Gasoline Generators and their Effects on Air Quality of Some Selected Business Centers in Tertiary Institutions in Rivers State

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Abstract:
This study considered gasoline generators and their effects on air quality of some selected business centers in tertiary institutions in Rivers State. Air quality monitor was positioned 1.5m above the floor to determine the concentration levels of CO, CO_2 and O_2. The measurements were done on a daily for a period of three weeks. At FCE (T), Omoku, the mean concentration values of CO for Business and Institution's generators were 109.2ppm and 62.3ppm; CO_2 283.6ppm and 27.4ppm and O_2 185.8% and 192.1% respectively. At IAUE, Port-Harcourt, CO for Business and Institution's generators had mean concentration values of 144.7ppm and 89.6ppm; CO_2 210.9 ppm and 188.8ppm, and for O_2, 225.4% and 239.2% respectively. Similarly, for RSU, Port-Harcourt, the mean concentration of CO for Business and Institution's generators were 144.8ppm and 84.5ppm; CO_2 171.1ppm and 124.ppm; and for O_2, 196.8% and 164.3%. respectively. CEAP, Port-Harcourt, CO had mean concentration values of 215.3ppm and light 92.2ppm, CO_2 226.2ppm and 109.2ppm, whileO_2 mean concentration values of 120.1% and 198.2% respectively. The concentration levels of CO, CO_2 for business generators were much higher compared to when Institutions' generators were used. The mean values of CO concentrations for the selected institutions for the period under study were higher than OSHA permissible exposure limit (PEL) of 50ppm (55mg/m^3), NIOSH recommended exposure limit (REL) of 35ppm (40 mg/m^3) and ACGIH threshold limit value (TLV) of 25ppm (28.6mg/m^3), while that of CO_2 concentration levels were less than OSHA's established permissible limit of 5000ppm, and American Conference of Governmental Industrial Hygienists(ACGIH) threshold limit value (TLV) of 25ppm. It was also observed that as the concentrations of CO and CO_2 increase, the O_2 levels also decrease. It is therefore, very important to state that tertiary institutions' managements in Nigeria should consider the provision of regular power supply on our campuses in order to discourage the use of gasoline generators by business owners and by so doing, the effects of environmental pollution associated with gasoline generators will be drastically curtailed.

Keywords: *Gasoline generator, Effects, Air Quality, Business Centers*

Introduction

One major contributory factor to poor air quality in Africa and Nigeria in particular, is the use of gasoline generators. Air pollution, basically, emanates from the combustion of fossil fuels which releases harmful by-products into the Earth's atmosphere (Boston University School of Public Health, 2017). Over the years, due to the lack of stable power supply, business centers, organizations, individual homes, and government institutions have resorted to the use of gasoline generators as an alternative source of power supply. Akindele & Oyinlade (2017) reported that more than six million Nigerians make use of fossil fuel generating sets and in a year, spent about ₦1.56 trillion ($13.35 Million) to fuel them. Findings from a study conducted by Ahmed et al. (2020), using the World Bank enterprise surveys data for 14 countries in Africa revealed that firms that did not own a generator were more negatively affected in sales due to the irregular nature of their power supply. No doubt, the use of these generators has contributed immensely to the growth and profits of these organizations, but not without any attendant effect on the air quality of the business environment. Gasoline is a product of petroleum refined in variable composition, primarily used as fuel in generators. Some of the by-products of hydrocarbon combustion include oxides of nitrogen (NO_x), carbon (ii) oxide (CO), black carbon (BC), some nitrate species, and other chemical constituents in gaseous and particle phases (IARC Working Group on the Evaluation of Carcinogenic Risks to Humans, 2014). These hydrocarbon by-products find their way into the surrounding air, leading to a decrease in air quality of the environment. Olivier and Peters (2020), reported that the 2% global increase in green house gases emissions in 2018 were significantly from combustion of fossil-fuel, including the ones generated by industrial activities.

Effects of Gasoline Generator's Fume

Ezetoha et al. (2020) pointed out some harmful effects of the exhaust emissions on humans to include "cancer, respiratory tract infection, carbon monoxide poisoning, fatigue, headache, bleeding, depression, and lowered immune system". A study conducted by Oguntoke and Adeyemi (2016) revealed that the percentage of persons who suffered from frequent exposure to emissions from fossil-fuel combustion for electricity generation in Abeokuta Metropolis to include "nasal congestion (66%), cough (33%), headache (24%) and fever (12%)". Some constituents of exhaust emissions are major contributors to global warming, especially carbon dioxide, methane, nitrous oxides and black carbon. Shahzad (2015) posited that some of the outgoing radiations are absorbed by carbon dioxide and other gases which is responsible for an increase in the surface temperature of the Earth. Mohajan (2019) stated that acid rain is considered as one of the most dangerous factors of local pollution.

