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Environmental Assessment of CO and SO_2 Pollution Resulting from Bye-Product of Biomass Fuel at Gboko Town, in Benue State, Nigeria

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Abstract: The assessment of Carbon monoxide (CO) and Sulphur dioxide (SO_2) was carried out at Gboko in Benue State, Nigeria. A total of six areas were surveyed across the town. The concentrations of the CO and SO_2 varied from 1.90 to 8.00 ppm and 0.10 to 0.24 ppm respectively. Studies indicate that, the average hourly concentration in parts per million (ppm) of CO and SO_2 in all the six points surveyed were found to be 4.98 and 0.15 ppm respectively, with a standard deviation of 1.83 ppm and 0.05 ppm. This is about 50.17 and 11.76 % deviations for CO and SO_2 from the National Ambient Air Quality Standard (NAAQS) of 10.00 and 0.17 ppm for CO and SO_2 respectively. These results do not pose an immediate threat to the environment but subsequent accumulation may be dangerous.

Keywords: Biomass, Bye-product, Concentration, Gasman Meter, Air Quality Standard, ppm, Pollution

1. Introduction

Firewood and crop residue are the major raw materials for the inhabitants of Gboko as a cooking energy source. The incomplete combustion process of these materials produced many pollutants. Therefore, the socio-economic status of residential and the commercial urban dwellers are dependent on firewood as a source of energy for their cooking.

The dangerous bye-product of the sources of energy is released into the immediate atmosphere where they affect man and other inhabitants of the immediate environment, causing diseases like cancer, trachea disorders and liver problems.

Biomass refers to the quantity of living plants and animals materials in a given area of natural vegetation [1]. It can be measured as fresh weight but more usefully in day weight [2].

The term Biomass is the energy context to describe all those sources that arise from photosynthetic processes. It covers sources such as agricultural and forest residues, industrial and municipal water and crops especially grown for conversion to fuels. Historically, Biomass was the sole source of energy for mankind, with most of its evolution to be replaced only in the last two centuries by fossil fuels. Presently, biomass is again being examined as a substitute for these same fossil fuels that displaced it earlier.

The energy stored in Biomass resources can be released through the process of oxidation or burning the materials (which is made up of carbon compounds) to release, carbon monoxide, water and energy. This energy produced is in form of heat energy. The total energy contained in any biomass material is the total heat energy measure when the materials is oxidized or burnt [3].

Globally, biomass is estimated to produce 40% of the highly carcinogenic polycyclic hydrocarbons produced by all sources [4]. Biomass smoke is generally heavier than air and tends to sink to the ground. It causes high concentration of

deadly particulates whenever it is burnt.

Gasman monitor is an instrument for measuring the concentration (observed thickness) of toxic gases like Sulphur dioxide (SO_2), Carbon monoxide (CO), Nitrogen dioxide (NO_2), PM10 particulates etc. The Gasman meter is an intrinsically safe personal Gas detector designed to alert the user of dangerous conditions in the immediate environment. The ragged design allows the instrument to be used in almost any application and the enclosure (with the exception of the sensor and sounder housings) is designed to IP65.

Researchers and establishment have worked on various pollutants determining their concentrations in the environment and its effect under such an investigation. However, this study is mainly restricted to air pollution using BIOMASS fuel within Gboko residents and commercial centers. This work involves the determination of the concentrations of carbon monoxide (CO) and sulphur dioxde (SO_2) in selected residential and commercial areas of Gboko town using Gasman Crowcon Meter. The research was conducted for six days. Studies indicate that, the average hourly concentration for CO and SO_2 is 4.98 ppm and 0.15 ppm respectively which is below the NAAQS of 10.00 ppm and 0.17 ppm for CO and SO_2 respectively.

2. Effect of Air Pollution on Human Health

Air pollution (Indoor and outdoor) is a major environmental problems affecting developed countries. Inhaled pollutants affect the lung and the respiratory tract but can also be taken up and transported by the blood stream throughout the body. Through deposition in the environment, air pollutant can also contaminate food and water. Pollution of the air result to too many millions of death and serious ill-health of people each year. An estimated number of three million people die over the world annually due to air pollution resulting in respiratory diseases, cardiovascular diseases and cancer of the lung [5]. For example, indoor air exposure to suspended particulate matter increases the risk of acute respiratory infections, which is one of the leading causes of infant and child mortality in developing countries.

World Health Organization (WHO) publication in 2002 on Biomass energy accord that such exposure accounts for one and half million deaths in Asia every year and about 300,000 to 500,000 excess deaths per year in Sub-Saharan Africa as published [6].

Indoor air pollution is the primary cause, in as many as 50 million cases of occupational chronic respiratory diseases have resulted from Biomass fuel energy [5]. The use of the Biomass fuel for heating and cooking is a major source of indoor and outdoor pollution. Summarizing the effects of air pollution might increase the understanding of the effects of our pollution on human health. Man consumes air more than he consumes water or food; he takes in an average of 16 kg of air each day [7].

