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# Assessment of Automobile Induced Pollution in an Urban Area

# (A Case Study of Port-Harcourt City, Rivers State, Nigeria)

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**Abstract.** Study (ies) on the effect of automobile emission in an urban city (Port-Harcourt, Rivers State) was carried for two weeks. Two locations noted for heavy traffic congestion in the city were chosen for the study. Monitoring times were chosen to capture the traffic congestion. In total, five(5) morning and evening measurement were conducted at each location over the course of two weeks(2) beginning from August 11$^{th}$ – 15$^{th}$ 2010 for garrison intersection and August 18$^{th}$ - 22$^{nd}$ 2010 for slaughter intersection. Concentration measurement for Hydrocarbon (HC) , sulphur dioxide ($SO_2$), Nitrogen dioxide ($NO_2$) and carbon monoxide (CO) were carried out in the morning (6.30 – 8.00am) and evenings (5.00 – 7.00pm) pea periods of traffic congestion using standard gas monitor (temperature at the time of measurement were noted).Results show that the levels of these gaseous emissions were higher than permissible level on Wednesday to Saturday at the two junctions both morning and evening. However, the level of these gases on Sunday at the two junction in the morning and evening were below detection limit. It imply that these areas are polluted in morning and evening when offices and commercial activities commence.

**Keywords:** Pollution, Automobile, Urban Area and Port-Harcourt

## 1. Introduction

Port-Harcourt is the capital of Rivers State in Niger Delta Region of Nigeria, and has an estimated population of about 3 million people. It occupies an area of 21,850 sq. km with an annual growth rate of 2 – 3%. It lies in the tropical rain forest of the Guinea-Congolian region and has two distinctive seasons (dry and wet).

A preliminary survey of the area indicates that there is always heavy traffic congestion in morning and evening hours especially in some junction. The air around the immediate environment of each of the area is heavily polluted with smoke and soot. Port-Harcourt is a fast growing city in terms of human population and industrialization.

Thus effects of these vehicle emissions have become increasing source of concern to the inhabitants. Unfortunately, the environment, socio-economic and health hazards these effects pose have not been addressed either by Non-Government Organization (NGOs) rather, emphasis is placed on the revenue derived from oil industries, refinery, markets and companies in this area.

A number of studies on air show that an average human being require 12kg of air each day[1]. A small concentration of pollutant present in the air becomes harmful to human health. The clean air free from solid, liquid or gaseous polluting substances is evidently very essential for human health and survival.

It was in notion of the potential effects of automobile emission to air pollution especially in urban area that this study was carried out with the view of establishing pollutants level and its compliance with set standards in the environment.

Air quality parameter were thus measured daily for 5days (between 18 – 08 - 2010 to 22 – 08 – 2010) per week for two weeks period. Knowing fully well that air is said to be polluted when chemicals, particulate matter or biological materials that cause harm or discomfort to humans or other living organisms or cause damage to the environment, are introduced into the atmosphere [2].

Many countries especially the industrialized countries have air quality guidelines and standards to regulate emissions into the environment. These standards are set in order to protect the health of the public [3].

Among the air pollutants are carbon (iv) dioxide $CO_2$ as a greenhouse gas, Carbon (II) oxide (CO), Oxides of Nitrogen ($NO_x$), oxides of sulphur ($SO_x$) and volatile organic compounds ($VOC_{s'}$). CO is one of the criteria pollutants because of its potential harmful effects. It is a colourless, odorless, tasteless, non-irritating but very poisonous gas. It is produced where there is incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide[2,4]. Other sources include fuel consuming industries and domestic fires [5].

The combustion process may be described in terms of the following simplified reactions 3HC [fuel] + $20_2 \rightarrow CO_2 + H_2O + CO + HC$ [6].

