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Effect of Automobile Exhaust Gases Pollution in Minna Metropolis of Niger State

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ABSTRACT: *In this paper, a feasibility study was carried out to ascertain the increasing level of pollution caused by automobile exhaust gases in three major towns in Minna metropolis of Niger State. It involves the analysis of exhaust gases collected from traffic congested areas in Chanchaga, Bosso and Lapai, using the methods of Hemby extraction/calorimeter, Ethylene blue, PRA–pararosanaline and formaldehyde, Saltzman and Molybdenum blue with the help of the UV-Vis spectrophotometer. Cartridges embedded in gas samplers to trap the exhaust gases and analysed for the concentration of each pollutant using the UV-Vis spectrophotometer. The results of the analysis of the exhaust gases revealed that the values obtained from the three major towns in Minna metropolis of Niger state are higher in concentration compare to the value of a clean air taken at sea level. This high increase in the level of concentration of exhaust gases portends a health risk to man.*

KEYWORDS : *Automobile Pollution, Exhaust gas pollution, Chanchaga, Lapai, Bosso*

I. INTRODUCTION

Air pollution is mostly due to industrial pollution in the developed countries. However, in Nigeria transportation has become a more significant source of air pollution. The growing use of old, poorly maintained passenger cars and busses and the use of diesel fuel have dramatically worsened air quality. The primary air pollutants found in most urban areas are carbon dioxide, carbon monoxide, nitrogen oxide, sulphur oxides, hydrocarbons and particulate matter (both solids and liquids).These pollutants are dispersed throughout the world's atmosphere in concentrations high enough to gradually cause serious health problems. Some commercial activities that are inherently associated with environmental pollution and inimical to the convenience of residents arises from the two main sources of pollutants in urban areas; transportation (predominantly automobiles) and fuel combustion in stationary sources such as residential, commercial, industrial heating and cooling and coal-burning power plants [1]. Motor vehicles produce high levels of carbon monoxides (CO) and major source of hydrocarbons (HC) and oxides of nitrogen (NOx), whereas, fuel combustion in stationary sources is the dominant source of sulphur dioxide (SO_2). The percentage composition of the earth's atmosphere in an un-polluted state is 78% of stable nitrogen (N_2), 21% oxygen (O_2), less than 1% argon and other inert gases [2]. It was reported that the acidity in the atmosphere comes from pollution by oxides of sulphur contained in the stack gases from domestic and industrial furnaces and by oxides of nitrogen in the exhaust fumes from buses, trucks and cars [3].

Coppalle *et al.* [4] reported that fossil fuel combustion, particularly as it occurs in automobiles, has been identified as the largest contributor to air pollution in the world, except during cooler months when wood fires contribute significantly. They classify the kind of pollution discharge by petrol vehicles as exhaust emissions (carbon monoxide, oxides of nitrogen, hydro-carbons and particles) and evaporative emissions. The evaporative emissions take account of vapours of fuel which are released into the atmosphere without being burnt. The combustion of fossil fuels produces extremely high levels of air pollution and is widely recognized as one of the most important 'target' areas for reduction and control of environmental pollution [5, 6]. Transport is a known source of many air pollutants. For some pollutants, such as lead and carbon monoxide, the transport sector is often a major contributor while for fine particulate matter; the transport sector is typically one of several sources of emissions. In Minna, like most cities in Nigeria, the use of old cars and busses has increased tremendously due to high cost of new vehicles. This situation has increased more danger to the environment in these areas. Until now there is little or no data on the effect or concentration of such pollutant in Niger state. In order to design an effective approaches to pollution management from automobile sources, it is important to diagnose urban air pollution problems, determine the impact of automobile sources and identify affordable and sustainable solutions. In this paper, the level of pollutants concentration due to those gases from the exhaust of

automobile in three different towns in Minna metropolis will be determined and identify the possible effect to health.

II. MATERIALS AND METHODS

2.1 Source of Materials

The exhaust gases used in this research work was collected from traffic congested areas in three different locations in three major towns (Chanchaga, Bosso and Lapai) in Niger State. In Chanchaga, gases were collected in three different locations; Mobil Junction (MJ), Gwari motor park (GM) and Minna central market (MM). In Bosso town, gases were collected in three different locations; Maitumbi Secondary School Junction (MS), Angwaroka Junction (AJ) and Flamigo Junction (FJ). In Lapai town, gases were collected in three different locations; IBB University gate (IU), Muhammad Doko Secondary School Junction (MD) and Emir Palace Junction (EJ).

