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IMPLICATIONS OF LACK OF MAINTENANCE OF VEHICLES ON AMBIENT AIR QUALITY

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ABSTRACT

This paper reported the results of the investigation of vehicular emissions in selected roads in Abeokuta, Nigeria. Five roads: Olorunsogo, Alabata, Onibode, Kobape, and Ibara-Orile roads were considered with eight different vehicle types (Honda, Mazda, Mercedez Benz, Mitsubishi, Nissan, Peugeot, Toyota, and Volkswagen) on each road. Vehicles were parked 8.0m away from the main road in downwind direction. The vehicular exhaust emissions monitored were CO_2, O_2, CO, and HC emissions. The total mean concentration of measured CO_2 emission from vehicular exhaust on all the roads, ranged between 389100 ppm for Nissan and 465600 ppm for Mitsubishi; O_2 emission ranged between 99000 ppm for Toyota and 192000 ppm for Peugeot, also CO emission ranged between 319400 ppm for Peugeot and 460800 ppm for Nissan while HC emission ranged between 2360 ppm for Toyota and 4652 ppm for Volkswagen. It could be noted that the air pollutants are high for most of the vehicles irrespective of the type and higher than both the European and Nigerian standards. This implies that vehicles are poorly maintained in Nigeria. This study therefore concluded that vehicular pollution in Abeokuta is significant with possible serious health and environmental consequences.

Keywords: Vehicular emissions, air pollution, urban areas, developing countries

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1. INTRODUCTION

The rapid growth in mobility in urban areas has improved Nigeria's economic development. So, the increase in air pollution because of the fleet of cars on the road corridors has been a concern. The maximum contribution to air pollution is from vehicular emissions (Mitra and Sharma, 2002). By definition, air pollution is known as the contamination of air by discharge of harmful substances, which we inhale at levels that can create some negative effects on the environment and human health (Bayram, 2006).

In recent years, there has been considerable research on vehicular emissions and fumes (Lilley, 2000; Marshall et al, 2003; Ababio, 2003; Cadle et al, 2000, 2001, 2003 and 2004). Pollution from motor vehicles has become an issue simply because of the steady increase both in the number of vehicles in use and the distances travelled by each vehicle. The atmosphere can neutralize toxic solid, liquid and gaseous substances by melting them; however, due to the production of excessive amounts of such substances and depending on the meteorological and topographic conditions, the atmosphere is in a continuous process of pollution (Kaypak and Özdilek, 2008).

A report by Kapaka (2003) showed that, vehicular emissions account for about 60% of the total pollutants emitted when compared to other sources and they are dangerous to the society. Classification of vehicles involved was not reported. In the developing nations, automotive air pollution is mostly a problem in large cities with high levels of traffic, such as Mexico City, Bangkok, and Abeokuta, Nigeria. In cities of advanced nations, power plants, factories, and other stationary sources constitute the greatest threat to air quality. However, Frey and Zheng (2002) noted that vehicular emissions are dependent on vehicle design, operation, and maintenance and fuel compositions.

According to Tan (2006), the number of kilometers covered by vehicles in the world rose significantly in the past three decades. As a result of these increases, the use of motor vehicles now generates more air pollution than any other single human activity. It is the fastest growing source of CO_2 and in urban areas, it accounts for the bulk of emissions of CO, HC, and NO_x. Unfortunately, vehicle emissions present an important environmental hazard that needs to be investigated, since it may shorten the life span of exposed people. Vehicle emissions significantly pollute air and require control (Karlsson, 2004).

This study assessed vehicular emissions along Olorunsogo, Alabata, Onibode, Kobape, and Ibara-Orile roads in Abeokuta by measuring the exhaust concentrations of pollutants from the exhaust pipes of different kinds of vehicles plying the roads to determine the magnitudes of emissions released into the ambient air.

2. MATERIALS AND METHOD

2.1. The study area

The study was conducted in Ogun State, Nigeria. Abeokuta is the capital and largest city in the state. The state has a total area of 16,980.55 km^2 and a population of 3,751,140 (according to 2006 Census) with a population density of 220/km^2. The State has twenty (20) Local Government Areas, with the highest number of higher institutions (about 14 Universities, public and private alike) in Nigeria.

