Contributions of CO, NO₂ and SO₂ from automobile emission to environmental problems in Niger state, Nigeria

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ABSTRACT

This study assessed the contribution of automobile emission to CO, NO₂ and SO₂ in Niger state, Nigeria. Three research questions were formulated to guide the study. The research questions assessed the quantities of CO, NO₂ and SO₂ being emitted in the study area. Q-Rae Plus Multi-gas Monitor was used to collect the data on the quantity of CO, while the Q-Trak Plus IAQ Monitor was used to collect the data on the quantity of NO₂ and SO₂. Mean was the statistical tool used to answer the research questions. The findings revealed among others, that emission of CO, NO₂ and SO₂ from automobile in Niger State is higher than the minimum Federal Environmental Protection Agency standard. Based on the findings of the study, recommendations were made which among others include; Developing effective control of automobile emissions quality management programmes; improvement of motor traffic flow and control which requires good city road network; provision of reliable mass transport system which will reduce the number of vehicles and motor cycles on Niger State roads and therefore reduce emissions; and strengthening of the vehicle inspections and maintenance department.

Keywords: SO₂, CO₂, Niger state, environmental pollution.

1. Introduction

Human activities have begun to affect the environment through the release of pollutants (known as greenhouse gases or global warming pollutants) that exacerbate the earth’s natural greenhouse effect. The environmental costs of automobile emission are hard to measure and vary according to local conditions. McCubbin and Delucchi (1996) corroborated this fact, and stated that health cost as a result of automobile emission could be as high as ten times that of cars and small buses. In their studies, most of the health hazards are as a result of the increased mortality due to the presence of volatile organic compounds, NO₂ and SO₂ in the inhaled air. The rest of the hazards are due to minor illness from ozone (O₃), formed in the atmosphere from volatile organic compounds (VOCs) and NOx. Salami, (2007) noted that vehicular emission has become the most complicated environmental challenges. In effect, cities which rely on a large number of automobiles for the bulk of daily transportation, and offering few efficient public mass transportation modes, may suffer from effects of automobile emission. It should be noted that perfectly operating motor engines would produce only water (H₂O) and carbon dioxide (CO₂) in the process of fuel combustion. However, with the problems of imperfect engines, improper fuel grades, lack of regular maintenance, physical ageing of engines, intensive use of vehicles and misuse of lubricants (especially motor cycles), all these factors combine to produce a constraint on perfect fuel
The ultimate effect is the emission of CO, Hydrocarbons (HCs), NO\textsubscript{2} and SO\textsubscript{2} from the exhaust system and engine parts of motor vehicles. With the importation of used vehicles into Nigeria, there are lots of hazardous effects including global implications of such effects. Used vehicles pollute the air with the emission of incomplete combustion of the old engines. These pollutants include: CO, NO\textsubscript{2}, SO\textsubscript{2}, benzpyrene, aldehydes, ketones, chlorinated organic compounds, ozonides and peroxides, carbon compounds containing nitrogen such as peracetyl nitrides. NO\textsubscript{2} will oxidize to HNO\textsubscript{3}, and SO\textsubscript{2} will oxidize to H\textsubscript{2}SO\textsubscript{4}, which now falls as acid rain or mist or fog.

The constant increase in the number of vehicles in Nigeria is likely to increase the proportion of harmful emissions. Moreover, the fuel composition makes it likely that the vehicles in use in Nigeria will release high levels of emission. Vehicle emissions are affected by fuel type, especially sulfur content. As sulfur content increases, the fuel efficiency decreases and emissions of sulfur oxides, particulate matter, and volatile organic compounds increase (World Bank, 2003). In the US, petrol has a standard of 15ppm of sulfur, and in the EU, it has a standard of 50ppm. The concentrations of sulfur in fuels in Nigeria most often range from 500-2,000ppm, with a maximum allowable sulfur level of 5,000ppm (United Nation Environmental Protection, 2007). Therefore, it can be expected that vehicles in Nigeria will release remarkably more pollution.