2.2 Procedure for Preparation of Samples

The exhaust gas samples were trapped in a funnel-cartridge soaked with hydrogen peroxide, H_2O_2. Each of the cartridge samples were further extracted with 20ml of H_2O_2. The extracted solution was then analysed for the gas pollutants using a Cecil model (1000 series) UV-Vis spectrophotometer. The procedures for the analysis of different pollutants are as follows:

Procedure for Hydrocarbons (HC) Analysis

The method for the analysis of hydrocarbon is Hamby Extraction/Colorimetric. In this method, 4ml of the gas extracted solution was taken and reacted with the reagent methylene chloride for two minutes. This solution was the drained into a curvette, 2g of Aluminum Chloride (which served as a catalyst material) was added to the curvette. This was then covered with it peflon cap and mixture was shaken vigorously for 3mins. The curvette was then placed in the UV-Vis spectrophotometer and scanned for the optimum concentration (ppm) of this pollutant the over range of 350–600nm.

Procedure for hydrogen sulphur-dioxide (H_2S) Analysis

The method for the analysis of H_2S is called Ethylene Blue. 4ml of the exhaust gas extracted solution was put into a test-tube containing a mixture of cenadium Sulphuric acid, $CdSO_4$, Sodium hydroxide NaOH, and Iron (III) chloride. $FeCL_3$, (this is known as the absorbing solution). A dye ethylene blue colouration is formed by the interaction of $FeCl_3$ and N'–N–diethyphenylenediamine. This is then scanned on the spectrophotometer for concentration (ppm) measured at 670nm.

Procedure for sulphur-oxides (SO_2–SO_x) Analysis

The method for the analysis of sulphur-oxides is called Para rosanaline and Formaldehyde (Leucobase). 4ml of the exhaust gas extracted solution was put in a curvette containing a solution of sodium chloride and mercury chloride which is then reacted with pararosanaline (Leucobase) in formaldchyde. This gives a red–violet colour of pararosanaline methyl sulphuric acid, showing a strong absorbance concentration (ppm) on the spectrophotometer measured at 560nm.

Procedure for nitrogen-oxides (NO–NO_x) Analysis

The method used for the analysis of nitrogen-oxides is called Saltzman. 4ml of the exhaust gas extracted solution was put in curvette containing absorbing solution hydrogen NaOH, trithanolanminesulphanilic acid, glacial acetic acid and N'–(naphyl) ethylene diamine hydrochloric acid (NEDA). A colour is developed instantaneously due to process of dye formation. This was measured at 550nm using a spectr**o**photometer.

Procedure for carbon oxides (CO-CO_x) Analysis

The method used for the analysis of carbon oxides is Molybdenum Blue. 4ml of the exhaust gas extracted solution was put in corvette silica and impregnated by ammonium molybdenum in sulphuric acid, H_2SO_4; this reacted with carbon-monoxide, CO to give a blue solution with absorption maxima on the spectrophotometer measured at 660nm. The blue colour development was instantaneous.

III. RESULTS AND DISCUSSIONS

3.1 Presentation of Results

The results of the air pollution gases analysis from the nine locations in the three towns in Niger State are tabulated in Table 1 below.

Table 1: Result of exhaust Gas Analysis in ppm.

Gases	Lapai			Bosso			Chanchaga		
	IU	MD	EJ	MS	AJ	FJ	MJ	GM	MM
HC	3.17	5.06	6.11	4.16	5.77	7.51	8.56	9.58	5.67
H_2S	0.45	0.71	0.82	0.91	0.55	0.76	0.89	0.96	0.68
$S0_2S0$	5.81	6.47	7.78	6.88	5.96	6.47	9.27	9.66	7.11
$N0_2N0$	3.78	5.66	7.02	4.81	4.67	6.72	8.90	9.12	6.96
$C0_2$-C0	9.70	9.82	12.01	8.15	9.00	11.76	14.21	15.36	10.97

Figures 1 shows the average concentration of pollutants in Lapai, Bosso and Chanchaga. The results show that Carbon dioxide/monoxide have the highest concentration and hydrogen sulphide having the lowest concentration. The pollution of gases in the three towns varies. Lapai has the least pollution while Chanchaga has the highest concentration of pollutants (Figure 1). The high rate of pollutants in Chanchaga is due to the high number of registered motor vehicle (Figure 2) and motor cycles (Figure 3) in the area. Figures 1, 2 and 3 showed that there is a relationship between the level of pollutants and the registered vehicles in these cities. Apart from having the highest number of registered automobiles, other reasons while Chanchaga may be the major contributor of these pollutants is presence of many aged automobiles, geographical location and poor vegetation cover.

