EVALUATION OF THE LEVEL OF URBAN POLLUTION CAUSED BY AUTOMOBILE EXHAUST GASES IN THREE MAJOR TOWNS OF BENUE STATE

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Abstract

This study was carried out to ascertain the level of urban pollution caused by automobile exhaust gases in three (3) major towns of Benue state. It involved the analysis of exhaust gases which were collected from traffic congested areas of Makurdi, Gboko and Otukpo. The exhaust gases were trapped using gas sampler and analyzed for the concentration of carbon monoxide, CO, nitrogen oxides, NO_2, sulphur oxides, SCh, hydrocarbons, HC, and particulate matter (both solids and liquids) using the Uv/vis spectrophotometer using the methods of Hemby extraction/calorimeter. The result obtained from these locations shows that the presence of these gases in the air is higher than those recommended for clean air. The study also showed an increasing number of motor vehicles and motor cycles in these locations which arc the major contributors of these gases. The data obtained from vehicle licensing office in Makurdi from January. 2005 to August, 2008 indicated that the volume of vehicles in these towns tripled within these years hence under this proportion of vehicle increase, the level of pollution may triple by 2011. The information contained in this work will help to create awareness in both government and non governmental agencies on the danger of vehicular pollution, and this will also be useful to researchers

Introduction

The industrialization of society, the introduction of motorized vehicles, and the explosion of population are factors contributing towards the growing air pollution problem. Pollution in Benue State of Nigeria is mainly due to automobile activities. The growing use of old, poorly maintained passenger cars particularly to run the rural routes of the state and the use of diesel fuel have dramatically worsened air quality in the state.

The primary air pollutants found in most urban areas are carbon monoxide, nitrogen oxides, 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.(Arvid & Manisli, 1987)

Some commercial activities that are inherently associated with environmental (air) pollution arise from two main sources of pollutants in urban areas through transportation (predominantly automobiles) and fuel combustion in stationary sources, including residential, commercial, industrial heating and cooling and coal-burning power plants. Motor vehicles produce high levels of carbon monoxides (CO) and are the major source of hydrocarbons (HC) and nitrogen oxides (NOx), whereas, fuel combustion in stationary sources is the dominant source of sulphur dioxide (SO_2). (Miller, 1989). Coppalle *et al* (2001) also wrote that motor vehicles cause most of the air pollution, except during cooler months when wood fires contribute significantly.

Fossil fuel combustion, particularly as it occurs in automobile, occurs in two ways, such as exhaust emissions which include dangerous gases such as carbon monoxide, oxides of nitrogen, hydro-carbons and particulates, and evaporative emissions such as vapors of fuel which are released into the atmosphere, without being burnt (Coppalle *et al* 2001). 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 her publication, Rachael, (1959) also reported that 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.

In order to design effective approaches to pollution management from mobile sources, it is important to diagnose urban air pollution problems, determine the impact of mobile sources, and identify affordable and sustainable solutions. Urban vehicle emissions are emitted near ground level where people live and work, hence urban pollution merits the attention. Our country lack database informations on environmental issues. This work therefore presents results of test and analysis that have been carried out on exhaust gases in some selected local government headquarters (Makurdi, Otukpo and Gboko) of Benue

State.

According to Michael, (1982), pollution may be described as the unfavorable alteration of our surroundings attributed to the anthropogenic activities of man. Environmental pollution takes place through changes in energy patterns, radiation levels, chemical and physical constitution and abundance of environmental pollution and global warming. According to, Sydney (1995), environmental pollution is the contamination of the physical and biological components of the earth/atmosphere system to such an extent that normal environmental processes are adversely affected. Perhaps the overriding theme of these definitions is the ability of the environment to absorb and adapt to changes brought about by human activities. In one word, environmental pollution takes place when the environment cannot process and neutralize harmful by-products of human activities (for example, poisonous gas emissions) in "due course" without any structural or functional damage to its system.

Until recently, environmental pollution problems have been local and minor because of the earth's own ability to absorb and purify minor quantities of pollutants. The industrialization of society, the introduction of motorized vehicles, and the explosion of the population, are factors contributing toward the growing air pollution problem (Socha, 1985). Although, air pollution from automobile engine was first detected about 1942 in Los Angeles, we have been polluting systematically our air since the beginning of the industrial revolution. With rising populations, increasing industrialization and productivity, and rapid growth of our cities each year the pollution problem grow worse (Gonah, 1999).