Carbon Monoxide

The presence of high concentration of carbon monoxide in the body can cause oxygen starvation due to its displacement by carbon monoxide. Carbon monoxide has greater affinity for haemoglobin than oxygen by 210 times (Blumenthal, 2001). Breathing air contaminated with a high level of CO can lead to reduction in the amount of oxygenated blood needed for the proper functioning of important organs like the heart and brain and persons with some type of heart

diseases are likely to suffer more (USEPA, 2022). "The toxicity of carbon monoxide is due to its ability to bind with hemoglobin to form COHb"(Higgins 2014).

Retention of CO_2 in the body is known as hypercapnia or hypercarbia and can result to respiratory acidosis when its concentration level is elevated (Patel et al, 2002). Experimental studies have shown that short-term exposure of humans to CO_2 concentration from 1000 ppm affects cognitive ability, decision making and problem solving (Azuma et al., 2018). Azuma et al. (2018) reported that of recent, studies have shown that CO_2 has direct impacts on human physiology at levels commonly found in indoor environments. Additionally, symptoms such as fatigue and drowsiness caused directly by CO_2 have been demonstrated by the use of Electro encephalogram (EEC) techniques (Snow et al., 2018).

Oxygen is an important element for the survival of humans (National Center for Biotechnology Information, 2022). It should be noted that if 100 percent oxygen is inhaled, could lead to irritation of the lung, nausea, dizziness, pneumonia, pulmonary edema, and collapse (Cameo Chemical, n.d). Oxygen, in liquid state, has a pale blue colour which becomes solid at -218°c (-36 °F), and in its pure form, oxygen is 1.1 times heavier than air. Oxygen is said to be "the most abundant element in the Earth's crust, at 461,000 ppm" and accounts for about 46% of the Earth's crust (Dodd, 2020 November 5). Oxygen's participation either in reactions with other elements or displacement of other elements from their compounds usually involves the production of heat and light, which is commonly referred to as combustion (Brasted, 2017 November 3). Oxygen has a number of uses such as synthesis gas, especially from coal, "resuscitation and an inhalant"(National Center for Biotechnology Information, 2022). Individuals with with good health, the normal oxygen saturation level is between 95% 100%, but persons with chronic lung conditions may have a reading below 95% (Harris et al, 2022).

Air Quality

The National Oceanic and Atmospheric Administration (NOAA, 2022) defines air quality as "a measure of how clean or polluted the air is". It is measured with the aid of air quality index (AQI) (NOAA, 2022). Clean air is considered to be the basic requirement for human health and well-being (World Health Organization (WHO), 2005). This is also supported by by T N Department of Health (n.d), that the number of persons suffering from diseases like asthma, stroke, lung cancer, chronic and acute respiratory problems can be drastically reduced by breathing clean air. Air quality monitoring is very crucial to the society because the data collected helps us to determine areas meeting the air quality standards and to ascertain if pollution control programmes devised in a locality are working efficiently or not (Chawre, n.d).

Permissible Limits for CO & CO_2

Carbon Monoxide: The permissible exposure limit(PEL) for CO concentration as established by the Occupational Safety and Health Administration (OSHA, 2015) for an eight-hour time - weighted average (TWA) is 50ppm or 55mglm^3.Similarly, the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) of an 8-hour TWA for CO is 35ppm(40 mg/m3 (Center for Disease Control and Prevention (CDC, 2019). The threshold limit value (TLV) of 25ppm or 28.6mg/m^3 for eight hours was established for CO by

the the American conference of Governmental Industrial Hygienists(ACGIH) (Schenck, 2015).
Carbon Dioxide Concentration: High carbon dioxide concentration reduces the ability of humans to transfer oxygen, carbon dioxide concentration should be maintained below 10mgl. However, the concentration of carbon dioxide in earth's atmosphere is currently rising since the beginning of the industrial age. OSHA (2015) puts permissible exposure limit for carbon dioxide (CO_2) at 5,000 part per million (ppm).