In recent years there have been many considered research on vehicle emission and fumes [6]. There is a common occurrence of carbon monoxides (CO) in urban cities with high levels commercial activities

[1]. Depletion of ozone layer is largely due to pollution from industries and the use of automobile [7]. Research conducted by [8] shows that Nitrogen oxide and sulphur oxide are linked to immune system impairment, aggravation of asthma and chronic respiratory disease reduced lung function and cardiovascular diseases. Particulate have been implicated in the development of lung cancer and high rate mortality [8]. Volatile matter can react with sunlight to form ozone which exacerbates asthma and has other adverse respiratory effects [9]. Modeling frameworks have also been used to predict the future emission levels in Europe [10]. Environmental investigation has also been conducted on the detection of excess ammonia emission from in-use vehicle [7]. These include the air pollution in a large tropical city with a high traffic density.

## 2. Materials and Methods

### Materials

The sample areas selected were slaughter junction ($sp_s$) and garrison junction ($sp_g$). The instruments used were TIF 8800, combustible gas detector model G275, Monoxor II gas detector model 8004, minmax XT and global position system.

### Methods

The levels of HC, $SO_2$, $NO_2$ and CO were monitored at properly defined position of the selected area.

The ambient temperature around the location was measured and co-ordinate of the sample point within the period in review recorded. The two $SP_g$ and $SP_s$ were selected for monitoring in the priority of traffic congestion.

The TIF 8800 combustible gas detector modem G275 was used to measure and record hydrocarbon concentration. Gases are measured by electrochemical sensors with a range of 0 to 20ppm and 0.1ppm resolution. Its operating temperature is between $^{O}C$ to 40 $^{O}C$ was also used as detector.

Minni max XT CO detector, model G100 was used to measure CO concentration. Gases are measured by electrochemical sensor with range of 0 to 1000ppm with operating temperature between 20$^{O}C$ to 50 $^{O}C$. The detectors operating humidity were 5 – 95% with replaceable batteries.

Global positioning system was used in recording the coordinate of the sample point.

## 3. Results and Discussion

Table 1: Average Automobile Result Summary at Garrison Junction between the hours of 8 – 9: 00am of 11 – 15/08/2010.

| | | | | Mean concentration (ppm) | | | | | Sample point |
|---|---|---|---|---|---|---|---|---|---|
| S/N | Days | Date | Temperature | HC | $NO_2$ | $SO_2$ | CO | | Co-ordinate |

| | | | ($^{O}$C) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Wednesday | 11/08/10 | 21 | 0.60 | 0.09 | 0.08 | 43 | | N04$^{O}$ 48$^{I}$01 1” E 007$^{O}$02 14.6 |
| 2 | Thursday | 12/08/10 | 21 | 0.57 | 0.08 | 0.05 | 37 | | N04$^{O}$ 48$^{I}$01 1” E007$^{O}$02’14.6 |
| 3 | Friday | 13/08/10 | 22 | 0.36 | 0.04 | .04 | 39 | | N04$^{O}$ 48$^{I}$22..6” E00702’18.0 |
| 4 | Saturday | 14/08/10 | 20 | 0.35 | 0.04 | 0.05 | 31 | | N04$^{O}$48’34.8 E007$^{O}$02’01.7” |
| 5 | Sunday | 15/08/10 | 20 | 0.03 | 0.02 | 0.01 | 18 | | N04$^{O}$48’33.7 E007$^{O}$02’01.9’ |

Table 2: Average Automobile Emission result summary of garrison junction between the hours of 4.30 – 5.30pm of 11 - 12/08/2010.

| | | | | Mean concentration (ppm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S/N | Days | Date | Temperature ($^{O}$C) | HC | Na | SO | CO | | Sample point Coordinate |
| 1 | Wednesday | 11/08/10 | 21 | 0.58 | 0.08 | 0.06 | 46 | | N04$^{O}$ 48$^{I}$034” E 007$^{O}$0138.2 |
| 2 | Thursday | 12/08/10 | 21 | 0.53 | 0.06 | 0.05 | 36 | | N04$^{O}$ 48$^{I}$32.0” E007$^{O}$03’56.8” |
| 3 | Friday | 13/08/10 | 22 | 0.33 | 0.04 | 0.04 | 33 | | N04$^{O}$ 48$^{I}$16.4” E00701’42.0” |
| 4 | Saturday | 14/08/10 | 20 | 0.30 | 0.04 | 0.03 | 28 | | N04$^{O}$48’12.8” E007$^{O}$01’54.9” |
| 5 | Sunday | 15/08/10 | 20 | 0.11 | 0.09 | 0.02 | 22 | | N04$^{O}$48’16.1” E007$^{O}$02’08.7’’ |

