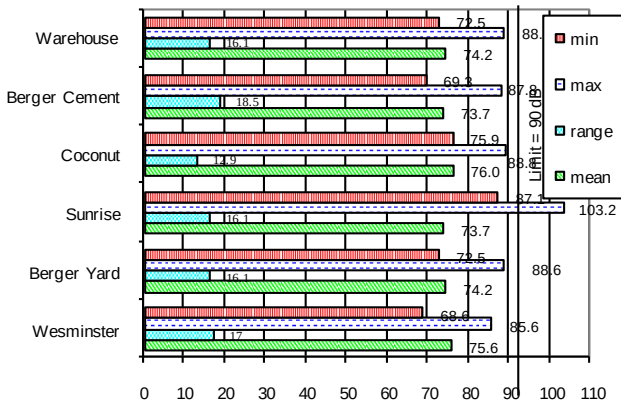


Figure 5. Noise levels at the bus stops.

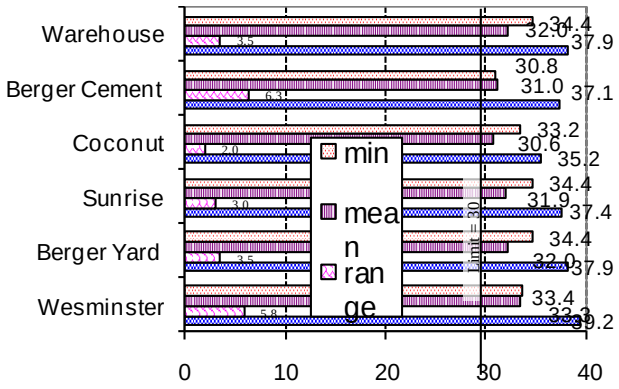


Figure 6. Temperature values at the sites (°C).

of 103.2 dB above the regulatory limit of 90 dB. The value is attributed to the bus stop being around a bridge where a lot of commercial activities take place. As further shown in Figure 5, only Warehouse has a minimum value in the sixties (68.7 dB). All the other minimum values ranged between 72.5 to 76.4 dB while all the mean values were between 73.7 and 76.0 dB.

Temperature

All the bus stops have their temperatures above the regulatory limit of within 30°C. As shown in Figure 6, the minimum recorded is around Berger Cement (30.8°C) and the highest around Westminster for outdoor temperature (39.7°C). The areas are not around depots but parking lots by the tankers.

Conclusion

The results from the study show that concentrations of SO_2 gas around 'tokunbo' market at Berger Yard/Tokunbo Bus stop and that CO are higher around depot zones and tankers garages. Noise is more rampant around bridges where commercial activities are of significance. NO_2 was not traceable because the sites are not proximate to mangrove or swamp forests. Temperature is high because the area is within the tropics. There are no marked differences between the values recorded for wet and dry days.

Some few earlier studies on air quality in Nigeria are either mere theoretical reviews, generalized, focused on industries, or over short durations (Faboye, 1997; Abam and Unachukwu, 2009; Baunbach et al., 1995; Koku and Osuntogun, 2007; Akanni, 2010). The results attest that GHGs are not only prominent around crude oil and gas production. Further investigations are needed to establish the concentrations of other gases such as CO_2, HC, CH_3 and SPM. Same for comparative evaluations of other main importations around the Lagos Ports complex such as bulk cement, sugar, salt, pastas, rice and vegetable oil as well as frozen foods such as fish, chicken and turkey. Nonetheless, the values establish the need for policy strategies that would ensure continuous monitoring and control of point sources emissions. As observed by Olowoporoku (2007), current regulations by the Federal Ministry of Environment and the Department of Petroleum Resources need be revisited with special attention to mobile sources. The need for local level involvement at the state and LGA cannot be over emphasized. This calls for legislative and enforcement supports for transport agencies as well as other stakeholders organizations such as road safety, commerce and industries and petroleum resources. It also calls for awareness campaigns for the citizenry including truck operators.

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