Materials and Method
Materials employed in this study include air quality meter with probes, global positioning system (GPS) and measuring tape. Figure 1.1 is the picture of the air quality meter.

Figure 1.1 : Air Quality Meter

Study Area: This study was carried out in four selected tertiary institutions in Rivers State, which include Federal College of Education Technical (FCE (T) Omoku, Iganitus Ajuru University of Education (IAUE), Port Harcourt, Rivers State University (RSU) Port Harcourt and Captain Elechi Amadi Polytechnic (CEAP, Port Harcourt. The geographical coordinate of Rivers State are 4.8396^o North and 6.9112^o East and has an elevation of 16 meters above sea level.
Rivers State is located in the Niger Delta region of Nigeria. The State was created in 1967, Rivers State is bordered by the following States: Imo to the North, Abia and Akwa Ibom to the East, and Bayelsa and Delta to the West. Port-Harcourt city is the State capital of Rivers State and the oil and gas capital of Nigeria. The last census of 2006 put Rivers State population at 5,198,761

Rivers State has a tropical climate mean temperature of 26°C (78.8°F) and mean rainfall of 2000mm. The area falls within the sub-equatorial climate belt and is marked by two distinct seasons, wet and dry season with 80% of annual rainfall between March to November and its dry season last from December to March. The state has the principal occupation of fishing and farming with a large deposit of crude oil and natural gas.

Method

The concentration levels of the gases (CO, CO_2 and O_2), relative humidity, and temperature of the selected business centers were measured by positioning the air quality meter 1.5m above the ground. The measurements were taken 30 minutes interval for one hour daily and lasted for three weeks.

Results and Discussion

Results

Table 1.1 is the global positions of the selected tertiary institutions for the study.

Table 1.1: The Global Positions of the Selected Tertiary Institutions.

LOCATION	NORTH	EAST
FCE (T), OMOKU	4°28′3″	6°40′1″
I.A.U.E, Port-Harcourt	4°48′16″	6°56′14″
RSU, Port Harcourt	4°47′30″	6°58′56″
C E A P, Port Harcourt	4°48′23″	6°55′54″

Figures 1.2, 1.3, 1.4, and 1.5 are bar charts showing the mean concentration levels of CO, CO_2 and O_2 when business generators (i.e bars with blue colour) and that of the institutions' generators (bars with dark red colour) were in use while figures .1.6 and 1.7 are plots of relative humidity and temperature of the selected business environment when business and the institutions' gasoline generators were in use.

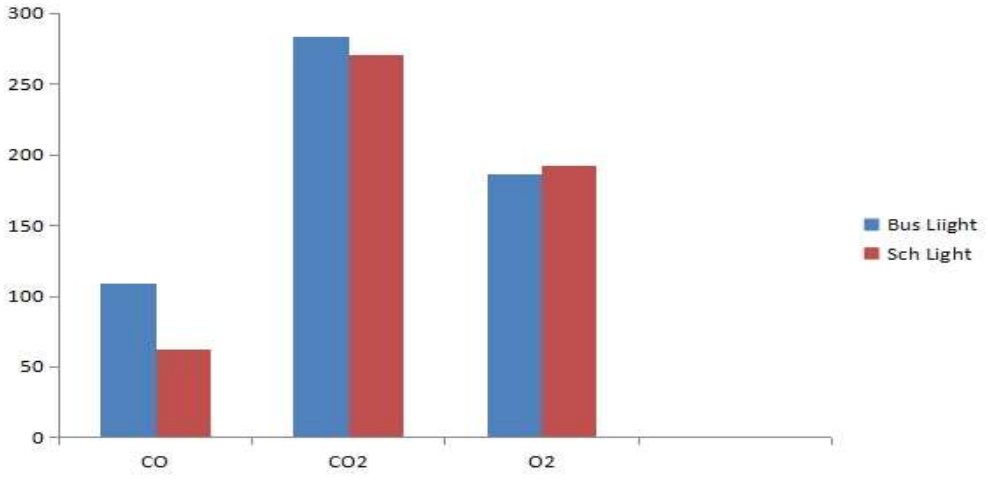

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Figure 1.2: Bar Chart of CO, CO_2 and O_2 concentration levels for FCE (T) , Omoku