Table 3: Average Automobile Emission Result Summary at slaughter junction between the hours at 8 – 9.00am of 18 – 22/08/2510

| | | | | Mean concentration (ppm) | | | | |
|---|---|---|---|---|---|---|---|---|
| S/N | Days | Date | Temperature ($^{O}$C) | HC | Na | SO | CO | Sample point coordinate |
| 1 | Wednesday | 11/08/10 | 22 | 0.66 | 0.07 | 0.06 | 39 | N04$^{O}$ 48$^{I}$18.8” E 007$^{O}$02’56.3" |
| 2 | Thursday | 12/08/10 | 23 | 0.67 | 0.06 | 0.031 | 40 | N04$^{Oo}$4758.7” |
| 3 | Friday | 13/08/10 | 22 | 0.70 | 0.06 | 0.07 | 43 | N04$^{O}$47’50.2” |
| 4 | Saturday | 14/08/10 | 21 | 0.27 | 0.05 | 0.04 | 37 | N04$^{O}$47’48.8” |
| 5 | Sunday | 15/08/10 | 22 | 0.07 | 0.01 | 0.01 | 14 | N04$^{O}$47’46.8” |

Table 4: Average Automobile Emission Result summary at slaughter junction between the hours of 4.30 – 5.30pm of 18/08/2010

| | | | | Mean concentration (ppm) | | | | |
|---|---|---|---|---|---|---|---|---|
| S/N | Days | Date | Temperature ($^{O}$C) | HC | Na | SO | CO | Sample point coordinate |
| 1 | Wednesday | 18/08/10 | 22 | 0.52 | 0.06 | 0.09 | 34 | N04$^{O}$ 4902.4” E 007$^{O}$01’48.8" |
| 2 | Thursday | 19/08/10 | 23 | 0.55 | 0.05 | 0.07 | 37 | N04$^{O}$49’22.1” E007$^{O}$01’95.4” |
| 3 | Friday | 20/08/10 | 22 | 0.61 | 0.07 | 0.08 | 39 | N04$^{O}$49’40.2” |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | E007$^{O}$02’13.0” |
| 4 | Saturday | 21/08/10 | 21 | 0.28 | 0.06 | 0.05 | 31 | N04$^{O}$49.05.4” E007$^{O}$02’28.9 |
| 5 | Sunday | 22/08/10 | 22 | 0.07 | 0.01 | 0.01 | 14 | N04$^{O}$48’42.3” E007$^{O}$02’4.28” |

**Discussion**

The data shows that the amount of HC at Garrison junction varies from day to another day and from time to time. The highest mean concentration of the HC (0.60 ppm) was recorded on Wednesday 11/08/2010 in the morning between the hours of 8-9.00am. The approximate values (0.53-0.58) also gotten on the evening of the same day and Thursday 12/08/2010 (morning and evening). This may be attributed to the high vehicular volume traffic jam and increased human congestion at this time of the days. There was an observed decrease in the values from Friday to Saturday. Sunday recorded the least mean concentration. The concentration of the HC at garrison is above the required 1hour standard of WHO. While the level of HC at slaughter were also quite very high especially on Friday morning 20/08/2010 that was recorded 0.70ppm. This may be due to the passage of heavy duty vehicles whose engine is diesel powered in combination with the vehicle and motorcycle. Sunday also recorded the least concentration this may be attributed to the fact that on Sunday people are mostly at home, they don’t usually come out.

Levels of $SO_2$ were alarmingly high for sites studied ranging between 0.01-0.09ppm, exceeding the 1-hour standard, for all evening experiment, which was above the Permissible limit of FEPA

CO concentration were also high for all average concentration which were about WHO and FEPA standard, although, they were within the standards on Sunday experiment.

The concentration of $NO_2$ was found in the range of 0.02-0.08ppm. the highest rate of $NO_2$ was found to be 0.09ppm at Garrison junction on a morning experiment on a Wednesday with a temperature of $21^0$C, exceeding the WHO and FEPA (0.02-06ppm) standards and least on a Sunday at slaughter junction with an average concentration of 0.01ppm on morning and evening experiment with temperature of $22^0$C.

