

# Environmental Health Implications of Motorcycles Emitted Gases in a Metropolitan Nigeria

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Received May 29, 2013; Revised December 27, 2013; Accepted January 05, 2014

**Abstract** A study to assess the various gases emitted by motorcycles in a metropolitan State, Uyo, in Nigeria was carried out. Two hundred commercial motorcycles the mostly available means of transport were used for the study drawn from seven motorcycle parks. The gases examined were nitrogen dioxide, sulphur dioxide, carbon monoxide, chlorine, hydrogen sulphide and ammonia. The overall collection results per motorcycle parks showed the following gases concentrations: Motor Park –A; NO<sub>2</sub>; 12.7ppm, SO<sub>2</sub>; 13ppm, CO; 1337ppm, H<sub>2</sub>S; 20.2ppm, NH<sub>4</sub>; 97ppm, Cl<sub>2</sub>; 20.3ppm, HCN; 80ppm. Motorcycle Park B-NO<sub>2</sub>; 12.1ppm, SO<sub>2</sub>, 11ppm, CO; 1508ppm, H<sub>2</sub>S; 20.4ppm, NH<sub>4</sub>; 116ppm, Cl<sub>2</sub>; 19.6ppm, HCN; 71ppm. Motorcycle: Park-C NO<sub>2</sub>; 11.7ppm, SO<sub>2</sub>; 8.7ppm, CO; 1084ppm, H<sub>2</sub>S; 14.1ppm, NH<sub>4</sub>; 48ppm, Cl<sub>2</sub>; 18.6ppm, HCN; 65ppm. Motorcycle Park D: NO<sub>2</sub>; 5.1ppm, SO<sub>2</sub>; 4.7ppm, CO; 550ppm, H<sub>2</sub>S; 18.4ppm, NH<sub>4</sub>; 48ppm, Cl<sub>2</sub>; 25.9ppm, CO; 550ppm, H<sub>2</sub>S; 18.4ppm, NH<sub>4</sub>; 48ppm, Cl<sub>2</sub>; 25.9ppm, HCN; 101ppm. Motorcycle Park E:NO<sub>2</sub>; 5.4ppm, CO; 596ppm, H<sub>2</sub>S; 4.9ppm, NH<sub>4</sub>; 48ppm, Cl<sub>2</sub>; 79ppm, HCN; 101ppm. Motor Park F: NO<sub>2</sub>; 51ppm, SO<sub>2</sub>; 5.4ppm, CO; 596ppm, H<sub>2</sub>S; 4.9ppm, NH<sub>4</sub>; 48ppm, Cl<sub>2</sub>; 7.3ppm, HCN; 40ppm. Motorcycle Park G: NO<sub>2</sub>; 11.9ppm, SO<sub>2</sub>; 10.5ppm, CO; 1616ppm, H<sub>2</sub>S; 18.4ppm, NH<sub>4</sub>; 185ppm, Cl<sub>2</sub>; 25.9ppm; HCN; 101ppm. The most harmful gas; carbon monoxide was significantly high in all the parks and the general results showed an alarming degree of polluted gases emission.

**Keywords:** motorcycles, gases, concentration, health

**Cite This Article:** JIMMY E. O. I., SOLOMON M. S., PETER A. I, and ASUQUO' C, "Environmental Health Implications of Motorcycles Emitted Gases in a Metropolitan Nigeria." *American Journal of Environmental Protection* 2, no. 1 (2014): 7-10. doi: 10.12691/env-2-1-2.

## 1. Introduction

Motorcycles are almost permanent primary means of transport in developing countries which actually reflect on the poverty level of the economy. Of recent many have abandoned their professional trades for motorcycle riding as fast way of making a living. Such mass exodus into this new trade has increased tremendously the number of motorcycles in some cities most which have gone through many hands as used motorcycles, hence the tendency of pollution.

Presently, our environment is witnessing the reduction in air quality due to overcrowding, traffic congestion and the general deterioration. Automobiles including motorcycles emit gases into the air that pollutes it which may result in smog, acid rains, eye irritation, cardiac and respiratory disorders and other diseases, [1] Average motorcycle is about 15 times more polluting per mile than passenger car, high truck [2].

Motorcycles collectively emit sixteen times more hydrocarbon, three times carbon monoxide. The environmental friendliness of motorcycles depends on the

age of usage, when such was built and how big the engine is [3].