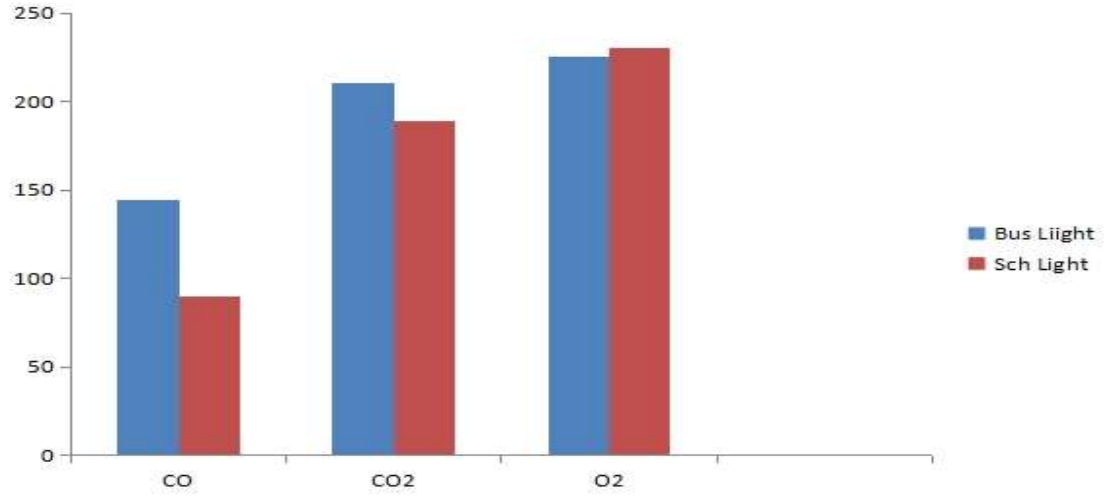

Figure 1.3: Bar Chart of CO, CO_2 and O_2 Concentration level for Ignatius Ajuru University of Education, Port-Harcourt

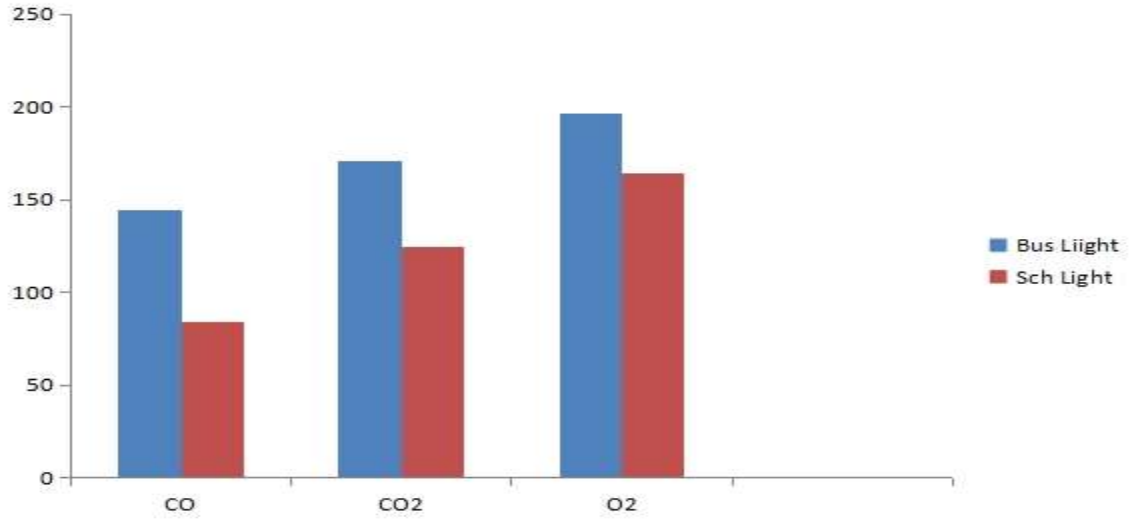

Figure 1.4: Bar Chart of CO, CO_2 and O_2 concentration levels for Rivers State University, Port-Harcourt.