The provision of air that is safe to breathe is just as important as safe water or food. Yet many millions of people, predominantly women and children in the poorest developing countries, are obliged to breathe air that is heavily polluted with biomass emission products. Air pollution in general and indoor air pollution in particular have been associated in many people's minds with industrialization and urbanization, thus with the cities of developed countries [8]. The WHO Air Monitoring Information System (AMIS) has demonstrated, however, that the worst ambient conditions reported today exist in the cities of developing countries. Similarly, although most studies of indoor air quality have been carried out in developed-country buildings, the greatest indoor concentrations of exposure to many important pollutants are found in both rural and urban households of developing countries. A significant proportion of this activity takes place in conditions where much of the airborne effluent is released into the living area. Although ventilation rates are often relatively high, emission factors for such fuels are so great that indoor concentrations and exposures can still be significant. Compared with gas stoves, for example, even stoves using one of the cleaner biofuels; wood typically releases 50 times more particulate matter, carbon monoxide and hydrocarbons in cooking an equivalent meal [9]. Taking into account other biofuels such as dung or crop residues, the resulting human exposures exceed recommended World Health Organization levels by factors of 10, 20 or more [6].

Exposure to biomass smoke is a significant cause of health problems such as acute respiratory infections (ARI) in children, chronic obstructive lung diseases (such as chronic bronchitis and asthma), lungs cancer and pregnancy-related outcomes. Global estimates shows that about 2.5 million death each year results from indoor exposures to particulate matter in rural and urban areas in developing countries, representing 4-5% of the 50-60 million global deaths that occur annually [10].

3. Materials and Methods

3.1. Study Area

Benue State was created on the 3rd February, 1976. It was carved out of the so called Middle Belt Region. It has land mass of 32,511 km^2. It is the seventh largest and seventh most populous State in Nigeria. It stretches between longitude 60-100 East and latitude 60-80 North. The State lies mostly within the lower Benue from the South-eastern borderlands to Cross-River plains. The River Benue is the major geographical feature from which the State derives its name. The River Katsina-Ala is the most important tributary of the Benue River. The Benue and her tributaries have lowered the State high plains and deposited alluvial soil in the trough. This form the bulk of farmland that is the pride of the State. Benue State has the greatest stretch of the river system in the country with over 100 natural ponds and lakes (Benue State Ministry of Information Makurdi).The Benue River is navigable up to Garoua in the Republic of Cameroon

at the peak of the rainy seasons. There are plans by the Federal Government of Nigeria to further dredge the river for navigation and other uses.

The State is located in the Southern Guinea Savanna which is a transition belt between the glassland savanna in the North and the rainforest in the South. The vegetation cover is mostly made up of giant grasses (elephant grass) and tree species like: vetellaria paradoxa,Parkia biglobosa, Prosopis Africana, Vitex doniana, Khaya senegalensis, etc. Along the banks of the Benue are found hydromorphic soils, which are fertile for several crops cultivation which has earned the State a nick-name: "The food-basket-of-Nigeria".

Gboko town is also strategically located and it is the headquarter of Gboko Local Government Area. It has a land mass of 4,493 km^2 and the town serves as the traditional headquarter of the Tiv speaking people. The traditional head of the Tiv people, Tor Tiv, is based in this town. A good network of truck a roads link the town with other Local Government Areas of the State and other parts of the country.

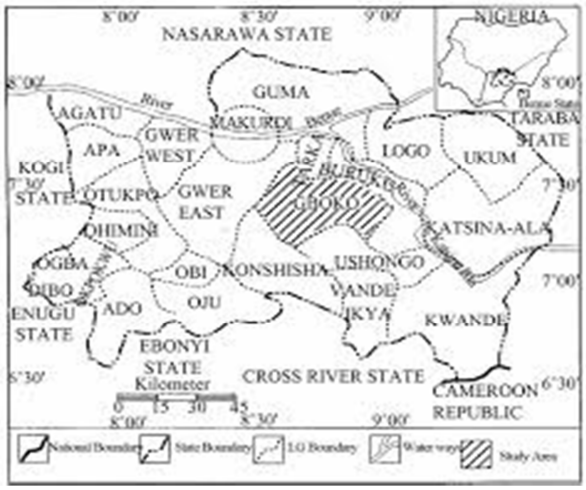

Fig. 1. *Map of Benue State, Showing study area.*

3.2. Identification of Survey Areas

Six different sites were considered in this research work; Gboko Old Garage (OG), Gboko New Garage (NG), Adekaa Market (AM), Tomato Market(TM), Hausa quarters (HQ) and Rice Mill (RM).

3.3. Methodology

A unit of Gasman instrument for cabon monoxide (CO) and Sulphur dioxide (SO_2) was used in this work. The instruments were calibrated and adjusted in ambient air at the experimental site where fames of aerosols from burning biomass resources were concentrated.

By turning the switch to the gas position, the green light emitting diode (LED) and the sounder operates after three seconds. The liquid crystal diode (LCD) was displayed 0.00 for TO version for CO Gasman Crowcon and 0.00 for the TO version for SO_2 Gasman Crowcon and its measured in parts per million (ppm).