Pollution of air has great influence on living organisms and man in particular. Alarming quantity of gases and smoke are discharged daily into the atmosphere. Globally, the pollutants which account for almost 98% of the total pollution are carbon monoxide; 52%, sulphurdioxide, 18%, hydrocarbon 2%, particulates; 10%, oxides of nitrogen, 6%. And human activities account for the high percentage [4]. Our environment is daily endangered by one of the man's activities, the commercial transport business as a means of survival and man is at great danger of being extinct from such activities. Most developed countries are not bothered about legislation involving motor bike as such are not primary means of transport. But the total amount of major pollutant emitted per year in urban cities is accounted for by vehicular transport. [5] It is therefore imperative to legislate this commercial venture in terms of road worthiness through yearly gas monitoring and education [6] to forestall salient mortality that is ongoing through environmental non surveillance.

## 2. Materials and Methods

The study was carried out in Uyo metropolis, the capital of Akwa Ibom State. It has the land mass of 115.86 square kilometers. Akwa Ibom State is a major oil producing state in Nigeria.

## 2.1. Study Population

Two hundred commercial motorcycles were studied from the following motorcycles parks:

- (1) Motor Park A
- (2) Motor Park B
- (3) Motor Park C
- (4) Motor Park D
- (5) Motor Park E
- (6) Motor Park F
- (7) Motor Park G

## 2.2. Materials

The following materials were used electronic gas monitors as follows; sulphur dioxide gas monitor, nitrogen dioxide gas monitor, carbon monoxide gas monitor,

hydrogen cyanide gas monitor, hydrogen sulphide gas monitor, Ammonia gas monitor, chlorine gas monitor. Altogether seven gases were monitored based on their significant influence on the environment and availability of gases monitoring devices.

## 2.3. Methods

The methods of the laboratory Department of the Ministry of Environment and that of environmental protection agency were used.

By accepted consent of the commercial motorcycle riders they were instructed to start their motorcycles. As the engine was teaming the electronic gas monitor was switched on. It was held a short distance facing the nozzle of the exhaust pipe where the smoke comes out. And the gas monitors record the exact level of the gas coming out on the monitor's screen. The readings for seven gases were recorded for different motorcycles.

## 3. Results

**Table 1. Level of motorcycle gases emission (i.e. per motorcycle)**

Gases	Lowest Reading	Highest Reading	Federal Ministry of Environment Unit	Decision Rule by Fed. Min. of Environment
Carbon monoxide	16ppm	66ppm	10-20ppm	Pollution
Nitrogen dioxide	0.1ppm	0.7ppm	0.04-0.06ppm	Pollution
Sulphur dioxide	0.1ppm	0.6ppm	0.01-0.1ppm	Pollution
Hydrogen sulphide	0.2ppm	0.9ppm	Not given	No decision yet
Ammonia	1ppm	6ppm	200ppm	No pollution yet
Hydrogen cyanide	1ppm	1.3ppm	Not given	No decision yet
Chlorine	0.1ppm		Not given	No decision

**Table 2. Summary of Motorcycle Gases Emission at Different Study Locations**

Location	Gases (ppm)						
	CO	Cl <sub>2</sub>	H <sub>2</sub> S	HCN	NO <sub>2</sub>	NH <sub>3</sub>	SO <sub>2</sub>
Motorcycle Park A	1339	20.3	20.2	80	12.7	97	13
Motorcycle Park B	1508	19.6	20.4	71	12.1	116	11
Motorcycle Park C	1084	18.6	41.1	65	11.7	108	8.7
Motorcycle Park D	550	7.8	7.6	33	5.1	48	4.7
Motorcycle Park E	596	79	8.4	28	4.1	51	5.4
Motorcycle Park F	596	7.3	4.9	40	05	48	5.4
(Motorcycle Park) G	1616	25.9	18.4	108	11.9	185	10.5

Ppm = Part per million.

**Table 3. Duration of motorcycles usage maintenance and pollutant gases**

S/N	Oral Interview	Age or Duration	Tested % of gas and FMENV	Decision
1	How old is your motorcycle	0 – 1 year	25	Mild pollution Moderate pollution severe.
		2 – 3 years	28	
		4 – 5 years	47	
2.	How often do you go to maintenance workshop	0- 1 year	10	Mild pollution Moderate pollution Severe pollution
		2 – 3 years	37	
		2 – 3 years	53	
		4 – 5 years		
3.	How long does it takes you to Change or repair your Carburetor/engine	0 – 1 year	12	Mild pollution Moderate pollution Severe pollution
		2 – 3 years	30	
		4 – 5 years	58	

FMENV: Federal Ministry of Environment.