Industrialization constitutes a key factor in the promotion of the social and economic welfare of the people and the responsibility of the State Government is to foster industrial growth with a view of promoting rapid economic development. The State has about 372 operational industries, 56 of which were newly commissioned between 2005 and 2014. The type of industries include food, beverage, chemical, pharmaceutical, basic metallic, iron/steel/fabricated metal products, pulp/paper products, communications, motor vehicle/miscellaneous assembly, Cement Companies etc. The State, because of its proximity to Lagos State, the largest commercial hub of Nigeria experiences both human and vehicular population boom as it is the passage way of heavy transport to the North via Ibadan and East via Sagamu.

The study was conducted in Abeokuta along Olorunsogo, Alabata, Onibode, Kobape, and Ibara-Orile roads (Plate 1) with 500 vehicles randomly selected, most of which released visible smoky exhaust due to lack of adequate maintenance. The vehicles sampled were manufactured between 1978 and 2012.

Figure 1 The study locations in Abeokuta, Ogun State, Nigeria (Google map)

2.2. Sampling of vehicular emission/pollutants

The exhaust emission tests were carried out at five different locations within Abeokuta. The Portable**,** Hand-Held, battery operated Kane automotive 4-gas analyzer with detector tube (Model Auto 4-1) was used to measure the vehicular emissions. The machine is capable of measuring CO (a resolution of 0.01 % with an accuracy of ± 0.5 % volume), HC (a range of 1.0 ppm), CO_2 (a resolution of 0.1 % with an accuracy of ± 0.5% volume) and O_2 (a resolution of 0.1 % with an accuracy of ± 0.5 % volume). The Kane Automotive 4-Gas analyzer Auto 4-1 model was designed to be used on petrol, LPG or CNG powered engines. All measured and calculated parameters can be printed on the optional infrared printer or saved to the analyzer's memory.

The analyzer was switched on and allowed to fully initialize to display zero setting, then the main menu was accessed and fuel type selected (diesel, petrol, CNG, and LPG). Having done these, the analyzer was returned to the zero settings with the main button, to check if the setting was within the allowable range (especially oxygen, O_2 which should be between 20.9 % and 21%). For petrol engine, the engine speed was raised to 2500 rpm while for diesel engine the accelerator pedal was fully depressed with transmission in neutral. This was maintained for 30 seconds to warm and precondition the engine. Then the engine was returned to idle by taking the foot off accelerator. The exhaust was observed for a while to ensure that the smoke was steady, then the analyzer's probe was completely inserted into the exhaust pipe and clamped. During the analysis, CO was recorded at the maximum level.

Idle method was used for this work. Eight vehicle types were selected for this paper: Honda, Mazda, Mercedes Benz, Mitsubishi, Nissan, Peugeot, Toyota, and Volkswagen. Emissions from their exhaust were reported in concentration units (parts per million (ppm) or percent (%) where 1% = 10,000 ppm). Also raw exhaust samples were taken from each of the vehicles.

3. RESULTS AND DISCUSSION

The mean concentrations of measured vehicular exhaust emissions at sampling points on all the selected roads are summarized in Tables1 to 6. At the sampling point on Olorunsogo road, the mean concentrations of CO_2 ranged between 77900 ppm for Nissan and 94200 ppm for Mitsubishi, while the mean concentrations of O_2 ranged between 21800 ppm for Mitsubishi and 37400 ppm for Peugeot, also the mean concentrations of CO ranged between 65300 ppm for Peugeot and 91900 ppm for Nissan, and the mean concentrations of HC ranged between 450 ppm for Toyota and 886 ppm for Volkswagen.

At the sampling point on Alabata road, the mean concentrations of CO_2 ranged between 73700 ppm for Nissan and 88000 ppm for Peugeot and Volkswagen, while the mean concentrations of O_2 ranged between 11100 ppm for Volkswagen and 36400 ppm for Honda, also the mean concentrations of CO ranged between 82700 ppm for Peugeot and 109300 ppm for Mitsubishi, and the mean concentrations of HC ranged between 430 ppm for Volkswagen and 856 ppm for Nissan while at the sampling point on Onibode road, the mean concentrations of CO_2 ranged between 71000 ppm for Volkswagen and 105400 ppm for Mitsubishi, while the mean concentrations of O_2 ranged between 11000 ppm for Toyota and 47800 ppm for Peugeot, also the mean concentrations of CO ranged between 47800 ppm for Peugeot and 84100 ppm for Nissan, and the mean concentrations of HC ranged between 279 ppm for Honda and 1341 ppm for Volkswagen.