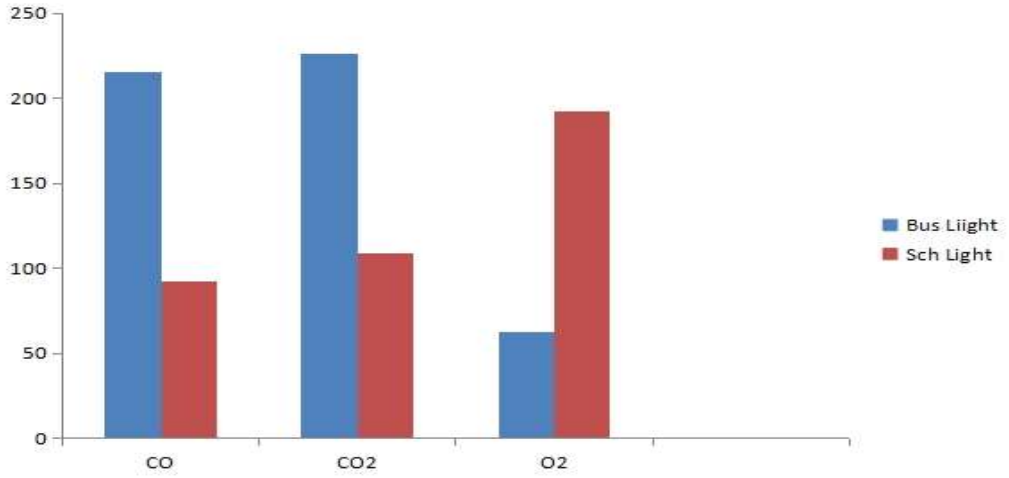

Fig 1.5: Bar Chart of CO, CO_2 and O_2 concentration level for Captain Elechi Amadi Polytechnic, Port-Harcourt.

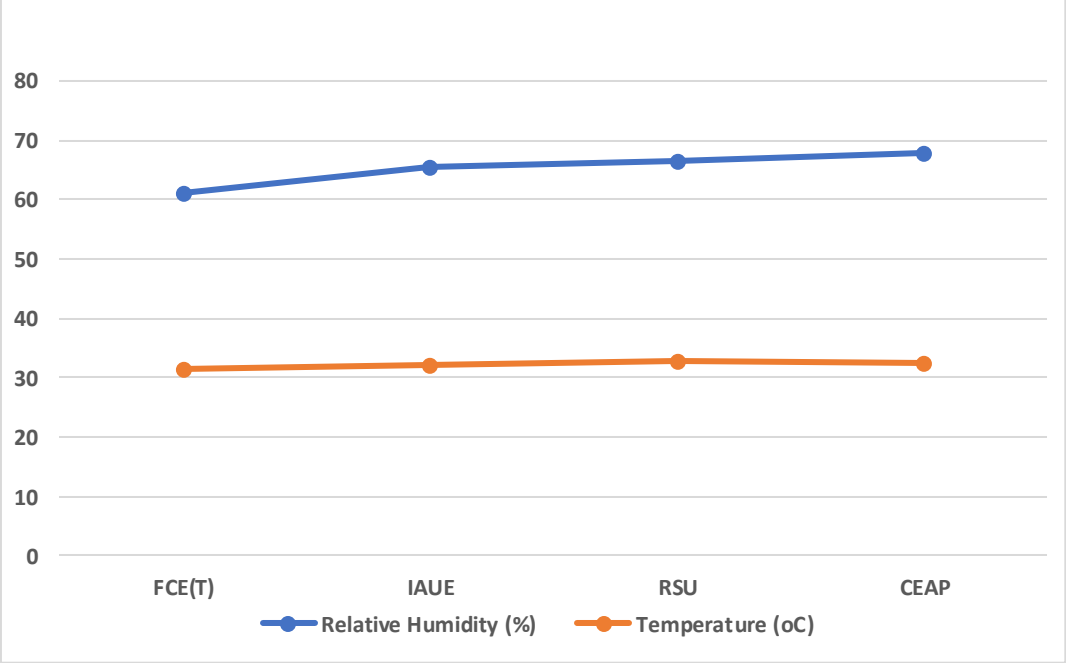

Figure 1.6: A Plot of Relative Humidity and Temperature for Business Gasoline Generators