Pollution occurs, on the other hand, because the natural environment does not know how to decompose the unnaturally generated elements (anthropogenic pollutants), and, on the other hand, there is a lack of serious commitment on the part of government on ways to decompose these pollutants artificially. Pollution has negative impacts on crucial environmental services such as provision of clean air and clean water (and many others) which are vital to the existence of life on earth. (Raphael, 1992).

Carbon dioxide in the atmosphere creates what is known as the green house effect. Carbon dioxide is a good transmitter of sunlight, but partially restricts infrared radiation going back from the earth into space. This produces the so-called greenhouse effect that prevents a drastic cooling of the earth during the night. Increasing the amount of CO_2 in the atmosphere reinforces this effect and is expected to result in a warming of the earth's surface. Currently, carbon dioxide is responsible for 57% of the global warming trend. In his publication, Roleff (1997) clearly gave the composition (in percentage) of the earth's atmosphere in an un-polluted state as; 78% of stable nitrogen, N_2, 21% oxygen, O_2, less than 1% argon and other inert gases. More than 0.03% carbon dioxide CO_2, ozone 0_3 small but transitory amounts of biological active substances like carbon monoxide CO, and methane CH_4, and nitrogen dioxide, $N0_2$, All the above gases occur in the atmosphere at a certain proportion or percentage. Toxicity depends upon the formulation and concentration of the compound or gas in the atmosphere.

According to Hopewell (1974) he wrote that the earth's atmosphere has a mass of six thousand trillion tons and a mixture of many gases. He gave the analysis of many samples of air collected far from sources of pollution as shown in the Table 1. Concentrations of gases in mixtures are conveniently expressed in parts per million (ppm).

Since the weight of CO (Carbon monoxide) dumped into the atmosphere each year is more than half the weight of all pollutants together, we might conclude that CO is the most dangerous of all. But other factors besides quantity create the potential harmfulness of pollutants. These factors includes the tolerance level, which is the maximum concentration of a pollutant that can be present in the air we breathe without unfavorable effects on our health, the other is the residence time, which is the average time it takes for a pollutant to be removed from the atmosphere by natural purification processes, and the interactions with other pollutants determine whether one pollutant tends to increase, decrease or have no influence on the effects of other pollutants.

The damage done to us by particles in the air we breathe depends on three factors which are; Their sizes, their chemical and physical characteristics, the extent to which they have absorbed gaseous pollutants and hold them in contact with tissue in the lungs. When we inhale, air travels through the nose, the trachea, the bronchi, and the bronchioles into the alveoli, the tiny sacs whose walls permit the transfer of oxygen from air into the blood and of carbon dioxide from the blood into the air.

John (1959), reported that a car is only considered smoky if it emits visible smoke from its exhaust pipe for a continuous period of more than 10 seconds. He went ahead to report that, a car is not classified as smoky if the exhaust emission are caused by heat or the condensation of water vapour, which can occur when the car has just been started, particularly on cold days. According to him, smoky cars contribute far more to air pollution than well maintained cars.. In certain circumstances, even well

maintained vehicles can sometimes produce smoke from their exhaust. This can occur during heavy acceleration, climbing steep hills and as engine turbo and supercharges are building sufficient speed to provide enough air to burn fuel properly.

Maxwell (2004) also reported on harmfulness of smoke as chemicals that can cause mild to severe irritation to the eyes, nose, throat and lungs. They can also be absorbed into the body and cause deterioration in general health.

According to an EPA publication (789), a study into the effects of air pollution found a link between high levels of fine particles, ozone, nitrogen dioxide and carbon- monoxide and an increase in the number of hospital admissions for respiratory and cardiovascular disease.

In his publication, Bootheroyd (1998) emphasized that old cars pollute more than new cars'. Old cars do not necessarily pollute most but newer cars, which are not properly turned and maintained, also cause a lot of pollution. He also reported that unleaded petrol is better for the environment.

Materials and Method

The samples used in this work were collected from traffic congested areas of three different local governments of Benue State. Four locations were selected in Makurdi, labeled *(Z\, Z_2*, Z_3, and Z_4); two locations in Gboko and Otukpo which were labeled (Y| and Y_2J and (X| and X_2) respectively. The trapped exhaust gases were analyzed using the ultraviolet visible (UV/Vis) spectrophotometer to determine the type of gases and their concentration in parts per million of air (ppm). The gas sampler was made up of a funnel with cartridges and hydrogen peroxide, H_2O_2 The hydrocarbons, HC, content was obtained using extract solution (exhaust gas plus H_2O_2), methylene chloride, aluminum chloride, A1C1 and a curvette.