A number of human activities have the potential of inducing the environment. One of the most important of these activities is the increase in atmospheric carbon monoxide due to the burning of fossil fuels from automobile emission. This is closely followed by the depletion of the ozone layer. Attempt at deliberate weather modification, as well as, direct heat output from energy production in cities and industrial areas also contribute to environmental problems. The consequences of these environmental problems make it necessary to maintain a constant and careful surveillance in this regard. The combustion of oil and gasoline from automobile emission accounts for the most of the environmental pollutants. For instance, Dosunmu, (1998) observed that more than 80% of carbon monoxide and 40% of the nitrogen oxides and hydrocarbons come from burning gasoline and diesel fuels in cars and trucks. Cities with larger populations will exhibit higher traffic pollution potentials due to large ownership of vehicles and tonnage of fuel consumption. With a population estimated at One Hundred and Fifty Million (150) million in 2006 for Nigeria and Niger State with about Four Million (CBN, 2000), Nigeria stands as the most populous country in Africa. Chidi (2009) reported that Nigeria undoubtedly harbours the highest number of vehicles in the West Coast of Africa. The report revealed that more than seven million vehicles operate on Nigerian roads on a daily basis, with the regrets that the nation's roads have suffered gross negligence due to lack of maintenance thereby contributing to the stress vehicles experience on the road and contributing more emission than expected.

The prices paid for petroleum products, particularly premium motor spirit (petrol) and automotive gas oil (diesel) are generally low in Nigeria (lower than what obtains in other OPEC countries - FGN (2000). This has in a way encouraged single occupier vehicle (SOV) ownership. The World Bank (1995) had estimated that the number of vehicles per 1000 inhabitants in Nigeria is above the average for other African countries, assuming the ownership ratio to be in the neighbourhood of 30 vehicles per 1000 inhabitants during the first quarter of the 1990s. Similarly, fuel consumption in both absolute and per capita terms were also found to be higher for Nigeria in a sample including some other African countries over the period 1989 –1992, for both gasoline (petrol) and diesel. For example, in 1992, total gasoline (premium motor spirit) consumed in Nigeria was estimated at 3,969 thousand tons,
with a per capita equivalent of 0.043 thousand tons. For diesel, it was 2,280 tons, with a per capita equivalent of 0.024 thousand tons. For the same year, the total consumption of gasoline in Kenya stood at 376.7 thousand tons, with per capita equivalent of 0.013 thousand tons. For diesel, the total was 537.3 thousand tons, with per capita equivalent of 0.019. The 2009 report shows that the Consumption of petrol in Nigeria will hit 35 million litres a day at the end of 2010. (http://www.gasandoil.com/goc/company/cna32654.htm, 2012). Traffic volume is relatively high in Nigeria among other African countries. The World Bank (1995) study revealed that an average Nigerian vehicle runs considerably more distance than an average European car per year – with the former covering as much distance as 30,000 km/year. Thus the combination of the large number of motor vehicles in Nigeria, higher ratio of vehicle ownership and fuel consumption, traffic work in terms of distance covered per vehicle per year, all contribute to increasing the emission potential of automobiles. It should also be noted that the average age of motor vehicles in Nigeria is generally high.

1.1 Research questions

This study answered the following research questions

1. What is the quantity of CO emitted from automobile vehicles as emission in Niger State?
2. What is the quantity of NO\textsubscript{2} emitted from automobile vehicles as emission in Niger State?
3. What is the quantity of SO\textsubscript{2} emitted from automobile vehicles as emission in Niger State?

2. Area of the Study

The study area covered the six major towns in Niger State, which are Bida (9°05’N 6°01’E), Mokwa (9°12’N 5°20’E), Minna (9°36’50”N 6°33’25”E), Suleja (9°11’N 7°11’E), Kontagora (10°24’N 5°28’E), and New Bussa (9°53’N 4°31’E9.883°N 4.517°E). Niger State lies on the 3.20° East and longitude 11.30° North of Nigeria. The State occupies a land area of 74,244 square kilometres, which is about 10% of the total land area of Nigeria. The 2006 census put the state population at 3,950,249. The study area map is shown in figure 1.

