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Measurement of Carbon Monoxide Emissions in Some Selected Area in Lagos State

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Author's contribution

The only author performed the whole research work. Author CCU wrote the first draft of the paper. Author CCU read and approved the final manuscript.

Research Article

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ABSTRACT

Carbon monoxide measurement was carried out in some selected area in Lagos State using carbon monoxide detector (Model DSM 8922). Some of the results are shown in Table 1. CO emission with minimum value of 45 ppm to a maximum value of 835 ppm. The values vary from time to time and depended on the number and age of vehicles plying the road at that time. Some areas have exposure of 100 ppm and above, making them highly toxic to human beings.

Keywords: Carbon monoxide; emission; measurement; air quality index.

1. INTRODUCTION

Vehicular emission is one of the environmental health problems that is on the increase due to increase in those who own vehicles in the world. It is estimated that large number of people are expose globally to traffic generated pollutants. Traffic pollution constitute about 90 of the ambient CO, 80 NOx, hydrocarbon and other matters that affect human health [1].

Carbon monoxide (CO), colourless, odourless, non-irritant and poisonous gas is lighter than air with molar mass of 28 and highly toxic at higher quantities to humans and animals. The gas is made up of one carbon atom and one oxygen atom joined with triple bond. Carbon monoxide is formed with insufficient oxygen in combustion engine in an enclosure. All fuel

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burning appliances have the potential to produce CO in varying concentrations. It is a good reducing agent and forms transition metal carbonyls, such as $Ni(CO)_4$. The photochemical reactions in troposphere produces about 5×10^{12} kilograms per year [2].

Since it is colourless, odourless, tasteless and toxic, it produces carboxyhemoglobin (COHb) with hemoglobin which affects oxygen delivering to body tissues resulting in anoxemia [3]. About 50% carboxyhemoglobin causes seizure, coma. The symptoms of it's poisoning is similar to so many poisonings and infections.

According to U.S environmental protection agency studies, the main source of carbon monoxide is vehicle emissions. A study carried out by the World Health Organization (W.H.O) task group on environmental health criteria for carbon monoxide revealed that man-made carbon monoxide emissions vary from 350 to 600 million tonnes per annum. The emission depends on the type of vehicle, it's speed, and how it operates.

As a developing country, Nigeria is threatened by traffic emissions apart from the general industrial pollution and pollution from oil industries [4,5,6]. This is as a result of bad roads, importation of old over used vehicles and lack of effective agency to regulate and enforce on the level of pollutants level expected to be good to human health.

According to studies conducted by [7,8] at Kaduna, Asokoro Abuja and Minna gave the CO_2 concentration as 1840 ppm for Sabo Kaduna, 1780 ppm, 1539 ppm in A.Y.A. Abuja, 1160 ppm in Asokoro, Abuja and 5000 ppm for Minna. This value is low compared to the WHO value of 20,000 ppm. The maximum value of CO emission measured is 15 ppm as against WHO baseline of 48 ppm and Federal Environmental Protection Agency of Nigeria (FEPA) 20 ppm.

The Air Quality Index (AQI), also known as the Air Pollution Index (API) or Pollutant Standard Index (PSI), is the quantity used to determine to the quality of the air at a particular place. When the AQI increases, increased number of people may experience increasing severe adverse health effects. To calculate AQI, one needs an air pollutant concentration as observed or a sensor which varies from different countries and is assigned a descriptor with colour code.

Air is commonly monitored by International Environmental Protection Agencies as well as state and local environmental agencies pollutants. According to the U.S AQI, air samples are often collected and analyzed several times daily in cities and other industrial areas. The value range of 0 to 50 ppm, 50 to 100 ppm, 100 to 200 ppm, 200 to 300 ppm, and 300 to 500 ppm, indicates; good air quality, moderate, unhealthy, very unhealthy and hazardous respectively [9]. Automobile exhaust contains particulates and other elements which contribute to global warming. Carbon monoxide poisoning causes serious poisoning in different countries [10]. The best procedure to determinate carbon monoxide in air is physically based instrumental procedures [11].

Exposure to 100 ppm and above is dangerous [12]. About 500 people die each year from sub-lethal poisonings in the USA because the signs and symptoms associated with carbon monoxide poisoning are not easily differentiated [13].

