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Air Pollution by Carbon Monoxide (CO) Poisonous Gas in Lagos Area Southwestern Nigeria

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ABSTRACT

We examined exposure to air pollution caused by households' wood burning of cooking, generating sets and vehicle emissions of carbon monoxide (CO) poisonous gas in the most populated urban city of Lagos Southwestern part of Nigeria. It is a known fact that many families including children and pregnant women; infant babies and individuals lost their lives due to poor quality air control policies, and inefficient control of air pollution caused by this deadly gas. Many are suffering with heart-related diseases as a result of CO poisoning and Government is not showing serious concern in this part of the world. All of the foregoing motivates this study to determine the level of human exposure to this deadly gas using Carbon Monoxide Detector so as to create the necessary adequate awareness of the quality of air within the metropolis whereby preventive measures could be put in place to curb the devastating effects on the innocent citizens, most importantly, the children.

Keywords: Air Quality; Air Pollution; Carbon Monoxide; Toxic; Human Exposure; Lagos

1. Introduction

Animal health, and quality of life are termed "Air pollution". [1] examined the control of air pollution caused by households' wood burning for heating and cooking in the developing world. Recently, [2] monitored and reported greenhouse gas emissions in Northern America and Europe. [3] based their work on "Fuel derived pollutants and boating activity patterns in the sea of galilee" Air pollution is a mixture of solid particles and gases in the air. Air pollutants are substances in the air that are very harmful to humans and the environment, such as sulphur dioxide (SO_2), nitrogen dioxide (NO_2) ammonia (NH_3), carbon monoxide (CO), volatile organic compounds (VOC), ozone (O_3) and carbon dioxide (CO_2), that are commonly called greenhouse gases [4].

Biologically, Carbon monoxide poisoning is the most common type of fatal air poisoning in many countries. Since it is highly toxic, it combines with hemoglobin to produce carboxyhemoglobin (COHb) which is ineffective for delivering oxygen to bodily tissues. This condition is known as anoxemia. Concentrations, as low as 667 ppm, may cause up to 50% of the body's hemoglobin to convert to carboxyhemoglobin [5]. Due to its high affinity for hemoglobin, most of the absorbed carbon monoxide will be found in the blood as carboxyhemoglobin, and therefore present in all tissues of the body. A level of 50% carboxyhemoglobin may result in seizure, coma, and fatality. The most common symptoms of carbon monoxide poisoning may resemble other types of poisonings and infections, including symptoms, such as headache, nausea, vomiting, dizziness, fatigue and a feeling of weakness. Infants may be irritable and fed poorly.

Worldwide, the largest source of carbon monoxide is natural in origin; it is due to photochemical reactions in the troposphere which generate about 5×10^{12} kilograms per year [6]. Other natural sources of CO include volcanoes, forest fires, and other forms of combustion. It has been unknowingly used by humans since prehistoric times, for the smelting of iron and other metallic ores. It has a molar mass of 28.0, which makes it slightly lighter than air, whose average molar mass is 28.8. Ideally, CO is therefore less dense than air [6].

The gas was first identified by Joseph Priestley in the eighteenth century, but it was Claude Bernard in 1870 that discovered the affinity between carbon monoxide and haemoglobin which accounts for its deadliness [7]. Carbon monoxide poisoning is the most common type of

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fatal poisoning in many countries [8]. Historically, it was commonly used as a method to commit suicide, usually by deliberately inhaling the exhaust fumes of a running car engine.

A study reported by Fromm and [9], shows that approximately 30% of people with severe carbon monoxide poisoning will have a fatal effect. Carbon monoxide poisoning occurs after enough inhalation of the gas. Exposures at 100 ppm or greater can be dangerous to human health [10]. It is known to be the most common cause of fatal poisoning in Britain today. It causes the accidental deaths of up to 500 people each year in the United States and a much larger number of sub-lethal poisonings [11]. [12] observed the Surface ozone and carbon monoxide levels at Oki, Japan: Regional air pollution trends in East Asia

In the period 1970-1988, 11,547 deaths due to carbon monoxide poisoning occurred in the United States as reported in [13]. In England and Wales, there are more than 60 deaths per year due to accidental exposure to carbon monoxide and some 500 admissions to hospital for treatment of such exposures. Children, pregnant women and individuals with heart problems are mostly affected; however, carbon monoxide poisoning is not limited to these groups of people only, it can affect anyone. It has been identified as the major cause of apparent haunted houses (a house or building often perceived as being inhabited by disembodied spirits of the deceased who may have been a former resident or familiar with the property). Symptoms such as delirium and hallucinations have led people suffering from CO poisoning to think they have seen ghosts or to believe their house is haunted [14]. Carbon monoxide poisoning is the most common cause of fatal gassing and is the cause of deaths in about 90% of fire victims as reported by [14].