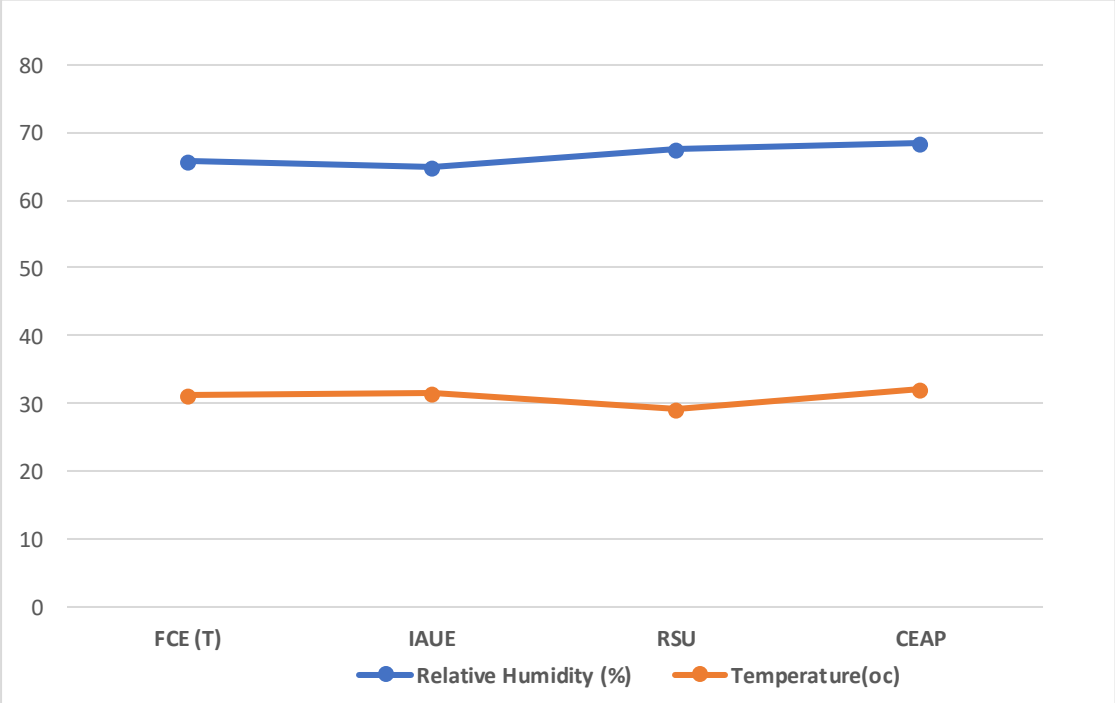

Figure 1.7: A Plot of Relative Humidity and Temperature for the School Light

Discussion

In figure 1.2, the concentration levels of CO for business gasoline generators and the institutions' generators are 109.2ppm and 62.3ppm while that of CO_2 for business gasoline generators and the institution's generator are 283.6ppm and 270.4ppm. Equally the concentration levels of O_2 for business and the institutions' generators are 185.8% and 192.1% respectively.

In figure 1.3, the concentration levels of CO for business and the institutions' generators are 144.7ppm and 89.6ppm while the concentration levels of CO_2 are 210.9ppm and 188.8ppm respectively. More so, the concentration levels of O_2 for business and the institutions' generators are 225.4% and 230.2%.

The concentration levels of CO for business and the institutions' generators in figure 1.4 are 144.8ppm and 84.5ppm while are that of CO_2 for business and the institutions' generators are 171.1ppm and 124.3ppm respectively. Similarly, the concentration levels of O_2 for business and the institutions' generators are 196.8% and 164.3%.

In figure 1.5, the concentration levels of CO for business and the institutions' generators are 215.3ppm and 92.2ppm while that of CO_2 for business and the institutions' generators are 226.2ppm and 109.2ppm respectively. The concentration levels of O_2 for business and the institutions' generators are 63.1% and 68.2%.

Finally, in figures 1.6 and 1.7, the mean values of relative humidity and temperature of the selected institutions for when business and the institutions' generators were in use for the under study, were fairly constant. This shows that there weren't much changes in the measured atmospheric variable of the selected locations.

Conclusion

The concentration levels of CO, CO_2 in ppm for business generators at FCE (T) Omoku, IAUE, Port Harcourt, RSU, Port Harcourt and CEAP, Port Harcourt for the period under study were much higher compare to when school generators were used.

The mean values of CO concentrations for the selected institutions for the period under study were higher than OSHA, NIOSH and ACGIH PEL, TLV and REL respectively, while CO_2 concentrations for the selected institutions were less than 5000ppm OSHA's established limit. It was also observed that as the concentrations of CO and CO_2 increase, the O_2 levels also decrease. It is therefore, very important to state that tertiary institutions' managements in Nigeria should consider the provision of regular power supply on our campuses in order to discourage the use of gasoline generators by business owners and by so doing, the effects of environmental pollution associated with gasoline generators will be drastically curtailed.

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