EFFECTS OF VEHICULAR EXHAUST FUMES ON URBAN AIR POLLUTION IN LAGOS METROPOLIS

N. A. NDUKWE AND F. O. JENMI
Chemistry Department, University of Lagos, Lagos, Nigeria.

ABSTRACT

Urban air pollution from industrial operations, automobile exhaust emissions, combustion of fuel, electric power generation and activities of the energy sector is becoming a global concern because of its adverse effects on plants, animals and human beings. Mitigation strategies or absolute solutions to this dangerous phenomenon can only be delineated if the nature and sources of various atmospheric pollutants can be identified. Analysis of exhaust fumes from gasoline-powered engines (light vehicles) and diesel-powered engines (heavy vehicles) in two major traditional areas of high vehicular traffic in Lagos Metropolis, namely Apapa and Ojota were carried out. Average concentrations of 0.075ppm, 2.143ppm 0.875ppm, 40ppm and 15.5ppm for H₂S, SO₂, NO₂, CO and CO₂ respectively from light vehicular emissions were detected while concentrations of 0.086ppm, 2.309ppm, 1.783ppm, 70ppm and 20.124ppm respectively were obtained for these pollutants from heavy vehicular emissions for a four month sampling period, January-April (dry season) when the impacts from these atmospheric pollutants are mostly felt. These values far exceeded the available FEPA limits for environmental pollution control in Nigeria which are: SO₂-0.1ppm, NO₂-0.06ppm and CO-20ppm, hence provides an expose on the challenge of the continuing undue impact of vehicular exhaust fumes on urban air pollution in Nigeria.

KEY WORDS: vehicular exhaust, automobile pollution, air quality

INTRODUCTION

Vehicular exhaust emissions account for the highest single source of urban air pollution in Nigeria. This is because most of the automobiles plying Nigerian roads are run with combustion engines that are mostly mechanically worn out and therefore emit over bearing quantities of fumes from their exhaust. Under ideal situations, combustion of any fuel especially hydrocarbon-based fuels generally lead to the formation of harmless water (H₂O) and carbon dioxide (CO₂) gas. Unfortunately, this is not always the case in automobiles where combustion of hydrocarbon fuels like premium motor spirit (gasoline) and gas oil (diesel) produces, apart from carbon dioxide and water, other air pollutants like carbon monoxide (CO), nitrogen oxides (NOₓ), sulphur oxides (SOₓ) and particulates which are introduced into the atmosphere (Adebanjo, A., 2000). This scenario is even worse in automobiles with worn-out engines or in fairly used vehicles (considered as being equivalent to new vehicles) as is common on Nigerian roads. Carbon monoxide a very toxic air pollutant is frequently associated with automobiles because of the ground level discharge of exhaust fumes and heavy exhaust build-up during periods of traffic congestion. In urban areas, the contribution of road transport to overall emissions can be quite significant as pollution levels are higher in areas with heavy traffic flow (National Road Traffic Forecast, 1997). The extent to which road transport is a significant source of specific pollutants at any place and time varies depending on the level of traffic and proximity of other sources of specific pollutants as well as the prevailing meteorological conditions (Narayanan P., 2007).

Public understanding about the environmental and health impacts of these pollutants from both automobile exhausts and other combustion processes has not been well pursued. Many people remain unsure of the extent to which toxic gases, metal oxides, acids, polynuclear-hydrocarbons and many other air pollutants arising from vehicular exhaust processes can actually damage the environment or harm our health (Oko Effiog u, 2000). It has been acknowledged that the symptoms of illness shown in the body are directly proportional to the concentration of pollutants in the air. Pollutants in the air produce harmful effects in human beings. For example air pollution may cause...
reduced visibility and respiratory problems. Medical research has linked air quality with lung cancer, emphysema, heart disease and allergies. Fumes from automobile emissions generally exert their injurious effect upon an organ by depressing or stimulating the normal metabolic function of that organ while large doses inhibit or destroy the activity of functional organs. (Akeredolu, 1992). The effects are likely to lead to annoying discomfort, though not necessarily serious disease. Other effects include eye irritation, rasping sensation in the throat and headaches (Weinhold, 2002).

Liquid fuels, especially hydrocarbon-based fuels are the common fuels used in most engines including internal combustion engines for supply of power to the engines. Hydrocarbon fuels for internal combustion engines include gasoline, diesel and aviation kerosene. These groups of hydrocarbon fuels are essentially composed of hydrocarbons such as branched-chain paraffins, olefins and aromatics with additives to improve the quality (Wiseman, 1979). These additives include new formulations like Disopropyl ether (DIPE ), highly branched ethers such as methyl tert-butyl ether (MTBE ) and ethyl tert-butyl ether (ETBE ) The ether groups improve the octane rating of the formulation and by the virtue of their oxygenated nature have the advantage of reducing atmospheric emissions (J Wallington et al, 1993 ).