Using analysis of variance (ANOVA) to compare the various gases emitted at different parks. The results

showed that carbon monoxide was significantly higher than chlorine (Cl<sub>2</sub>)  $461.25 \pm 174.3$ ,  $24.55 \pm 9.27$  ( $P < 0.05$ )

respectively. It was also significantly higher than hydrogen sulphide ( $\text{H}_2\text{S}$ ),  $461.25 \pm 174.3$ ,  $12.34 \pm 4.66$  respectively ( $P < 0.05$ ). It was higher than hydrogen cyanide (HCN),  $461.25 \pm 17.43$ ,  $28.8 \pm 10.9$  ( $P < 0.05$ ). It was higher than Nitric dioxide ( $\text{NO}_2$ )  $461.25 \pm 174.3$ ,  $3.96 \pm 1.4$  ( $P < 0.05$ ). Carbonmonoxide was significantly higher in concentration than ammonia,  $461.25 \pm 17.43$ ,  $50.07 \pm 18.9$  ( $P < 0.05$ ). Also, it was higher in concentration than sulphur dioxide ( $\text{SO}_2$ ),  $461.25 \pm 174.3$ ,  $3.28 \pm 1.24$ , ( $P < 0.05$ ). However, there was no significant difference in chlorine and  $\text{H}_2\text{S}$ ,  $\text{NO}_2$ ,  $\text{NH}_4$  and  $\text{SO}_2$   $P > 0.05$  ( $q = 4.38$ ). Also, there was no significant difference in gases concentration between  $\text{H}_2\text{S}$  and HCN,  $\text{NO}_2$ ,  $\text{NH}_4$  and  $\text{SO}_2$   $P > 0.05$  ( $q = 4.38$ ). HCN showed no significant difference in its concentration with  $\text{NO}_2$ ,  $\text{NH}_4$  and  $\text{SO}_2$ ,  $P < 0.05$  (4.38), equally  $\text{NO}_2$  showed no significant difference with  $\text{NH}_4$  and  $\text{SO}_2$  same with  $\text{NH}_4$  and  $\text{SO}_2$ ,  $P > 0.05$  (4.38). The distribution of gases at various parks showed variations, park A,  $491.98 \pm 18.5$ , Park B,  $551.5 \pm 209.9$ , Park C  $395.3 \pm 149.4$ , Park D,  $201.89 \pm 76.3$ , Park E,  $219.07 \pm 82.8$ , Park F,  $215.9 \pm 81.6$ , Park G,  $591.7 \pm 223.6$ . The results also showed that the concentration of gases in some parks were significantly different,  $P < 0.05$ , whereas in a few was not significantly different  $P > 0.05$ . Altogether, carbon monoxide showed significantly higher concentration than all other gases in all the parks.

#### 4. Discussion

This study has shown that motorcycle gases emission contributes to air pollution in Uyo metropolis. This is in line with Shirvastava [8], that vehicular exhausts are a source of considerable air pollution and that the ever increasing vehicular density posed continued threat to ambient air quality. The level of gases coming out from motorcycles in the sampled areas of Uyo metropolis was identified. The lowest level and highest level readings were taken and a very wide gap existed between the lowest reading and highest reading taking into consideration the Federal Ministry of Environment acceptable limit for example, carbon monoxide had the lowest normal reading of 16ppm which was from only one motorcycle whereas all the rest had reading above Federal Ministry of Environment limit with the highest reading being 66ppm. Other gases in the Federal Ministry of Environment list namely sulphur dioxide, Nitrogen dioxide had the same problem, i.e. wide gap between the lowest and highest reading.

Only Ammonia did not exceed acceptable limit given in FMENV list Ammonia not being included among major pollutants probably means that its presence in the air is not significant health wise other wise it would have been included. SIEP (95) REPORT document that ammonia does not last very long in the environment because it is rapidly taken up by plant, bacteria and animal and that no health effect have been found in humans exposed to typical environment concentrations of ammonia that is why it is not probably significant. The remaining three gases, chlorine, hydrogen sulphide, hydrogen cyanide's lowest and highest level obtained in this study had no safe limit level by Federal Ministry of Environment list. However, the presumption here is that they may have also exceed the safety limit health wise.