It was recorded that more than 60 deaths per year and 500 people admitted to hospital for treatment as a result of effects of carbon monoxide in England and Wales [14].

Exposure can occur during equipment use in buildings or semi-enclosures [15]. Riding in pickup trucks, steaming automobiles with blocked exhaust pipe and propulsion engines on boats, result in carbon monoxide poisoning [16].

When the Sources and concentration of carbon monoxide are: 0.1 ppm, we have (natural atmosphere level), from: 0.5 to 5 ppm (average level in homes), 5 to 15 ppm (near properly adjusted gas stove in homes), 100 to 200 ppm (exhaust from automobiles in central areas), 5,000 ppm (exhaust from a home wood fire) and 7000 ppm (undiluted warm car exhaust without a catalytic converter). Different people have different level of tolerance for carbon monoxide [17]. Excessive carbon monoxide exposure may result to heart damage [18]. The carbon monoxide tolerance level for one can be changed [19]. According to various research findings, carbon monoxide poisoning at various range results in different effects at different time range such as headache, vomiting, dizziness etc. [20].

An indigenous E.I.A study carried out in Ntak Inyang village, in order to find out the sustainability, or otherwise, of the chosen site for the Akwa Ibom state government's science and technology park. The study revealed the importance of acquiring ecological baseline of the existing study area before embarking on a project in order to prevent environmental damages rather than wait to remedy them after they have occurred. The study which was carried out during the dry season revealed that the CO was between 2.02-4.50 ppm which is quite low compared to the Nigerian Federal Ministry of Environment standard of 10 ppm. The gaseous emissions were determined for upwind and downwind at one hour interval and distance of 100 meters. It was found to be low due to a lot of factors, some of which are: the geographic location, the prevailing poor rate of industrialization and transportation activities.

Also, research study done in the University of Nigeria, Nsukka, revealed that the carbon monoxide emission in Nigeria is low compared with that from developed countries. It also showed that Lagos (which for many years remained the federal capital and the most industrialized city in Nigeria), the oil producing areas, as well as other major urban centers where high level of industrial activities may lead to enormous problems of environmental contamination. The commercial and industrial nerve centre of Lagos, Nigeria, has been shown to contribute about 10% of national emissions investigated. Atmospheric air quality standards are violated by many pollutants for a substantial part of the year and this causes potential contribution to atmospheric acidification of the region and also poses serious danger to human health and ecology.

Apart from the health impact, CO plays an important role in atmospheric chemistry. The reactions involving CO provide the dominant sink for the hydroxyl radical [21] together with nitrogen oxides. The level of CO controls the overall oxidative capacity of the atmosphere. Changes in CO emissions, influence the climate by affecting methane and other greenhouse gases that oxidized by the OH radical [22,23]. CO can also play the role of precursor of tropospheric ozone [24]. Relatively long atmospheric lifetime, ranging from 10 days in summer over continental regions to more than a year over polar region in winter is long enough to use CO as a sound tracer for anthropogenic pollution [25].

2. RESEARCH METHODOLOGY

There are three methods used to measure carbon monoxide in air; 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. Other methods include catalytic oxidation, electrochemical analysis, mercury displacement, and the dual isotope technique.

The detector tube is used to estimate concentrations above 5 mg/m^3. Air passes through special manufactured tubes with a chemical agent that detects the presence of carbon monoxide with change in colour.

In this particular research project, the detector tube method is used to measure carbon monoxide from the different sources; generators (fuel and diesel), motorcycles, cars, trucks.

Fig. 1. Picture of the carbon monoxide detector

Fig. 1 is the carbon monoxide detector (model: DSM8922) used has the following specifications: CO range: 0-999PPM, Resolution: 1ppm, Accuracy: ±20% at 0~100 ppm; ±15% at 100~500 ppm; (at 20± 5 ºC, 50± 20% RH), Battery: 3AAA alkaline, Battery life is 250 hours when the backlight is off and 35 hours when the backlight is on, Power supply: 3 "AAA" batteries, Response time: within 60 seconds, Operating humidity: 5%~99% RH (No Condensation), Storage Condition: -40~158 F; -40~70 C, Operating Temperature: 14~140 F; -10~60 C, Meter Size: 6.89 x 1.85 x 1.1 inches; 175 x 47 x 28 mm.

