

Full Length Research Paper

Investigation of carbon monoxide concentration from anthropogenic sources in Lagos, Nigeria

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The work investigated the carbon monoxide (CO) concentration from anthropogenic sources in eight, different Local Council Development Authority (LCDA) in Lagos State Nigeria. The CO concentration obtained as a result of movement of cars, trucks, motorcycles, working of generators, commercial and residential activities etc., was measured using the digital carbon monoxide detector (model: DC01001) manufactured by General Tools and Instrument, New York. It was found that trucks emitted highest concentration of CO (289.64 ppm) followed by generator operated on diesel (116.23 ppm) while cooking with firewood emitted the lowest concentration of CO (5.75 ppm). Carbon monoxide concentration from residential and commercial areas, are moderate and considered safe for those in the area. On the other hand CO concentration from trucks is very high based on the US air quality index (AQI) and therefore considered unhealthy for the people. It is obvious from this study that CO concentration is generally associated with the use of fossil fuel which suggest that the less we rely on fossil fuel, the more healthy the environment.

Key words: Carbon monoxide, concentration, anthropogenic, fossil fuel, environment.

INTRODUCTION

There has been growing concern about environmental pollution problem all over the world. The people well-being is solely the mirror of a healthy environment. Air pollution can be defined as the release of substances into the air, some of which can cause problems for humans, plants, and animals. These include dust, gases, smog, acid rain, the greenhouse effect, and depletion in the ozone layer. Each of these problems has serious implications for our health and well-being as well as for the whole environment. The air pollution emanating from the anthropogenic sources has been reported to have damaging effects on the health of the exposed populace (Erhabor et al., 1992; Wanner, 1990) and in cases of extreme events, it can cause increased death rate among the exposed group.

The sources of air pollution can be grouped into 2: sources and man-made (anthropogenic) sources. Natural processes that affect air quality include volcanoes, which produce sulfur, chlorine, and ash particulates. Wildfires produce smoke and carbon monoxide. Cattle and other animals emit methane as part of their digestive process. Many forms of air pollution are man-made. Industrial plants, power plants and vehicles with internal combustion engines produce nitrogen oxides, VOCs, carbon monoxide, sulfur dioxide and particulates. In most mega cities, vehicles are the main source of these pollutants. Stoves, incinerators, and farmers burning their crop waste produce carbon monoxide, carbon dioxide, as well as particulates in rural areas. Other man-made sources include aerosol sprays and leaking refrigerators

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as well as fumes from paint, varnish, and other solvents (USEPA, 2009). Pollutants can cause respiratory disease, acute intoxication and adverse reactions in sensitive people. Symptoms such as breathing difficulties, eye irritation, skin rashes and intestinal upsets appear immediately after exposure. Other chronic effects occur only after long exposures. These are often difficult to predict, and are caused by the slow build-up of chemicals in the body or the gradual accumulation that damages the human tissues. One of the major pollutants that humans are exposed to is Carbon monoxide (CO). It is a colorless, odorless, non-irritant and tasteless poisonous gas. It is slightly lighter than air. It is highly toxic to humans and animals at high concentrations. The gas consists of one carbon atom and one oxygen atom connected by a triple bond which consists of two covalent bonds as well as one dative covalent bond. Carbon monoxide is formed when there is not enough oxygen to produce carbon dioxide (CO₂), such as when operating a stove or an internal combustion engine in an enclosed space. In the presence of oxygen, carbon monoxide burns with a blue flame, producing carbon dioxide. Carbon monoxide is produced by the incomplete combustion of solid, liquid or gaseous fuels. Appliances fueled with gas, oil, kerosene, wood or coal used in boilers, engines, oil burners, gas fires, water heaters, solid fuel appliances and open fires may produce CO. All fuel burning appliances have the potential to produce CO in varying concentrations. Biologically, Carbon monoxide poisoning is the most common type of fatal air poisoning in many countries (Walker and Hay, 1999). It combines with hemoglobin to produce carboxyhemoglobin (COHb) which is ineffective for delivering oxygen to bodily tissues termed anoxemia (Fairburn et al., 1992; Omaye, 2002). It is easily absorbed through the lungs (Ernst and Zibrak, 1998). Inhaling even relatively small amounts of the gas by humans can lead to hypoxic injury, neurological damage, and even death.