The increased number of fairly used cars, trucks, trailers and tankers with worn-out engines plying the rural and urban centers in Nigeria as in many African countries has resulted in the increased amount of automobile exhaust fumes released into the environment (FEPA 1991). The main thrust of measures to cut down on pollution from vehicles has been directed towards improving exhaust emissions performance of new vehicles as the scope for improving the existing vehicles is limited by their original design capabilities. The setting of mandatory vehicle emission and fuel quality standards rather than the specification of particular technologies gives manufacturers the flexibility to develop a solution which best suites their requirements, (Bolade, 1991).

Road traffic also contributes to two important regional scale pollution problems, viz: acid deposition and photochemical ozone. Sulphur and nitrogen oxides are a major cause of acid rain while nitrogen oxides also contribute to ozone depletion. Road traffic pollution has also been considered to contribute to global warming as a result of carbon dioxide emissions. Carbon dioxide emission is directly related to the carbon content of the fuel and the amount of fuel burnt. Diesel-run vehicles with direct injection engines are much more fuel efficient than petrol-run vehicles. However, as diesel is a denser fuel than petrol, more carbon dioxide is emitted for every litre burnt. (Brayan J. S. and Anthony M 1971).

Man through his numerous activities introduces vast amount of gaseous pollutant into the environment. Atmospheric pollutant such as; hydrogen sulphide, sulphur (1v) oxide, nitrogen (1v) oxide carbon monoxide and carbon (1v) oxide can gain entrance into the environment via; emissions from automobile exhaust pipes, combustion of fossil fuel, gas flaring, generators, bush burning for agricultural purposes, solid waste combustion, air craft emissions and other emitting sources.

Atmospheric pollution resulting from sulphur-rich fuels has an effect on death rates, especially respiratory and cardiovascular deaths. It also exerts aggravating effect on the agricultural production and the ‘green house effect’. Studies have shown that sulphur content is one of fuel properties with considerable influence on the environment and fuels with high sulphur content generate particulate emissions causing adverse influence on efficiency of the catalytic exhaust emission control systems of automobile engines (Horsfall M Jnr, Spiff A.I, 1998 ).

Although Nigeria crude oil is basically of low sulphur grade, but most of the automobile fuels are imported due to the dilapidated state of the Nigeria refineries. Thus, there is a high risk of exposure to high sulphurized fuels from these imports.

This study is intended to highlight and report the status of automobile emissions in Lagos metropolitan area and their effects on urban air pollution.

**METHODOLOGY**

Atmospheric gases in two locations from the study areas of Apapa (about 200 meters from the major Nigeria port of Tin Can Island) and Ojota (along the ever busy Ikorodu Road) were collected in-situ by sucking into appropriate absorbent solution thus; NO₂ was absorbed in 1:2 mixture of 0.2% butyl alcohol and 0.1M sodium hydroxide solution, CO₂ was absorbed in 0.1M barium hydroxide solution, SO₂ in 0.1% hydrogen peroxide solution; H₂S in 5%
cadmium sulphate solution and CO in Lamotte test kit 7782 using Lamotte air pump at selected rate 1cm$^3$/min for 30mins for each of the gases and the concentration of various atmospheric pollutants determined by the below outlined analytical techniques. The sampling was carried out between January-April (dry season) during the period of high vehicular traffic when the impacts from these atmospheric emissions are mostly felt.

* Carbon (iv) oxide (CO$_2$): the concentration of CO$_2$ in the air sample was determined by the use of Simple Chemical Method (Malygin A, Ponomareva V, 2007).

* Hydrogen Sulphide (H$_2$S): the amount of hydrogen sulphide in the exhaust fume polluted air was determined by Iodometric titration method (Mendham J, Denney R, Barnes D and Thomas M, 2000).

* Sulphur (iv) oxide (SO$_2$): Sulphur (IV) oxide was quantified by titrimetric method (Snell F D, Ettre L S, 1973).

* Nitrogen (iv) oxide (NO$_2$): NO$_2$ was determined colourimetrically using HACH Reagent and absorbance measured by the use of Spectronic 20D$^+$ instrument at 543nm (Thermo Electron Scientific Instrument Corporation, 2003)

* Carbon (II) oxide (CO): carbon monoxide was determined by colourimetric method, in-situ using Lamotte Air monitoring instrument measurement KIT (7782) (Lamotte company, 1988).

RESULTS AND DISCUSSION

The results of the analysis for the various atmospheric pollutants determined from heavy and light vehicular emissions are as shown in Tables 3.1, Tables 3.2 and 3.3 give the values of the tolerance limits for ambient air pollutants and the Nigerian ambient air quality standard for these emissions.