At the sampling point on Ibara-Orile road, the mean concentrations of CO_2 ranged between 73800 ppm for Mitsubishi and 90100 ppm for Peugeot, while the mean concentrations of O_2 ranged between 17600 ppm for Toyota and 35300 ppm for Honda, also the mean concentrations of CO ranged between 79300 ppm for Peugeot and 117000 ppm for Mitsubishi, and the mean concentrations of HC ranged between 526 ppm for Toyota and 951 ppm for Mercedes Benz while at the sampling point on Kobape road, the mean concentrations of CO_2 ranged between 76000 ppm for Volkswagen and 105,000 ppm for Mitsubishi, while the mean concentrations of O_2 ranged between 24200 ppm for Mitsubishi and 54200 ppm for Peugeot, also the mean concentrations of CO ranged between 44300 ppm for Peugeot and 88900 ppm for Mercedes Benz, and the mean concentrations of HC ranged between 305 ppm for Honda and 1332 ppm for Volkswagen.

The total mean concentrations of measured CO_2 emission from vehicular exhaust on all the roads ranged between 389100 ppm for Nissan and 465600 ppm for Mitsubishi, while the total mean concentrations of O_2 ranged between 99000 ppm for Toyota and 192000 ppm for Peugeot, also the total mean concentrations of CO ranged between 319400 ppm for Peugeot and 460800 ppm for Nissan, and the total mean concentrations of HC ranged between 2360 ppm for Toyota and 4652 ppm for Volkswagen. All the concentrations of the measured vehicular exhaust emissions for almost every vehicle were absolutely high with the adverse implications that would be enormous.

The results presented in Tables 1-6 (in ppm) do not compare favourably with the European and National standards shown in Tables 7&8, as the values in Tables 1-6 are higher compared to the European and National standards. This implies that most of the vehicles on Nigerian roads pose a great risk to the environment.

4. CONCLUSION AND RECOMMENDATION

This study has shown that the concentrations of pollutants from these poorly maintained vehicles are much higher than the European and National standards. This implies that such vehicles are very harmful to the environment and climate (Table 9). It could be noted that these air pollutants are high for most of the vehicles irrespective of the type and higher than both European and National standards. This shows poor vehicle maintenance. This study therefore concluded that vehicular exhaust pollution in Abeokuta is significant with possible serious health consequences.

This study suggests the following:

- Public enlightenment programmes on vehicular emissions should be encouraged.
- Government should provide mass transit transportation such as good train system, and big busses.
- Strict adherence to standard regulations should be a must, as most emission control devices in fairly-used imported vehicles are usually called to question.
- Vehicle owners should be made to understand why they should regularly go for checks and maintenance, so that exhaust emissions could be reduced.
- Used vehicles entering the country must pass an approved emission test to demonstrate that their emission control equipment is functioning as intended.

If these measures are properly put in place, greenhouse gases and other harmful substances will be reduced and Nigeria will be making a move towards a green economy.

Table 1 The Mean Concentrations of Measured Vehicular Exhaust Emissions From Olorunsogo Road.

Vehicle Type	Mean Concentrations of Vehicular Exhaust Emissions			
	CO_2 (ppm)	**O_2 (ppm)**	**CO (ppm)**	**HC (ppm)**
Honda	85200	37000	77000	494
Mazda	88900	35300	74200	548
Mercedes Benz	79600	37000	88400	768
Mitsubishi	94200	21800	81700	479
Nissan	77900	28600	91900	642
Peugeot	90200	37400	65300	669
Toyota	92500	22000	76000	450
Volkswagen	80000	28100	87800	886

Table 2 The Mean Concentrations of Measured Vehicular Exhaust Emissions From Alabata Road.

Vehicle Type	Mean Concentrations of Vehicular Exhaust Emissions			
	CO_2 (ppm)	**O_2 (ppm)**	**CO (ppm)**	**HC (ppm)**
Honda	73800	36400	92700	708
Mazda	84800	24500	92300	686
Mercedes Benz	82200	28600	94500	826
Mitsubishi	83000	16000	109300	611
Nissan	73700	22800	105000	856
Peugeot	88000	26900	82700	821
Toyota	77500	21900	98900	610
Volkswagen	88000	11100	99000	430

Table 3 The Mean Concentrations of Measured Vehicular Exhaust Emissions From Onibode Road.