Different people and populations may have a different carbon monoxide tolerance level (Thom et al., 2000). On average, exposures at 100 ppm or greater is dangerous to human health (Chichkova and Prockop, 2007). Carbon monoxide exposure may lead to a significantly shorter life span due to heart damage (Henry et al., 2006). The carbon monoxide tolerance level for any person is altered by several factors, including activity level, rate of ventilation, a pre-existing cerebral or cardiovascular disease, cardiac output, anemia, sickle cell disease and other hematological disorders (Lipman, 2006). Symptoms such as delirium and hallucinations have led people suffering poisoning to think they have seen ghosts or to believe their house is haunted (Donnay, 2004). Carbon monoxide poisoning in pregnant women may cause severe adverse fetal effects.

Based on the different contamination due to emission from both natural and man-made sources, it is therefore important to have knowledge of the air quality in a particular environment. Air quality is an indication of the healthfulness of the air based on the quantity of polluting

gases and particulates (liquid droplets or tiny solid particles suspended in air) it contains. Air is considered safe when it contains no harmful chemicals and only low levels of other chemicals that become harmful in higher concentrations to humans, animals, plants, or the ecosystems (Encarta, 2009). The aim of this work is to investigate the CO concentration in the selected LCDA in Lagos State.

MATERIALS AND METHODS

The CO concentration was detected and measured with the aid of a digital carbon monoxide detector (model: DC01001) manufactured by general tools and Instrument, New York. The equipment is designed for CO detection in the range of 0 and 999 ppm, with 1 ppm resolution and accuracy of $\pm 20\%$ at 0 to 100 ppm; $\pm 15\%$ at 100 to 500 ppm; (at $20 \pm 5^\circ\text{C}$, $50 \pm 20\%$ RH). Eight (8) different local council development authority (LCDA) in Lagos, Nigeria were selected for the study. The choice of the location was based on the accessibility, activities peculiar to the location and congestion in the areas. Lagos was chosen because of its status as the economic capital of Nigeria that houses a lot of central business districts. The investigated areas are Ikeja, Festac, Ikoyi, Gbagada, Apapa, Kosofe, Surelere and Isolo which can be grouped into industrial area, commercial and residential areas according to the activities predominant in such vicinity. 5 different measurements were taken for 2 h in each location in 1 LCDA and average values were taken. The CO concentration from cars, trucks, motor cycles, petrol generators, diesel generators and household kitchens and firewood cooking areas were considered in each location the same numbers of point source were considered.

RESULTS AND DISCUSSION

Figure 1 displays the mean values of the CO concentrations emitted as a result of car movements in each LCDA over a period of 2 h. The highest CO concentration was obtained in Kosofe (76.7 ppm) which can be traceable to the fact that there is high vehicular movement in this area since this is where Ojota is located. The lowest CO concentration was obtained in Isolo (32.5 ppm) this may be associated with low vehicular movement in the area during this period. According to the US AQI limit, it is only Isolo that has good healthy concern as related to CO concentration while all other locations considered can be said to have moderate healthy concern to CO concentration. Figure 2 presents the mean values of CO concentrations from motorcycles and generators that are operated with petrol and diesel. The results showed that generators operated with diesel emit more carbon monoxide than those operated with petrol. The highest CO concentration (117.36 ppm) in this group was obtained from generator operated with diesel. It was also observed that though the locations are different there is no significant difference between the CO emitted from the same set of equipment considered elsewhere. There is also no significant difference between the CO values obtained in petrol generators and motorcycles in all the locations considered. This may be because the 2