The choice of the different locations where carbon monoxide readings were taken was based on the accessibility, central location and congestion in the areas. Lagos state; being the economic capital of Nigeria has a lot of central business districts. The most of locations selected are in Ikeja (the state capital) and its environs due to the presence of factories (Coca Cola and Cadbury), publishing house (daily times), television stations (Lagos television station), shops and residential buildings. Festac and Apapa were selected because they are industrial areas and the rate of carbon monoxide may be relatively high. Readings was also taken from Ikoyi, residential area and Gbagada, a commercial area.

Specific locations were visited such as: Ikeja; Omole estate, Computer village, Ojodu, Alausa, Allen avenue and Agidingbi, Festac, Ikoyi, Gbagada and Apapa with exposure time taken at 2 hours intervals.

3. RESULTS AND DISCUSSION

Some of the results of measuring carbon monoxide emissions from different sources are presented in Table 1. The instrument for measuring the emission was taking from place to place in the month of May 2012 The exposure time duration was 2 hours interval.

Table 1. Average values of sources with high concentration in carbon monoxide

Duration (minutes)	Generator petrol (ppm) ± 15.16	Generator diesel (ppm) ± 40.2	Cars (ppm) ± 43.93	Trucks (ppm) ± 88.5	Motorcycle (ppm) ± 43.7
0	73.67	58.5	132.50	497.5	345.0
10	44.67	94.5	179.00	547.5	381.0
20	43.00	116.5	208.00	579.0	406.0
30	75.67	281.5	208.00	440.5	438.5
40	81.00	433.5	262.50	677.0	165.0
50	78.67	438.5	288.25	835.0	150.5
60	66.33	452.5	280.25	493.0	260.5
70	58.50	318.0	353.00	542.5	256.5
80	108.00	334.5	466.00	649.5	246.0
90	89.00	184.0	484.00	767.0	256.0
100	99.00	196.5	484.00	567.5	248.5
110	54.50	220.5	234.50	586.5	310.0
120	47.00	351.0	227.50	487.5	321.5

From the Table 1, it is also observed that trucks produce the highest carbon monoxide in comparison to the other sources. The reason may be due to the type of engine and fuel used (diesel). It is also observed that generators operating on diesel emit more carbon monoxide than generators operating on petrol. It is therefore, safe to conclude that diesel is a larger emitter of carbon monoxide than petrol. This also accounts for the high concentration of CO in trucks.

Comparing the average values of CO emissions from different sources; petrol generators, diesel generators, cars, motorcycles and trucks. CO emission ranged from a minimum of 45ppm to a maximum of 835ppm. Generally, the values fluctuate 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 (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.

Table 2 shows the average values of carbon monoxide emitted at the commercial and residential areas. The emissions at the residential and commercial areas are within the tolerance level and varied with time.

Table 2. Average values of carbon monoxide emission over a period of two hours

Duration (minutes)	CO concentration (ppm), commercial environments ± 8.2	CO concentration (ppm), residential areas ± 3.6
0.0	39.0	29.5
10.0	36.6	29.5
20.0	32.8	35.5
30.0	25.0	15.0
40.0	24.6	14.0
50.0	23.2	29.5
60.0	28.4	23.0
70.0	51.5	26.0
80.0	63.5	10.0
90.0	66.5	10.0
100.0	96.5	2.0
110.0	45.5	4.0
120.0	61.0	8.0

4. CONCLUSION

According to [12], exposures to 100ppm and above are very dangerous to human health. Therefore, CO emissions from petrol generators, diesel generators, cars, motorcycles and trucks shows a level of carbon monoxide that is highly toxic to human beings in some areas of Lagos where the study was covered.

The major source of carbon monoxide emission observed in the studied area was from automobiles mainly trucks with a minimum of 120ppm to a maximum of 855ppm.

Some factors that contribute and affect the final outcome of the measurement from different anthropogenic sources include: the carbon monoxide detector was handheld which preferably would have been a fixed monitor, the battery life of the carbon monoxide detector, The temperature of the environment, the direction of wind, the nature of the environment (either confined or an opened space) and the nature of the source (in terms of age, maintenance and size).

The investigations should be taken over a long period (one year or two years) to determine the emission of carbon monoxide in terms of seasons, temperature and time. It is recommended that Government provide separate transportation routes far from residential areas as well as a time restriction for trucks due to their high level of carbon monoxide emission.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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