3. Materials

Q-Trak Plus IAQ Monitor, Model 8552 was used to measure CO for research questions 1. The machine uses an electrochemical sensor with a range of 0 to 500ppm, a resolution of 0.1ppm, and a response time of 60 seconds. Its operating temperature range is between 5\textdegree{}C and 45\textdegree{}C (41\textdegree{}F to 113\textdegree{}F), and its humidity is between 5 and 95\%. Q-Rae Plus Multi-gas Monitor, PGM-2000/2020, was used to measure and record NO\textsubscript{2} and SO\textsubscript{2} for research questions 2 and 3. NO\textsubscript{2} and SO\textsubscript{2} were measured by electrochemical sensors with a range of 0 to 20ppm and a 0.1ppm resolution. The sensor response time is 35 seconds for SO\textsubscript{2} and 25 seconds for NO\textsubscript{2}. Its operating temperature is between -20\textdegree{}C to 45\textdegree{}C (-4\textdegree{}F to 113\textdegree{}F) and its operating humidity is between 0\% and 95\%.

3.1 Method of data analysis

The data collected for CO, NO\textsubscript{2} and SO\textsubscript{2} with the use of computer analyser for the study was analysed using mean and statistics graph (bar chart) with excel computer software.
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minimum standard of 10ppm for CO, 0.04 -0.06ppm for NO2 and 0.01ppm for SO2 stipulated by the Federal Environmental Protection Agency (FEPA) was used to guide the study.

(KEY: ST1– New Bussa, ST2 – Kontagora, ST3 – Mokwa, ST4 – Bida, ST5 – Suleja and ST6 – Minna)

**Figure 1:** Map of Niger state showing the study area

**Figure 2:** Traffic Congestion in the study area

4. Results

4.1 Research question 1

What is the quantity of CO emitted from automobile vehicles as emission in Niger State?
To determine the quantity of CO emitted in Niger State, three days of readings were taken in the morning, afternoon and evening at six different junctions in each of the study area for three days. Three days mean computed are presented in Table 1 and figure 2.

Table 1: Mean concentrations of CO emitted in the study area of Niger state

<table>
<thead>
<tr>
<th>Days</th>
<th>MINNA</th>
<th>SULEJA</th>
<th>BIDA</th>
<th>MOKWA</th>
<th>NEW BUSSA</th>
<th>KONTAGORA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>11.22</td>
<td>13.5</td>
<td>11.12</td>
<td>11.33</td>
<td>11.11</td>
<td>9.83</td>
</tr>
<tr>
<td>Day 2</td>
<td>11.83</td>
<td>12.83</td>
<td>11.28</td>
<td>10.01</td>
<td>10.89</td>
<td>9.94</td>
</tr>
<tr>
<td>Mean</td>
<td>11.87</td>
<td>13.48</td>
<td>10.99</td>
<td>10.78</td>
<td>10.9</td>
<td>9.99 (PPM)</td>
</tr>
</tbody>
</table>

Analysis of the result in Table 1 shows that the quantity of Carbon Monoxide (CO) measured in Minna, Suleja, Bida, Mokwa and New Bussa were higher than the 10ppm minimum standard stipulated by the Federal Environmental Protection Agency, the reading of 9.99ppm in Kontagora is almost exactly as the standard.

Figure 2: Bar chart showing the mean concentrations of co emitted in the study area of Niger state

Figure 2 shows the details bar chart of the mean distribution of CO collected from the study area and the average mean for the study area with day 3 readings in Suleja showing the highest mean value of 14.11ppm and day one in Kontagora showing the minimum mean value of 9.83ppm.

4.2 Research Question 2

What is the quantity of NO₂ emitted from automobile vehicles as emission in Niger State?
To determine the quantity of NO₂ emitted in Niger State, readings were taken in the morning, afternoon and evening at six different junctions in each of the study areas for three days. Three days mean computed are presented in table 2 and figure 3.