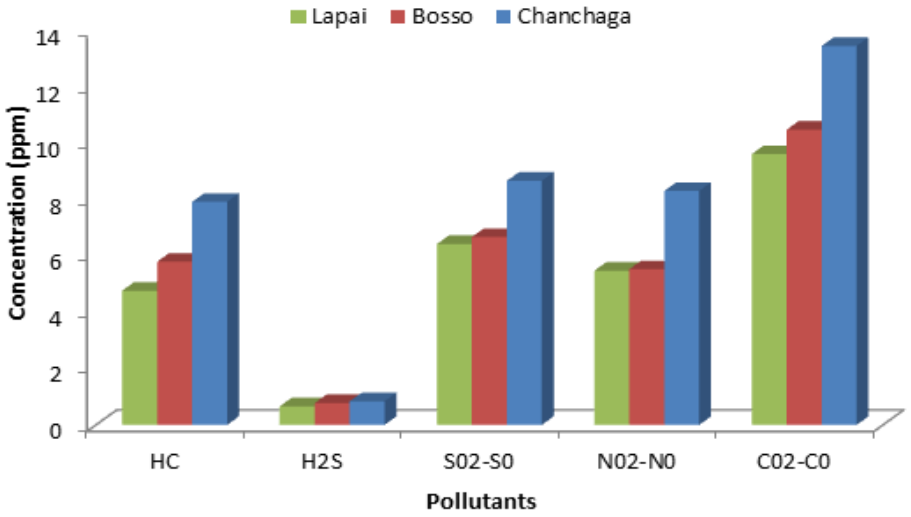

Figure 1: Pollutants in three cities

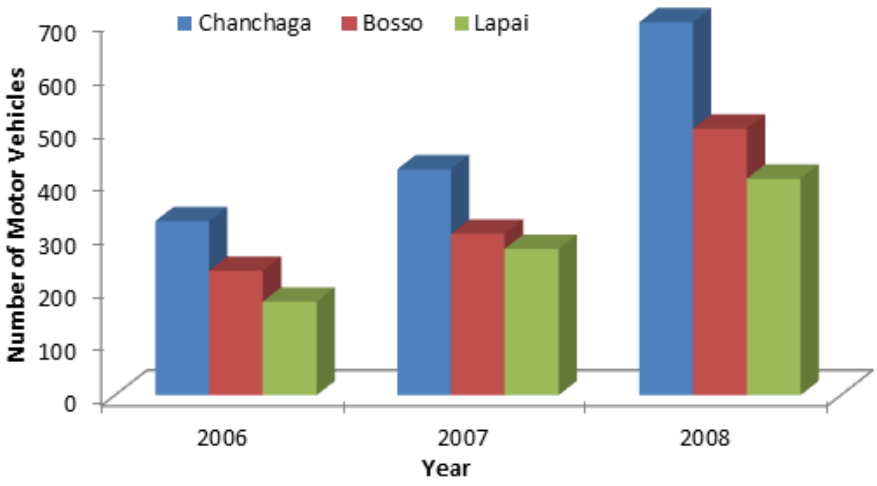

Figure 2: Registered motor vehicles in three cities

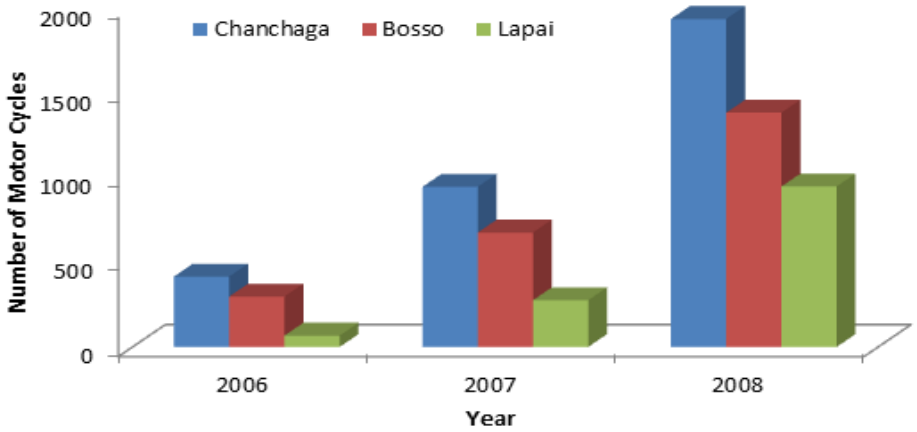

Figure 3: Registered motor cycles in three cities

3.2 Health Implication

For a healthy air free of contamination, the concentration of some of the gases relevant to this study is given in Table 2 below [3]. When these values are compared with the average concentration of the three towns as shown in Figure 4, it can be observed that the concentration of the pollutants in Minna metropolis are outrageously high and therefore detrimental to human health, livestock and crops. The high level of Carbon dioxide (CO_2) in the atmosphere creates what is known as the greenhouse effect and will therefore results in global warming. Another dangerous gas is the Carbon monoxide. The fact that it cannot seen, taste or smell and does not irritate the eyes, nasal passages or lungs makes it an insidious poison. It passes unchanged through the walls of the lungs into the blood. There it combines with hemoglobin, the substance in red blood corpuscles that carries oxygen to all the tissues of the body [7, 8]. The combination of CO with hemoglobin produces carboxyhemoglobin and resulting in decrease in the transportation of oxygen from the lungs to the tissue. The presences of Oxides of Sulphur (SOx) pollutants in