The long ques with Idling cars and slow morning traffic may also explain CO and $SO_2$ high concentrations, as slower moving vehicles emit more pollution. Commercial vehicles, especially taxies and trucks, were observed to emit more black and white smoke which is associated with higher levels of $SO_2$ and CO.

Slaughter intersection had the greatest average concentration of measured pollution compared to Garrison intersection. This is because of the concentration of industries, firms and companies in the area, therefore the movement of people, heavy duty; commercial and private vehicles plying the rout have contributed significantly to traffic congestion and thereby increasing emission concentration. The concentrations also fluctuate greatly depending on the vehicle composition and speed. Generally, average concentrations of emission were highly exceeding the standards, during the morning and evening experiment on Wednesday, this is because Wednesday is the major market day known as oil mill market day in Port Harcourt city and roads are usually characterized by commercial vehicles and traffic congestion. Sundays experiment was observed to have the least concentration values which were most times within standards. This explains the fact that Sunday is a day of rest especially for workers and marketers. Port-Harcourt city is occupied mainly by Christians who attend church and other religious function with private vehicles thereby reducing the number of commercial vehicles plying the road.

Higher concentration were mostly observed with commercial vehicles, including taxies, trucks, public buses and during traffic ques. Commercial vehicles, therefore, might be the most effective first target for emission reduction.

The high levels of $SO_2$, $NO_2$, HC and CO have obvious health implication. The WHO 1-hour guidelines were developed to protect citizens from Health outcomes because $SO_2$ related symptoms, such as runny nose, chest pain, coughing, eye irritation and sore throat. Not only that, high concentration of $SO_2$ may indirectly cause health problem through particulate formation. Both $SO_2$ and $NO_2$ can interact with other compounds in

the air to form particular matter [9]. Since particulate matter has been linked to a multitude of adverse health effects and even mortality [8]. The measured $SO_2$ concentration may be dangerous.

## 4. Conclusion

The results of this study shows that transport-related pollution in Port-Harcourt is significant and need to be monitored without intervention. It is likely that air quality will deteriorate as the city continues to grow which will result in possible severe health consequences. The concentrations of pollutant exceeded 1-hour standard of WHO, some of the day, the experiment was conducted. The overall comparison of data for different sections shows that concentrations of the pollutants were fluctuating depending on the volume of traffic and pollution.

Therefore the River State environmental Protection Agency should thus recognize air quality management as a priority and work to prevent further environmental degradation by adopting effective policy, such as targeting high emitting commercial vehicles, as a whole, Nigeria should work to improve fuel quality through sulfurs reduction and adopt more stringent vehicle import requirement and enforcement.

## 5. References


[1] P. Arcado Environmental Engineering, A design Approach, Asoke Publishers 2006, Pp 467-508.

[2] Air Pollution, en.wikipedia.org/wiki/air/pollution retrieved 10/1/2012.

[3] M. Radjevic and V.N. Bashkin. Practical Environmental Analysis, the Royal Society of Chemistry, Cambridge, United Kingdom, 1999, Pp 466.

[4] Carbon Monoxide, in air quality of guidelines, World Health Organization, Second edition. www.euro.who.int/-data/assets/---/AQG 2nded-5-carbon monoxide. PDF retrieved 12/1/2012.

[5] Air Pollution monitoring, http://nzic.org.nz/chemprocesses/ environment/14A. PDF retrieved 15/1/2012.

[6] P. Narayaman . (2007). “Environmental Pollution Principle Analysis and Control, CBS Publishers, Pp 71-100.

[7] M. Erica Vehicle Emission and Health Impact 2000, http//ezinearticles.com. Retrieved 25/11/2011.

[8] P. Schwela, “Air Pollution and Health in Urban Area” Reviews on Environmental Health. 2000,<http://en.wikipedia.org>. Retrieved 10/10/2011.

[9] WHO (World Health Organization) “Air Quality, Guidelines for Europe”. 2005,WHO Regional Office for Europe, Copenhagen.

[10] J. Agunwaba Waste Engineering and Management Immaculate Publication 2001 pp 382-399.