Vehicle Type	Mean Concentrations of Vehicular Exhaust Emissions			
	CO_2 (ppm)	O_2 (ppm)	CO (ppm)	HC (ppm)
Honda	96600	37000	60800	279
Mazda	89000	46100	56000	410
Mercedes Benz	74500	44000	76100	653
Mitsubishi	105400	27600	54000	347
Nissan	82700	28800	84100	439
Peugeot	92400	47800	47800	516
Toyota	103500	11000	74900	399
Volkswagen	71000	45000	77000	1341

Table 4 The Mean Concentrations of Measured Vehicular Exhaust Emissions From Ibara-Orile Road.

Vehicle Type	Mean Concentrations of Vehicular Exhaust Emissions			
	CO_2 (ppm)	O_2 (ppm)	CO (ppm)	HC (ppm)
Honda	81000	35300	88300	619
Mazda	87000	25100	88500	640
Mercedes Benz	81300	30100	98300	951
Mitsubishi	78000	18300	117000	650
Nissan	73800	28500	98400	778
Peugeot	90100	26100	79300	759
Toyota	87900	17600	89300	526
Volkswagen	81000	18200	96900	663

Table 5 The Mean Concentrations of Measured Vehicular Exhaust Emissions From Kobape Road.

Vehicle Type	Mean Concentrations of Vehicular Exhaust Emissions			
	CO_2 (ppm)	O_2 (ppm)	CO (ppm)	HC (ppm)
Honda	91500	38800	59400	305
Mazda	87000	50100	52700	410
Mercedes Benz	83400	26200	88900	636
Mitsubishi	105000	24200	58200	365
Nissan	81000	33500	81400	431
Peugeot	89500	54200	44300	534
Toyota	97200	26500	62700	375
Volkswagen	76000	48000	70100	1332

Table 6 Total Mean Concentrations of Measured Vehicular Exhaust Emissions from the Five Roads.

Vehicle Type	Mean Concentrations of Vehicular Exhaust Emissions			
	CO_2 (ppm)	O_2 (ppm)	CO (ppm)	HC (ppm)
Honda	428100	184500	378200	2405
Mazda	434700	181100	368700	2694
Mercedes Benz	401000	162600	446200	3834
Mitsubishi	465600	107900	420200	2452
Nissan	389100	142200	460800	3146
Peugeot	450200	192400	319400	3299
Toyota	458700	99000	401800	2360
Volkswagen	396000	150400	430700	4652

Table 7 International (European) Standards for Vehicular Exhaust Emissions

Emission Standards	CO (ppm)	HC (ppm)
Euro II	25000	300
Euro III	5000	100
Euro IV	3000	50

Source: Lu, 2011

Table 8 National Standards for Exhaust Emissions

Emission Standard	CO (ppm)	HC (ppm)
New model	35000	600
Existing model	45000	800

Source: NAC, 2011

Table 9 Pollutants and their Health and Environmental Effects

Pollutants	Health Effects	Environmental Effects
Carbon Monoxide (CO)	Reduces the flow of oxygen in the blood stream and increases the likelihood of exercise-related heart pain in people with coronary heart disease. At low doses it can impair concentration and neurobehavioral function.	Greenhouse gas contributing to global warming.
Carbon Dioxide (CO2)	Non	Major greenhouse gas contributing to global warming.
Nitrogen Oxides (NOx)	May exacerbate asthma and possibly increase susceptibility to infections. It could also lead to coughing, shortness of breath and decreased lung function.	Formation of ground- level ozone or “smog,” which is highly corrosive and damages crops and forests. It contributes to acid rain and is a greenhouse gas that contributes to global warming.
Unburned Hydrocarbons (HC)	Low molecular weight compounds cause eye irritation, coughing and drowsiness. High molecular weight compounds can be mutagenic or carcinogenic.	Ground level ozone precursor.
Sulfur Oxides	It irritates the eyes and increases the frequency and severity of respiratory symptoms and lung disease.	It is a major precursor of acid rain.

Source: Ghio *et al.* 1999, Pooley *et al.* 1999.

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