It is difficult to detect the presence of carbon monoxide in our surroundings; its inconspicuousness makes it particularly dangerous for humans. Carbon monoxide is very harmful, poisonous and highly toxic to living organisms. It is therefore very important to prevent such harmful and deadly poisonous gas through adequate awareness of possible causes and the way to minimize the risk of exposure is most essential. Thus, there is the need to determine the level of human exposure to carbon monoxide in our environment. In fact, it is the most common cause of fatal poisoning in Nigeria today most especially users of domestic generators. It causes the accidental deaths of up to over 1000 families annually as a result of inhalation and a much larger number in other parts of the country due to lack of adequate education on the poisonous fumes emitted from these generators, equipment and other vehicles. This research therefore, focuses on the determination of the level of human exposure to carbon monoxide gas using carbon monoxide detector. We need to identify the major sources of carbon monoxide in the study area, and harness a great deal of information that is relevant to air quality in the area. We also need to enlighten individuals and organizations, the importance of proper maintenance of combustion equipment thereby reduces the risk of carbon monoxide to acute health risks; and also to ensure adequate awareness of carbon monoxide gas and to indicate the major source of the emissions in Lagos State, Nigeria.

2. Methodology

Three methods are most commonly used for the routine estimation of carbon monoxide in air. These are the continuous analysis method based upon non-dispersive infrared absorption spectroscopy (NDIR); the semi-continuous analysis method using gas chromatographic techniques and a semi-quantitative method employing detector-tubes [15]. In this particular research project, the detector tube method was adopted to measure carbon monoxide from different sources; e.g. domestic generators; kitchen; firewood; motorcycles, cars and trucks. The data was obtained using primary data collection methods.

Primary data collection involves actual visitation of different sites within Lagos metropolis to record and analyze values of carbon monoxide emission using the detector (model: DSM8922); **Figure 1**, to obtain data and relevant information required for the analysis.

3. Data Collection

The choice of the different locations where carbon monoxide readings were recorded was based on; 1) accessibility, 2) central location and 3) congestion in the areas. Lagos, being the economic capital of Nigeria has a lot of central business districts; most of the locations selected

Figure 1. Carbon monoxide detector.

are Ikeja industrial area and its environs due to the presence of heavy factories in this part of the metropolis, publishing house (daily times), television stations (Lagos television station), shops and residential buildings. Festac and Apapa areas were selected because of the heavy presence of industrial sites in these areas and the rate of carbon monoxide emissions is relatively high. The Detector was used to acquire data in Ikoyi residential area and Gbagada as a commercial area.

3.1. Sampling Techniques

This research targeted a sample size of a minimum of 10 cars, 9 trucks, 6 motor cycles, 5 petrol domestic generators, 5 diesel generators, 3 household kitchens, 2 eatery kitchens, 3 commercial areas, 3 residential areas and 2 firewood cooking areas; due to time constraint and unwillingness of some drivers and home owners to permit data collection on their cars and premises. Out of this sample size, specific locations were visited such as: Ikeja; Omole residential estate, ever busy commercial area of Computer village, Ojodu; Alausa; Allen Avenue and Agidingbi; Festac area; Ikoyi area, Gbagada area and Apapa both jndustrial, commercial and residential areas of the State for even distribution.

3.2. Data Interpretation and Analysis

The results of carbon monoxide emissions recorded from the different sources were presented in **Figures 2-5**. The instrument was taken from place to place to measure different sources of the carbon monoxide gas. The exposure time duration was selected to be 2 hours at a time per a place. The average values for each type of sources from different locations were computed.

4. Discussion of Results

The average values of carbon monoxide emission from different sources in the study area as presented in **Figure 2**. From this figure, the values of carbon monoxide emissions from environmental sources (such as commercial

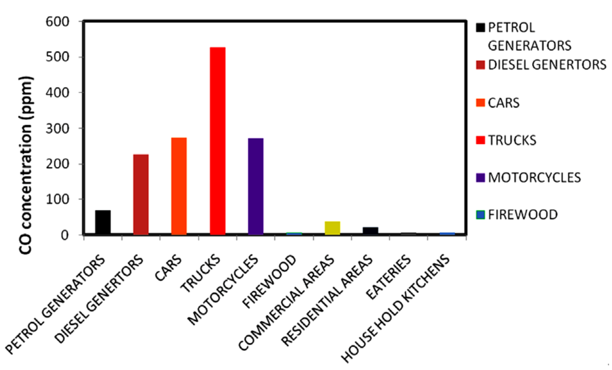

Figure 2. The average values of CO emissions from different sources and environments.