The Gasman meter is adjusted before a stable reading is taken. The Gasman meter is ready when the green light is stable. The alarming condition is indicated by the means of flashing red LED and sounder. It automatically resets after gas concentration has passed out of alarm range. Measurements were made for one hour in each position. Three measurements were taken in each position and the average value was obtained.

The Carbon monoxide and Sulphur dioxide concentration was recorded from the Gasman instruments in one hour interval and recorded in parts per million (ppm).

4. Results and Discussion

Table 1. *Hourly average concentration of CO (ppm) for the assessed areas.*

Assessed area	Hourly Concentration of CO (ppm)
Rice Mill (RM)	4.50
Hausa Quarters (HQ)	4.80
Adekaa Market (AM)	8.00
Old Garage (OG)	6.00
New Garage (NG)	4.70
Tomato Market (TM)	1.90
Averege	4.98

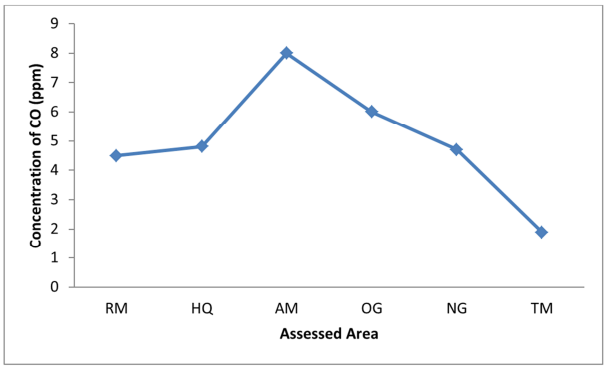

Fig.2. *Hourly average concentration of CO (ppm) in Gboko town.*

Table 2. *Hourly average concentration of SO_2 (ppm) for the assessed areas.*

Assessed area	Hourly Concentration of SO_2 (ppm)
Rice Mill (RM)	0.10
Hausa Quarters (HQ)	0.18
Adekaa Market (AM)	0.10
Old Garage (OG)	0.24
New Garage (NG)	0.18
Tomato Market (TM)	0.12
Averege	0.15

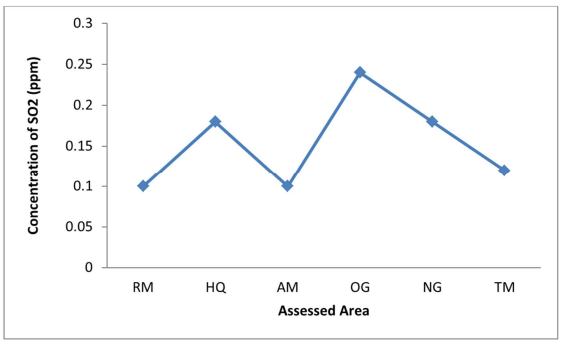

Fig. 3 *. Hourly average concentration of SO_2 (ppm) in Gboko town.*

The results obtained as presented in Table 1.0 shows that the average hourly concentration for CO in Gboko town is 4.98 ppm. This value is below the National Ambient Air Quality Standard (NAAQS) of 10.00 ppm for hourly values. It can be seen from Fig 2.0 that other areas like Adekaa Market (AM) however recorded a higher hourly average concentration of 8.00 ppm. This is attributed to the incomplete combustion that occurs in all fires and even in the most efficient appliances and furnaces in AM. Also, all fossil fuels (e.g. coal, fuel oil, kerosene, gasoline, natural gas) contain carbon, as do other natural fuels (wood and charcoal). When these fuels burn (or oxidized), CO is emitted as one of the gaseous by-products. This value is however very close to the 10.00 ppm recommended value by NAAQS.

The values do not pose any threat as ascertained but the cumulative effect could be dangerous. This is because most residential and commercial areas make use of biomass fuel for more than 8 hours daily that results to CO accumulation.

The result obtained as presented in Table 2.0 shows that the average hourly SO_2 concentration for Gboko town is 0.15 ppm. This value is below the NAAQS hourly standard of 0.17 ppm for SO_2. Fig.3 also shows that other areas like Old Garage however recorded a higher hourly average concentration of 0.24 ppm. This value is also below the 0.97 ppm recommended value by NAAQ.

Although the unprocessed biomass fuel is the cheapest source of energy for cooking especially within Gboko town. Its adverse effect is greater when compared with our health safety in a given environment. The thicker the smoke emitted, the greater the concentration of values. It is toxic in nature and very harmful especially in the system within the blood transporting source.

5. Conclusion

This research work has established the presence of Carbon monoxide and Sulphur dioxide gases emitted from the unprocessed biomass fuel in the assessed area at Gboko Town, when used as a source of energy for cooking within the residential and commercial areas. Results obtained shows that the concentration for CO and SO_2 is 4.98 and 0.15 ppm respectively which when compared, is below the NAAQS of 10.00 and 0.17 ppm for CO and SO_2 respectively. It is on this note that, health wise; care must be taken seriously when staying long period at the source of biomass fuel. It is also observed that those toxic gases are primarily air pollutants sources which constitute about 65% as estimated by the Nigerian Environmental Protection Agency [13].

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