<table>
<thead>
<tr>
<th>Days</th>
<th>MINNA</th>
<th>SULEJA</th>
<th>BIDA</th>
<th>MOKWA</th>
<th>NEW BUSSA</th>
<th>KONTAGORA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>0.07</td>
<td>0.07</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>Day 2</td>
<td>0.07</td>
<td>0.07</td>
<td>0.06</td>
<td>0.06</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Day 3</td>
<td>0.06</td>
<td>0.07</td>
<td>0.06</td>
<td>0.05</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>Mean</td>
<td>0.067</td>
<td>0.073</td>
<td>0.063</td>
<td>0.057</td>
<td>0.06</td>
<td>0.05 (PPM)</td>
</tr>
</tbody>
</table>

Table 2 shows that the quantity of NO₂ measured in Minna, Suleja and Bida areas were higher than the 0.04 -0.06ppm minimum standard stipulated by the Federal Environmental Protection Agency. Mokwa, Kontagora and New Bussa shows almost exactly as the standard.

**Figure 3**: Bar chart showing the mean concentrations of NO₂ emitted in the study area of Niger state

Figure 3 indicates the bar chart of the mean distribution for day 1, 2 and 3 with the average mean for the study area. Mean distribution of day 1 and 2 in Minna and day 1, 2 and 3 in Suleja shows the highest mean value of 0.07ppm while day 3 in Mokwa, day 2 in New Bussa and day 1, 2 and 3 in Kontagora show the minimum mean value of 0.05ppm.

**4.3 Research Question 3**

What is the quantity of SO₂ emitted from automobile vehicles as emission in Niger State?
To determine the quantity of SO$_2$ emitted in Niger State, three days of readings were taken in the morning, afternoon and evening at six different junctions in each of the study area for three days. Three days mean computed are presented in Table 3 and Figure 4

**Table 3: Mean concentrations of SO$_2$ emitted in the study area of Niger state**

<table>
<thead>
<tr>
<th>Days</th>
<th>MINNA</th>
<th>SULEJA</th>
<th>BIDA</th>
<th>MOKWA</th>
<th>NEW BUSSA</th>
<th>KONTAGORA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>0.023</td>
<td>0.015</td>
<td>0.018</td>
<td>0.017</td>
<td>0.018</td>
<td>0.012</td>
</tr>
<tr>
<td>Day 2</td>
<td>0.017</td>
<td>0.016</td>
<td>0.017</td>
<td>0.018</td>
<td>0.017</td>
<td>0.011</td>
</tr>
<tr>
<td>Day 3</td>
<td>0.02</td>
<td>0.018</td>
<td>0.018</td>
<td>0.02</td>
<td>0.025</td>
<td>0.011</td>
</tr>
<tr>
<td>Mean</td>
<td>0.0197</td>
<td>0.0163</td>
<td>0.0173</td>
<td>0.0173</td>
<td>0.02</td>
<td>0.011 (PPM)</td>
</tr>
</tbody>
</table>

Analysis of the result in Table 3 shows that the quantity of SO$_2$ measured in Minna, Suleja, Bida, Mokwa and New Bussa areas were higher than the 0.01ppm minimum standard stipulated by the Federal Environmental Protection Agency except in Kontagora that shows almost exactly as the standard.

![Figure 4: Bar chart showing the mean concentrations of SO$_2$ emitted in the study area of Niger state](image)

Figure 4 indicates the bar chart of the mean distribution for day 1, 2 and 3 with the average mean for the study area. Mean distribution of day 3 in New Bussa shows the highest mean value of 0.025ppm while day 2 and 3 in Kontagora shows the minimum mean value of 0.011ppm.

**4.4 Discussion**

The quantity of Carbon Monoxide (CO) measured in Minna, Suleja, Bida and Mokwa out of the six study areas was higher than the 10ppm minimum standard stipulated by the Federal Environmental Protection Agency except in Kontagora and New Bussa that falls almost exactly as the standard. This is because these areas were more concentrated with transport...
activities from both motor vehicles and motor cycles. The result revealed that the higher the number of motor vehicles and motor cycles the higher the emission problems to the environment. (Obajimi, 1998) supported this findings when he stated that in Nigeria, several rural towns that had in the past enjoyed fresh and dry air are currently experiencing air pollution problems. On the global sense, Seneca and Tausig (1994) arrived at the same conclusion that transportation is the major culprit of air pollution accounting for over 80% of total air pollutants. This is a clear indication that vehicle emissions are a major source of environmental problem and must be controlled if acceptable air quality is to be assured. In addition, there is numerous health problems associated with high concentration of these emissions. This findings of high concentration of CO was also confirmed by WHO (2000) which reported that concentrations of CO are highest at near street intersections, in congested traffic, near exhaust gases from internal combustion engines and from industrial sources, and in poorly ventilated areas such as parking garages and tunnels.