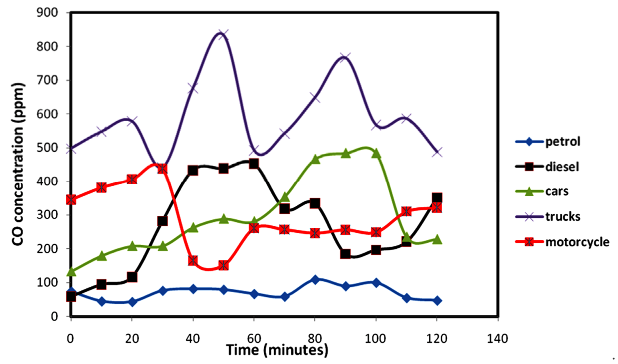

Figure 3. Average values of CO emissions from different sources.

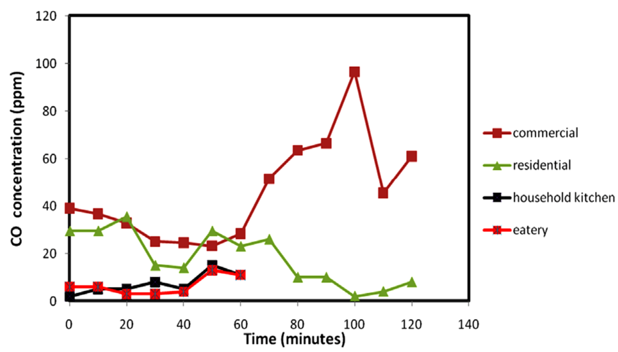

Figure 4. Average values of CO emissions from different sources.

areas, residential areas, eateries, household kitchens and firewood cooking spots) are relatively small compared to values recorded in machines operating on fossil fuels (*i.e.* petrol generators, diesel generators, cars, motorcycles and trucks). From the corresponding graph, it was also observed that trucks produce the highest values of carbon monoxide gas as recorded by the Detector in comparison to the other sources. The reason could be due to the type of engine and the fuel used (diesel). From the graph it was also observed that generators operating on diesel fuels recorded more carbon monoxide emissions than generators operating on petrol fuels. It is therefore safe to conclude that diesel engines have larger emissions of carbon monoxide than petrol engines as recorded in this research work. This could also accounts for the high concentration of CO recorded in Trucks. Firewood cooking spots, eateries and house hold kitchens produce relatively lower values of carbon monoxide emissions.

Figure 3 shows graphical representations of the average values for CO emissions from different sources. The figure includes values from petrol generators, diesel generators, cars, motorcycles and trucks. CO emissions recorded ranged from a minimum value of about 45 ppm to a maximum value of about 835 ppm. Generally, the values recorded during the field work fluctuated periodically. The variations in values obtained in cars, motorcycles and trucks were due to the volume of vehicles moving at that particular time and the age of the vehicles. At the points of high values of CO concentration, the traffic was heavier and at the point of low values of CO concentration, the traffic was lighter. From the figure, it was also observed that the CO emissions from petrol fuel generators have relatively lower values that were moderately constant, *i.e.* almost steady. This may not be unconnected to the fact that the generators were constantly running in an open space. High values of carbon monoxide emissions in diesel fuel generators could be due to ageing, or because they are in an enclosed area and it could be because diesel fuels have very high carbon content than the petrol fuels.

The average values of CO emissions from commercial areas; residential areas; household kitchens, eateries and firewood cooking spots were shown in **Figure 4**. The values recorded ranged from a minimum of about 1 ppm to a maximum of about 96 ppm. It was observed from the graphs that the highest values of carbon monoxide emissions were recorded in the commercial areas relative to the other sources. This could be due to high volume of vehicle and human activities taken place at the markets, such as; grinding of all kinds; smoking; wood burning, welding works and so no and so forth. These activities were taken place at the time the data was collected. The variations in values are functions of how long these activities lasted. High concentration in CO emissions shows increased activities at the areas and low concentration in CO emissions shows less activities. These suggest that concentration in CO emissions in a place is a function of the human activities taken place in a particular area. Similarly in the residential areas, CO emissions depend on the human activities taken place at that particular area. In commercial areas, values of carbon monoxide emissions recorded were relatively higher than the values recorded in residential areas. It was also observed from the graph that the values of CO emissions from eateries, household kitchens and firewood cooking spots were relatively low. This could be due to the absence of high density human and automobile activities.