Concentrations of 0.075ppm, 2.182ppm, 0.874ppm, 40ppm and 15.449ppm for H$_2$S, SO$_2$, NO$_2$, CO and CO$_2$, respectively were detected from the light vehicular emissions while concentrations of 0.0863ppm, 2.309ppm, 1.762ppm, 70ppm and 20.440ppm for the pollutant gases were respectively obtained for heavy vehicular emissions. The high level of these atmospheric pollutants detected from the two sampling locations can be largely attributed to constant discharge of activities plying these roads and other emitting sources like industries, factories, mechanic workshops etc stationarily located within these areas. These values far exceeded the FEPA standards for environmental pollution control in Nigeria which are: SO$_2$-0.1ppm, NO$_2$-0.06ppm, CO-20ppm respectively. The values obtained for both heavy and light vehicular emissions respectively indicate that the concentrations of these atmospheric pollutants (H$_2$S, SO$_2$, NO$_2$, CO and CO$_2$) are far above the tolerance limits and the Nigerian ambient air quality standards.

These results confirm that an emission from vehicular transportation fuel use is a prime source of air pollution in contemporary cities (e.g. Lagos, Nigeria) and this introduces a broad social control on the nature of urban air quality. This implies a significant increase in human exposure to atmospheric pollutants. The results obtained for a control location at Magodo Estate in Lagos confirm this statement as levels obtained were 0.012ppm H$_2$S, 0.062ppm SO$_2$, 0.042ppm NO$_2$, 18.01ppm CO and 9.51ppm CO$_2$.

$$
\begin{array}{|c|c|c|c|c|}
\hline
\text{Pollutants} & \text{1 Light Vehicular Emission} & \text{2 Heavy Vehicular Emission} & \text{3 Average} \\
\hline
1 Hydrogen Sulphide & 0.083 & 0.068 & 0.074 & 0.075 \\
2 Sulphur (IV) Oxide & 2.102 & 2.243 & 2.202 & 2.182 \\
3 Nitrogen (IV) Oxide & 0.878 & 0.978 & 0.767 & 0.874 \\
4 Carbon Monoxide & 36 & 44 & 40 & 40 \\
\hline
\end{array}
$$
Table 3.2: Tolerance Limit for Ambient Air Pollutants

<table>
<thead>
<tr>
<th>POLLUTANTS</th>
<th>LONG TERM Limits + (Hours)</th>
<th>SHORT TERM Limits + (Mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen Sulphide</td>
<td>0.002 24</td>
<td>0.002 30</td>
</tr>
<tr>
<td>Sulphur dioxide</td>
<td>0.05 24</td>
<td>0.5 30</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>0.085 24</td>
<td>0.085 30</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>1.0 24</td>
<td>5.0 30</td>
</tr>
<tr>
<td>Nitrogen oxide</td>
<td>0.004 24</td>
<td>0.1 30</td>
</tr>
</tbody>
</table>


Table 3.3: The Nigerian Ambient Quality Standard

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Limits (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO₂</td>
<td>0.01-0.1</td>
</tr>
<tr>
<td>NO₂</td>
<td>0.04-0.06</td>
</tr>
<tr>
<td>CO</td>
<td>10-20</td>
</tr>
<tr>
<td>Photocatalytic oxidant</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Source: Federal Environmental Protection Agency Guidelines and Standards for Environmental Pollution Control in Nigeria (1991)

CONCLUSIONS

This study has shown that clean air policies aimed at developing strategies to reduce the risk of adverse consequences of vehicular emissions on human health and the environment should be embarked on and these include:

- The use of low sulphur fuels which has gained ground in the most developed countries of the world.
- The use of friendlier technologies – modification of engine designs to reduce the amount of pollutant formed during fuel combustion.
- Ensurance of strict compliance by all motorists through an efficient motor inspection team in all the states of the federation.

ACKNOWLEDGEMENT

We sincerely wish to thank Dr. P.M. Emeka of Lagos State University Teaching Hospital (LUTH) Idi Araba, Lagos, Mr. Begusa B. M, Chemistry Department, University of Lagos for their technical support and Professor B. I. Alo, Chemistry Department University of Lagos for his valuable and insightful contributions on the manuscript.

REFERENCES


Bob Weinhold August 2002. The Environmental Health Perspectives, Journal of the National Institute of Environmental Health Science Vol. 110 (N 0. 8) pp 426-427.


Department of Environment, U.K, National Road Traffic Forecast (Great Britain) 1997 Transport and Regions.


Oko Effio U. 2000 Monitoring of Air Pollutants and Health...
Effects within the Lagos Metropolis, Medilag Consult, Research Project, College of Medicine, University of Lagos, IIdi-Araba.