The mean level of per motorcycle gases collected was to check the level of gas pollution and the mean number of motorcycles that meets Environment Protection Agency's acceptable limit. Only one motorcycle in carbon monoxide analysis met the Environmental Protection Agency (EPA) standard which is not statistically significant to influence the mean.

Taking into consideration the number of motorcycles that ply the road, conclusion can be drawn from this result that a greater percentage of pollutants are released daily into the air and the air in Uyo metropolis is not pure. This is in line with putting vehicular transport to accounts for about 85% (by weight) as a main source.

It was observed that old motorcycles contribute more to air pollution in Uyo looking at their emission levels, and the problem is further compounded by the failure in maintaining their motorcycles as should be done to reduce rate of dangerous gases emissions level. This is in line with [9]. Also contributing to pollution is the disconnection of smog control devices and this suggests that these devices tend to become less efficient every year following purchase. This shows the non-compliance attitude of the commercial motorcyclists in terms of maintenance and also failure in enforcement of EPA standard by government/law enforcement agencies. The problem could also be due to manufacturers not adhering to regulatory standards given when manufacturing motorcycles sent to Nigeria.

It also showed that motorcycles are not environmentally safe to be used as primary means of transportation in Uyo metropolis. The air pollution rate is very high. Reliance on motorcycle as a primary means of transportation is really a problem to people and the environment at large. The concentration of  $\text{SO}_2$  as indicated by the results manifest on materials, vegetation, visibility and human health.  $\text{SO}_2$  contributes to erosion of metals in structures such as bridges, buildings and their roofs, deterioration of electric equipments, bleaching and weakening of fabrics,  $\text{SO}_2$  pollution is capable of curtailing activities (such as scheduled air line flights) which depend on clear sight.

It has been estimated that sulphuric acid emanating from automobile exhaust with other gases and aerosols in the atmosphere is responsible for most of the acid rain. This acid precipitation can destroy forms of aquatic life, especially salmons, and reduce specie diversity in aquatic ecosystems, damage food crops and tress, and leach plant nutrients from plants and soils [10].

The disruption of Nitrogen cycle by emission of nitrogen dioxide into the air plays an important role in wide-range of environmental problems ranging from the production of troposphere (lower atmosphere) smog the perturbation of stratospheric ozone and contamination of groundwater by acid rain which is formed through photochemical reaction.

High concentration of carbon monoxide when inhaled ties up haemoglobin in blood and deprives the body of oxygen. [11,12]. This can lead to headache, fatigue, impaired judgement, and greater workload on the hearts. In addition to heart disease, carbon monoxide poisoning may cause road traffic accidents by causing driver's fatigue and poor judgement [13]. Other effects are: ozone layer depletion with future climate change, toxicity hazards to plants and animals, impairment of atmospheric

visibility, nervous, respiratory and cardiovascular disorders [14].

The study had shown that the urban dwellers in Uyo metropolis will have serious health problem now and in the future if this trend of motorcycle gases emission continue without environmental education and management.

## 5. Recommendation

The following recommendations are made to reduce air pollution problem associated with motorcycles gases emission.

1. On the short term, the urban management authority or the three tiers of the government responsible should introduce mass transit vehicles for inter-urban movements. This will help to greatly reduce the number of motorcycles on the roads as well as reduce the quality of petrol burnt per limit time.
2. The construction of ring roads in Uyo to ensure the redirection of inter-city routes away from the city centre. This will also ensure the reduction of the number of motorcycles plying the urban roads in metropolis and hence, a reduction in the pollutant concentration index.
3. Enforcement of environmental protection: Agency's and regulations by empowering this agency financially and otherwise. On this note, the Federal Ministry of Environment must be active in their duty. Defaulters should be made to pay penalty fees heavily.
4. Vehicle inspection officers should take their work seriously, and should be empowered by government to function effectively.
5. Aggressive mass enlightenment programmes to teach the public especially vehicle owners and users the danger of air pollution and measures to be adopted to reduce or mitigate its effect. This will encourage proper motorcycle maintenance.

6. On the long term measure motorbikes sent to Nigeria henceforth should be adequately monitored to find out whether manufacturers have complied to the regulatory standard given to them and if not, imports from such countries must be banned.
7. The upsurge in the use of motorcycles suggests a decentralization of urban social and commercial services to contemporary urban designers. This will require proper planning of urban transportation routes resulting in less number of motorcycles plying the urban's routes. This also will reduce the pollutant concentration index.

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