The hydrogen sulphur dioxide, H_2S, content was obtained using extract solution, test tube, solution mixture of Cenadium Sulphur dioxide ($CdSO_4$), sodium hydroxide (NaOH), iron (III) chloride ($FeCl_3$), N' - N' - diethylphenylene diamine.

The sulphur-oxide (SO_2 - SO_X) content was obtained using extract solution, curvette, sodium chloride, NaCl, magnesium chloride, MgCl, para rosanaline. Formaldehyde.

The nitrogen-oxide (NO -NO_X) content was obtained using extract solution, curvette, solution of sodium hydroxide, NaOH, triethanolamine sulphanilic acid, glacial acetic acid, N - (naphyl) ethylene diamrnine hydrochloric acid (NEDA).

The carbon-oxides (CO - CO_2) content was obtained using extract solution, curvette, silica, ammonium molybdate, tetraoxo-sulphate (iv) acid, H_2SO_4.

Experimental Procedures

The exhaust gas samples were trapped from the various locations 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 solutions were them analyzed for the gas pollutants using a Cecil model (1000 Series) UV/Vis spectrophotometer.

(a) Procedure used for Analyzing Hydro-Carbons (HC)

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

(b) Procedure used for Analyzing Hydrogen Sulphur-dioxide (H_2S)

Ethylene Blue method was used. 4 ml 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' - diethylphenylene diamine. This is then scanned on the spectrophotometer for concentration (in ppm) measured at 670nm.

(c) Procedure used for Analyzing Sulphur-Oxides (SO_2 - SO_X).

PRA - Para rosanaline and Formaldehyde (Leucobase) was used. 4 ml 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 Para rosanaline (Leucobase) in formaldehyde. This gives a red -violet colour of Para rosanaline methyl sulphuric acid, showing a strong absorbance concentration (in ppm) on the spectrophotometer measured at 560nm.

(d) Procedure used for Analyzing of Nitrogen- oxides (NO - NO_X).

Saltzman method was used. 4 ml of the exhaust gas extracted solution was put in curvette containing absorbing solutions of sodium hydrogen, NaOH, triethanolanmine sulphanilic 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 spectrophotometer.

(e) **Procedure used for Analyzing of Carbon Oxides (CO - CO_X).**

Molybdenum Blue method was used. 4 ml of the exhaust gas extracted solution was put in a curvette silica gel impregnated by ammonium molybdate 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.

Results and Discussion

The results of the air pollution gas analysis in parts per millionth of air (ppm) from the three (3) major towns in Benue State using the Uv/vis spectrophotometer Cecil model 1000 is presented in table 2. The subscribes represents the various locations in the town while X, Y, and Z are the average values in these towns, Otukpo, Gboko and Makurdi respectively.

The increasing rate of registered motor vehicles (M.V) and motor cycles from 2005 to August, 2008 in Otukpo, Gboko and Makurdi towns of Benue State are represented in table 3.

Discussion

The results of the analysis of the concentration (ppm) of the exhaust gases from the three (3) towns in Benue State in table 2 is plotted in a histogram, figure 1.

Makurdi being the centre of activities in the state contributes the highest amount of all the pollutants with the concentration of CO_2-CO (15.00pprn) been the most active, with the exception of NO_2-NOx been contributed highest by Gboko. Gboko is the next contributor of these pollutants and having the bar of CO_2-CO as the tallest by its histogram plot. Otukpo is the least contributor of these pollutants with H_2S as the least bar and $C0_2$-CO as the tallest bar by its histogram plot.

The total average concentration values of the three (3) town's shows clearly that CO2-CO is the most dominant pollutant in air. The presence of the other pollutants are in the magnitude of SO_2-Sox greater than NO_2-NOx greater than HC greater than H_2S in Makurdi,, Gboko and Otukpo respectively. While most of Makurdi lies in a valley resulting in acceleration out of the town, Gboko town is in a higher altitude than Otukpo being partly responsible for these values.

For a healthy air free of contamination, the concentration of the elements should have the values (in ppm) given in Table I, but these values are higher, and this is detrimental to human health, livestock, crops and the generation yet unborn. Table 3 gives the increasing rate of registered motor vehicles and motor cycles respectively, Makurdi, Gboko and Otukpo from 2005 to August, 2008.

Conclusion and Recommendation

The data obtained from motor vehicle licensing office in Makurdi and the result of the gas analyzer shows that the higher the number of automobiles found in a particular town, the higher the concentration of pollutants produced. This means that as more automobiles are continuously registered, there will be a continuous increase in the level of the concentration of pollutants in such an environment.