the atmosphere come from the combustion of coal and oil containing sulphur compounds. When these are burned, most of the sulphur is converted to SO_2. When SO_2 is inhaled, it dissolves in the moisture on the mucous membrane lining the reparatory tract and the sulphuric acid so formed damages the tissue. When Oxides of Nitrogen (NO_x) is inhaled, it can cause irritation to the lungs and lower resistance to any respiratory infection.

Table 2. Composition of Clean, Dry Air near sea level [3]

Gases	Formula	Conc.
Hydrocarbons	HC	1.0–1.2
Hydrogen Sulphide	H_2S	0.5
Sulphur dioxide/oxide	SO_2-SOx	0.08–0.10
Nitrogen dioxide/oxides	NO_2-NOx	0.02–0.5
Carbon Dioxide/monoxide	CO_2-CO	0.1

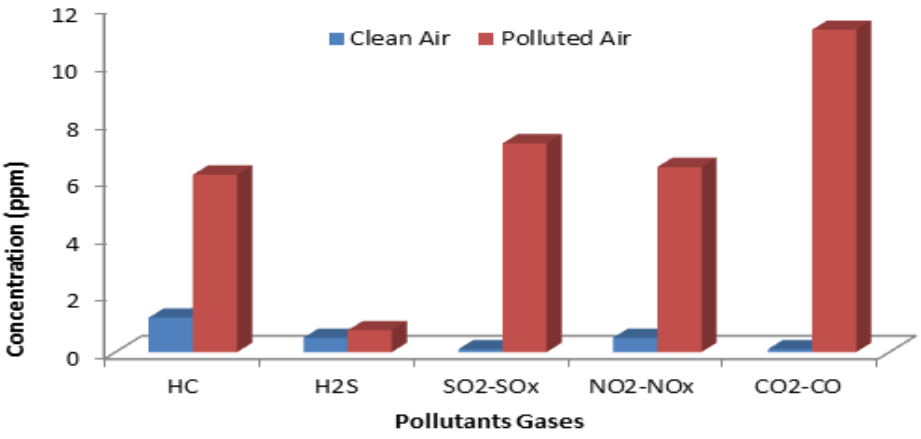

Figure 4: Composition of Clean, Dry Air near sea level

IV. CONCLUSION

The high concentration of pollutants in the three major towns of Chanchaga, Bosso and Lapai has been attributed to the number of registered automobiles in these areas. The oxides of Carbon have the highest concentration in all three towns investigated with Chanchaga having the highest level of concentration and Lapai with the lowest. When the average concentration in the three towns is compared with clean air, it was observed that the concentrations of the pollutants in Minna metropolis are outrageously high and therefore detrimental to human health, livestock and crops.

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