Carbon monoxide emissions from different trucks were plotted together as shown in **Figure 5**. The value varies from between minimum of about 107 ppm and a maximum of about 855 ppm. Data from nine trucks was recorded and plotted together. The graph shows an upward and downward trend resulting from fluctuation. These fluctuations as earlier discussed were functions of the type of engine, the age and the type of fuel used. The values recorded were relatively very high which could be as a result of carbon contents in the fuels of trucks and heavy automobiles.

Figure 3 graphically represents and compares the average values of CO emissions from different sources. The

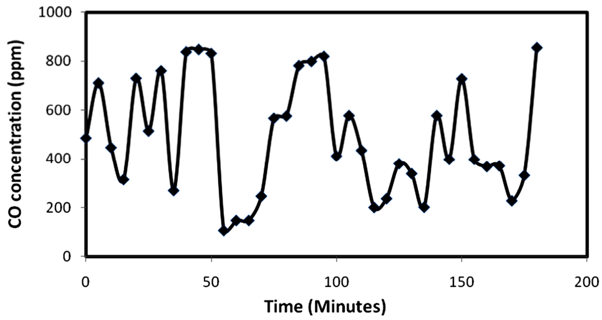

Figure 5. Observed air pollutant emission from trucks.

figure includes values from petrol generators, diesel generators, cars, motorcycles and trucks. CO emission ranged from a minimum of 45 ppm to a maximum of 835 ppm. Generally, the values are fluctuating from time to time. The variation in cars, motorcycles and trucks is as a result of the number of vehicles running at that particular time and the age of the vehicles (*i.e.* the cars, motorcycles and trucks). At the points of high concentration in CO, many vehicles are passing by the instrument and at the point of low concentration very few vehicles pass by the instrument. It is also observed from the figure that emission of the pollutant from petrol generators are relatively low and the values do not fluctuate, they are almost steady. This is because the generators were constantly running and in an open space. CO production in diesel generators are high due to ageing and being in a confined area and also because diesel fuels have a very high carbon monoxide content.

Figure 4 graphically represents and compares the average values of CO emissions from different sources. The figure includes values from commercial areas, residential areas, household kitchens, eateries and firewood cooking. CO emission ranged from a minimum of 1 ppm to a maximum of 96 ppm. It is observed from the graphs that commercial areas have the highest production of carbon monoxide with respect to the other sources. This is due to the high density of activities (markets; grinding pepper; smoking; driving, wood burning and welding works etc.) taking place at that particular time. The variation of values depended on how long these listed activities lasted for that is at the points of high concentration in CO, activities increased and at the points of low concentration in CO, activities reduced. It is safe to conclude that concentration in CO depends on the activities taking place at that particular area. Similarly to residential areas, CO concentration depends on the activities taking place at that particular area. In comparison to commercial areas, carbon monoxide emissions at residential areas are relatively lower than that of commercial areas. It is observed from the graph that CO emissions from eateries, household kitchens and firewood cooking are relatively low. This is due to the absence of high density activities.

Figure 5 is a graphical representation of a typical carbon monoxide emission from a collection of trucks together. The values ranged from a minimum of 107 ppm to a maximum of 855 ppm. The graph comprises of values from nine trucks. The graph shows an upward and downward trend resulting from fluctuation. These fluctuations as earlier discussed are as a result of the type of engine and the fuel used. The values are relatively very high because of the presence of other trucks and automobiles.

5. Conclusion

According to [10], exposures to carbon monoxide at 100 ppm or greater are very dangerous to human health. Therefore from **Figure 4**, the level of carbon monoxide emission from commercial areas, residential areas, household kitchens and eateries is tolerable by the human system and considerably less threatening. Whereas in **Figure 3**, which presented CO emissions from petrol generators, diesel generators, cars, motorcycles and trucks depict a level of carbon monoxide that is highly toxic to human body, it is therefore advisable to avoid closeness to these sources. For as long as fossil fuels are being used to run automobiles; domestic generators, cooking and other related activities, carbon monoxide will be emitted into the environment thereby making it unsafe. From the results, automobiles dominate other sources of carbon monoxide within Lagos environs. The CO emissions from the domestic generators might not be unconnected to the rate at which families are wipe out due to fumes from generators kept within the flats or at an enclosure in the residential buildings. With this report, Government needs to take decisive steps towards adequate enlightenment programme to educate the Nigerian people on the need to take ample preventive measures and curb the destruction to lives via this menace.

6. Tribute

The Authors wish to acknowledge the contribution of Late Prof. E. B. Babatunde to this work in his life time. It is our prayer that God will grant him eternal rest.

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