It is therefore recommended that government should quickly take an urgent step to reduce the number of vehicles that are no more road worthy in the state. An awareness campaign should be initiated

to educate the general public on the dangers of air pollution particularly by automobiles. The data presented in this work will be useful for this campaign and also for researchers.

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Table 1 : Composition of Clean, Dry Air Near Sea Level

Parameters	GASES							
	HC	H_2S	SO_2-S O_X	[NO_2-NO_X	CO_2-co	0_3	Ki-	Xe
CONCENTRATION	1.0-1.2	0.5	0.08-0.10	JX02-O5	0.1	0.01-0.05	1.0	0.08

(SOURCE: Hopewell, 1974)

Table 2: Result of Exhaust Gas Analysis (ppm) or Concentration Values (ppm) of the Pollutants from Qtukpo (X), Gboko (Y), and Makurdi (Z)

Gases	Sample Sites										
	XI	X2	X	Yl	Y2	Y	Zl	Z2	Z3	Z4	Z
HC	2.22	J.02	2.62	5.00	5.10	5.05	7.40	9.11	2.10	4.06	5.67
MlS	jx6<Lj	0.66	0.63	0.67	0.72	0.70	0.88	0.95	JX66_	0.77	0.82
SO_2-$S0_x$	4.71	4.84	4.78	7.07	7.35	7.21	9.00	9.99	4.71	8.60	8.08
NO_2-N O_X	4.20	4.40	4.30	7.20	7.16	7.18	7.77	8.89	4.25	7.06	6.99
CO_2-C O	9.55	9,68	9.62	11.04	12.24	11.64	13.16	15.00	9.05	11,41	12.16

KEY

HC H_2S Hydrocarbons Hydrogen
SO_2-SO_X Sulphide Sulphur dioxide/oxide Nitrogen
CO_rCO dioxide/oxide Carbon dioxide/monoxide

Table 3: Registered Motor Vehicles & Motor Cycles in Makurdi, Gboko and Otukpo from 2005 to August, 2008

Town	Year								Total	
	2005		2006		2007		2008		MV	MC
	MV	MC	MV	MC	MV	MC	MV	MC		
Makurdi	450	900	800	`1600	1300	2600	1450	2900	4000	8000
Gboko	300	850	400	1150	450	2600	550	2900	1700	7500
Otukpo	250	800	300	1100	420	2400	530	2700	1500	7000

(Source: Benue Revenue Licensing Office, Makurdi).