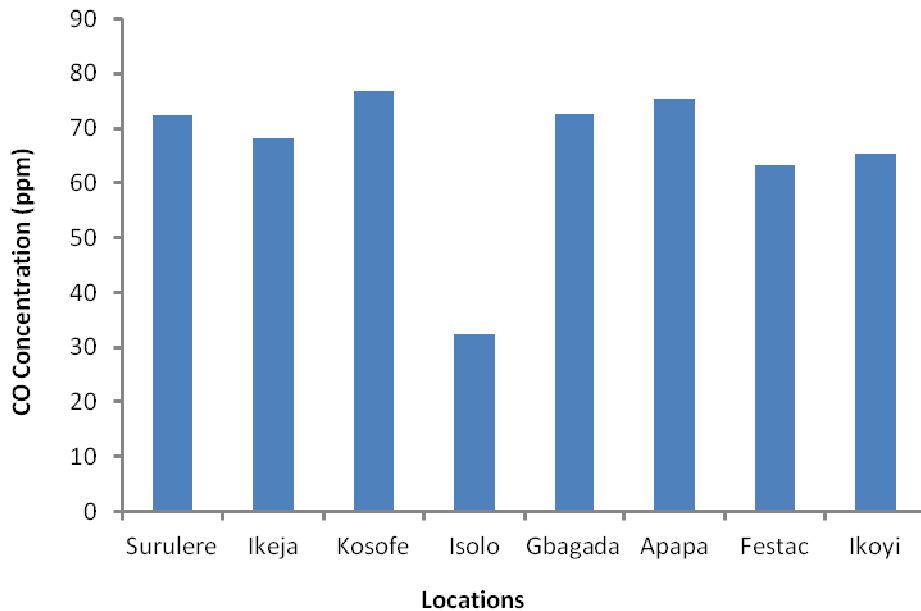


Figure 1. Mean Values of CO concentration from cars.

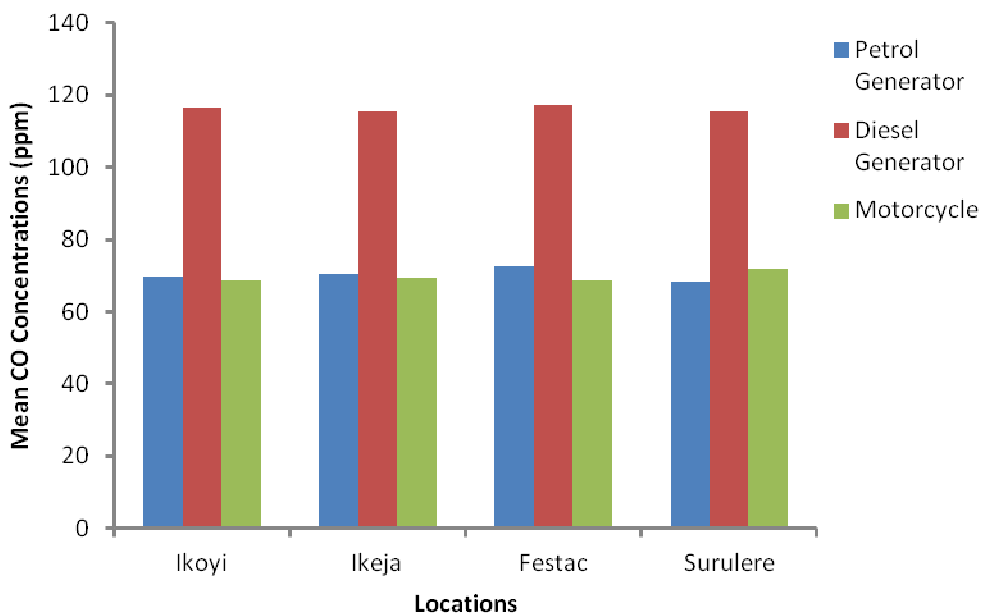


Figure 2. Mean CO Concentrations from Generators (Petrol and Diesel) and Motorcycles

equipments used petrol. Motorcycle and generator operated with petrol can be categorized as moderate healthy concern with CO concentration while those with diesel can be said to be unhealthy for sensitive people based on the US AQI limit.