The quantity of NO$_2$ measured in Minna, Suleja and Bida out of the six study areas is higher than the 0.04 -0.06ppm minimum standard stipulated by the Federal Environmental Protection Agency while Mokwa, Kontagora and New Bussa read almost exactly as the standard. WHO, (2000) stated that road traffic is responsible for half the total NO$_2$ emissions. Goyal (2006) also supported the fact that automobile emissions contribute about 50-80% of NO$_2$ concentration in developing countries. This situation is alarming and it is due to the poor economic development of the developing countries. Long term effects from NO$_2$ exposure from automobile emission reacts with hydrocarbons to produce ozone and result to respiratory irritant which is known to exacerbate asthma.

The quantity of SO$_2$ measured in Minna, Suleja, Bida, New Bussa and Mokwa is higher than the 0.01ppm minimum standard stipulated by the Federal Environmental Protection Agency except in Kontagora that falls almost exactly as the standard. Koku and Osuntogun, (2007) carried out a similar study in Lagos and the results obtained for SO$_2$ per minute were found to be higher than FEPA limits. This was also supported by Erica, (2009) who discovered that the hourly SO$_2$ concentrations in Abuja exceeding the Nigerian ambient air quality standard during all readings and in all locations. The overall levels of automobile emissions being contributed to the environment in Niger State from this study show an increasing trend and thus possess a potential health effects to the population. In addition low quality of fuel, lack of traffic regulation and infrastructure, and lack of air quality enforcement contribute to the high levels of automobile emissions. The findings show that the contributions of automobile emissions to the environmental problems in Niger State are obvious. The menace of the large number of motor cycles (Okada) on Niger State roads is an issue of concern. The concerns are not only about increased NO$_2$ and SO$_2$ emissions from motor cycles but also about the impact on driving performance. Akio (2003) stated that many motor cycles use rich combustion, in which fuel is burned in excess in order to achieve optimum driving performance with minimum displacement. On the other hand, petrol engine lacks oxygen-sensor control while motor cycles has no readjustment mechanism, and the oxygen excess is not corrected which contribute to an increased NO$_2$ and SO$_2$ emissions as indicated in the result from New Bussa showing the highest mean value of SO$_2$. It should be noted that New Bussa is a rural settlement surrounded by water and the major source of transportation is the motor cycles.

5. Conclusion
The emissions of CO, NO\textsubscript{2} and SO\textsubscript{2} as a greenhouse gas has been contributing to environmental problems in Niger State as indicated in this study. This has been documented in numerous studies showing the links between greenhouse gasses, air pollution, ozone depletion and chronic health problems. This is supported by Samet, Dominici, and Curriero (2000) stating that greenhouse gasses are major contributors to air pollution, whose levels have been strongly linked to morbidity and mortality from cardiopulmonary and cerebrovascular diseases, lung cancer and infant mortality in the US.

5.1 Recommendations

The following recommendation was made based on the findings of the study

1. There should be reliable and efficient mass transport system to reduce the number of motor vehicles and motor cycles on our roads and therefore reduce the emissions of CO, NO\textsubscript{2} and SO\textsubscript{2}.
2. All motor vehicles and motor cycles moving on the road must pass vehicle inspection and maintenance test.
3. There is the need for immediate and effective traffic control programmes and good city road network to reduce idling period for vehicles and motor cycles on highways and streets.
4. The Niger State government should be determined to protect the environment and human health by putting in place effective policies and programmes to reduce the effects of CO, NO\textsubscript{2} and SO\textsubscript{2} from automobile emissions.

6. References