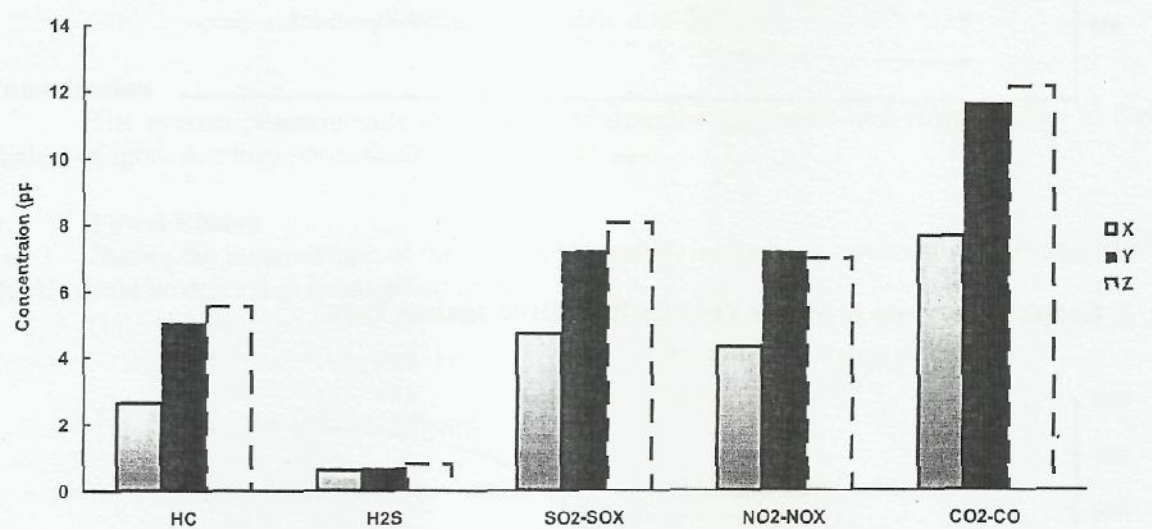

Fig. 1: The Chart Showing the Distribution of Pollutant Gases in the Three Towns

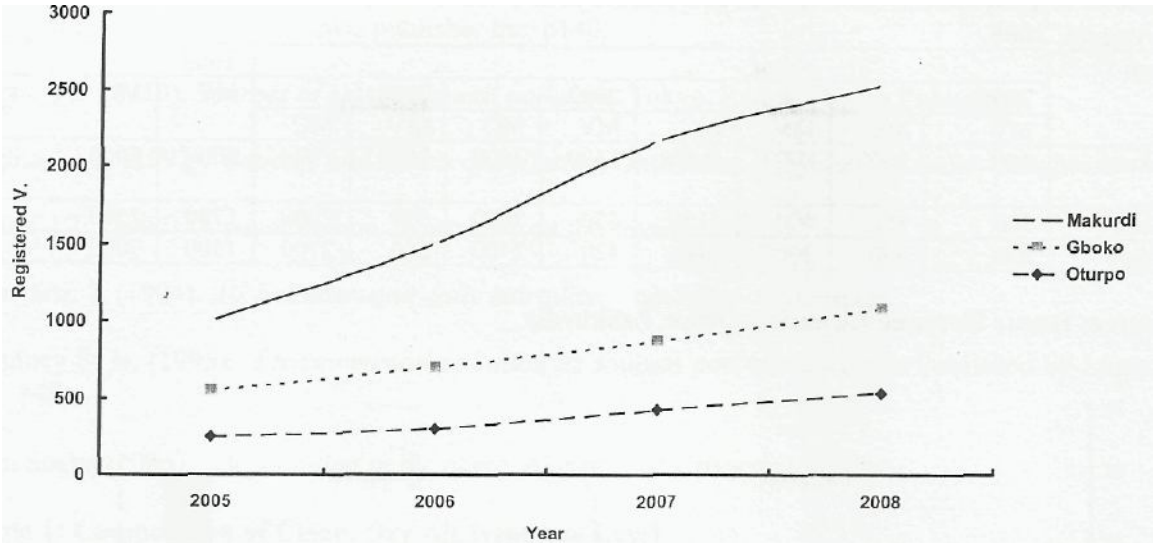

Fig. 2: Graph of Increase in Motor Vehicles Registered against Year

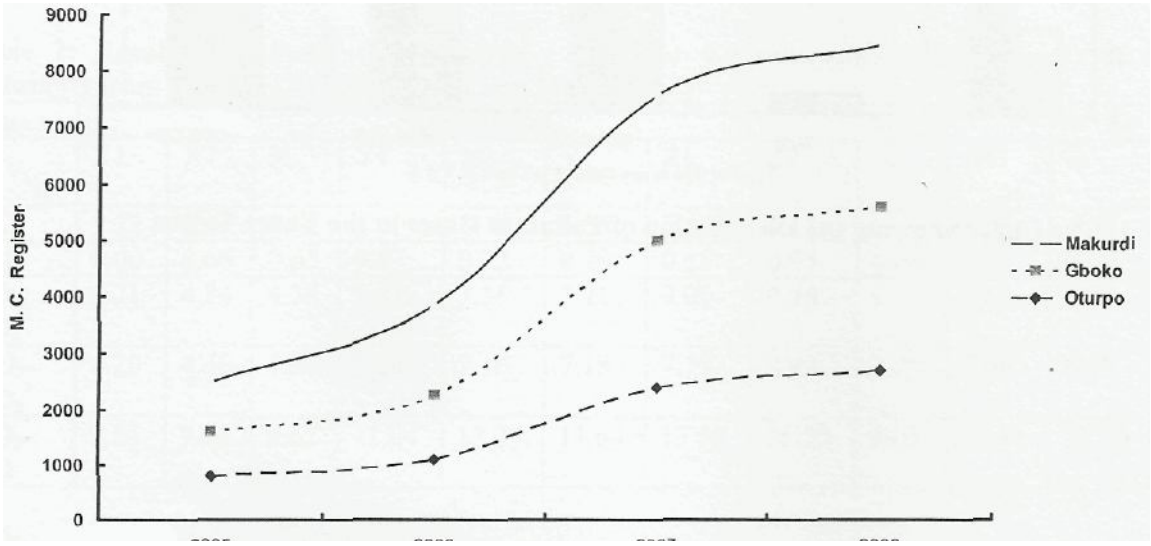

Fig. 3: Graph of Increase in Motor Cycles Registered against Year