Figure 3 is a bar chart representing the mean values of carbon monoxide concentration from different sources in the environment. It is observed that carbon monoxide concentration from commercial areas, residential areas

and firewood cooking are relatively small compared to equipment operating on fossil fuels (that is, petrol generators, diesel generators, cars, motorcycles and trucks). This study revealed that trucks produce the highest carbon monoxide (289.64 ppm) in comparison to the other sources. The reason may be due to the type of combustion taking place in their engine as well as the fuel used (diesel). It is also observed that all equipment operated on diesel (generator and truck) emit more CO

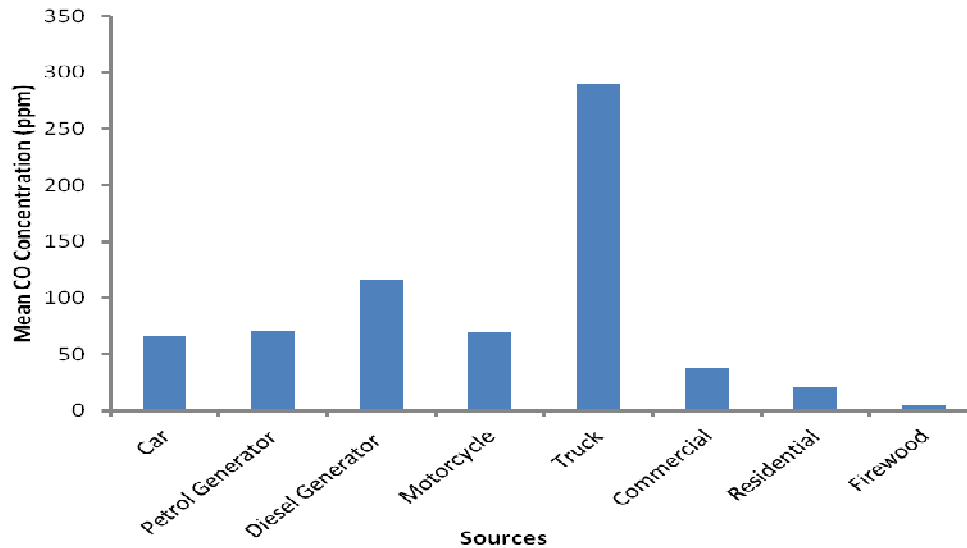


Figure 3. Variation of mean CO concentrations from all sources.

than those operated on petrol which therefore suggest that diesel combustion engine is a higher emitter of carbon monoxide than petrol. The CO concentration from the commercial area (38.17 ppm) is moderate and is within the specified healthy limit, though high when compared with that from domestic sources. This is due to many commercial activities (markets, grinding pepper, smoking, driving, wood burning, welding etc) taking place at that particular time. The source of CO from the residential area is majorly the kitchen using cooker, fridge and some household appliances. It was observed that the CO concentration from this group is within the healthy limit as it is low compared to concentration from commercial area. The CO concentration was also observed to be activity dependent, that is, it depends on what is going on in the area and does not vary with location but with what is released into the atmosphere from the different activities going on in the designated location. The area where firewood is used has the lowest CO concentration (5.75 ppm) than any other sources considered. This is because there is availability of abundant air (oxygen) for complete combustion with firewood thereby eliminating the production of carbon monoxide; a product of incomplete combustion. Chichkova and Prockop (2007) suggested that exposures to CO concentration at 100 ppm or greater are very dangerous to human health. Therefore, concentration of carbon monoxide from diesel engine and truck may be considered unhealthy to human beings and should be avoided.

CONCLUSION AND RECOMMENDATION

It has been established from this study that concentration of carbon monoxide can be obtained from anthropogenic sources. It was revealed that the equipment operated on

diesel has highest concentration of carbon monoxide, followed by those operated on petrol. The major source of CO concentration observed from sources considered was from trucks and generators. It is obvious from this study that CO concentration is generally associated with the use of fossil fuel which suggests that the less we rely on fossil fuel, the more healthy the environment. The study also revealed that the more the activities in an area the higher the CO concentration from such location. Based on the results of this study, we are recommending that Government should make policy that restrict the time of movement (whether night or early in the morning) for trucks due to their high level of carbon monoxide concentration.

There is need for the government to encourage the exploitation of other sources of energy that are renewable in place of fossil fuel.

There should be frequent seminars and conferences on carbon monoxide for proper awareness of risks associated with it. It is good if each house (powered by generator) to have carbon detectors that will trigger an alarm when the CO safe limit is exceeded and the generator house should also be well ventilated.

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