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Research Article
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Heavy metals analysis present in lamp black in two major sites of Port-Harcourt Polytechnic Rumuola Port-Harcourt

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ABSTRACT

Port Harcourt is a major city in south-south geopolitical zone in Nigeria that experienced a black soot deposition in the environment. The city experienced a coverage of black soots on cars, clothes, houses, plants, etc. Soot concentration continued to increase until the first quarter of 2017. After much public hazards, the frequency and concentration of soot deposition began to decline. It has been shown that these soot contains heavy metals which are toxic to human as a result of long term or high level exposure to pollutant common in environment including air, water, food and numerous consumer products. In this study, we assessed the levels of toxic metals in soot sample. The soot samples were taken from two different locations in Port Harcourt Polytechnic Rumuola, Port Harcourt. The soot were analyzed for heavy metals (Lead, Arsenic and Mercury). The concentrations of the selected toxic heavy metals were determined in duplicate using aflame atomic absorption spectrophotometer. The samples analyzed contained a detectable amount of the metals of interest. The concentration levels found in the soot sample from the classroom and business centre respectively were as follows; Pb, 0.864/0.01 1mg/kg; As, 0.0623/0.0400mg/kg and Hg, 0.0762/0.0001mg/kg. It is obvious from the present study that the classroom soot is high and continuous exposure to these toxic heavy metals can constitute potential health risk to humans since it has been known that heavy metals can accumulate in the biological system over time and are known to induce skin problems or diseases such as cancer.

Keyword: Soot, Port-Harcourt, Heavy metals, Niger-Delta, Polytechnic

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INTRODUCTION

Soot is a mass of impure carbon particles resulting from the incomplete combustion of hydrocarbons, Omidvarborna et al. (2015). It is more properly restricted to the product of the gas phase combustion process but is commonly extended to include the rfuel particles such as coal,, charred wood and petroleum coke that may become airborne during pyrolysis and that more properly identified as cokes or char.

Wikimedia commons;(2015), Soot sometimes called lampblack or carbon black, is a fine back or brown powder that can be slightly sticky and is a product of incomplete combustion. A major component of soot is black carbon which absorbs more light than any other form of particulate matter. Since soot is sticky, it tends to stick to exhaust pipes and chimneys where the combustion occurs, Wisegreek,(2015). In pollution terms, soot is the common

term for a type of particle pollution known as Pm 2.5 which is particulate matter 2.5 micrometre in old diameter or smaller. Soot is composed of a variety of chemicals and its exact composition depends strongly on what is being burned.

Soot is a type of air pollution, which comprises a variety of other pollutant like chemical acids, metals and dust particles. By its nature, it can take the form of a solid, liquid or gaseous state (Seinfeld et al; 2018). Over the years, soot has been classified as a threat to public health due to the heavy metals found in it such as Arsenic, lead, Mercury which are carcinogenic (Kalagbor et al., 2019). It is very possible for these soot to be contaminated with heavy metals that can cause morphological abnormalities, reduced growth cancer and increase in mortality rate. These heavy metals; Lead, Arsenic and Mercury have not been considered available in soot as a result of their environmental impact (diseases) for both biotic and abiotic factors. Hence, the determination of Lead, Arsenic and Mercury in soot present in business centre and classroom in Captain Elechi Amadi Polytechnic uses analytical method to determine the concentration of these three heavy metals in soot and their implication.

The importance of soot cannot be overemphasized. Although it is a harmful by-product of combustion which is used as a raw material for production of inks and dyes. Hence the study or research was intended to ascertain or analyze some heavy metals present in soot. Secondly to carry out investigation or research on the environmental impact of soot. Ekpette and Maduawuchi, (2022) in a study titled "Analysis of trend and emergent factors of artisan refining in the Niger Delta region of Nigeria: recently discovered form of air pollution in Rumuolumeni due to illegal refiners and burning of tyres the study reveals that the public health problems among Rumuolumeni resident increased from 32% - 66% of cancer patients.

Niranjan and Thakur; (2017) in a study titled "The toxicological mechanisms of environmental soot (black carbon) and carbon black" focused on oxidation stressed and inflammatory path ways" established that soot apart from being carcinogenic in nature, can also lead to multiple diseases to man. Ana et al. (2009) in their study "Environmental risk factors and health outcomes in selected communities of the Niger Delta Area Nigeria": reveal that there is an increase in lung cancers in Port Harcourt residence and that this is due to the residents' exposure to atmospheric contamination. Whyte et al.(2020) in a survey of the resident perception of the effects of pollution in Rivers State Nigeria, equally confirmed that residents are not just aware of the soot problem, but they claim that soot is the main cause of chronic cough; eye, noise, throat and skin irritation. Soot is a by-product of burning fossil fuels, particularly coal, it is released into the air as either extremely small particles or liquid droplets. It is emitted by a variety of sources, including: burning coal for electricity or industrial fuel. Manufacturing, oil refining, motor vehicles, burning of sundry wastes. Bush burning can also be a source of soot in our environment according to Adiele et al. (2015), Nrior et al. (2017).

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MATERIALS AND METHODS

Apparatus and equipment

- Beakers and flasks
- Atomic absorption spectrophotometer
- Test tubes
- Measuring cylinder
- Acetone solvent/ethanol
- Pipettes (microliter with disposable tips)
- Volumetric flask of suitable precision and accuracy

Reagents

- Air
- Acetylene
- Nitrogen dioxide gas
- Metal free water
- Stock metal solution
- Aluminium nitrate solution
- Hydrogen tetraoxosulphate (vi) acid (H_2SO_4)
- Trioxonite (v) acide (HNO_3)
- Prechloric acid ($HC1O_4$)

ATOMIC ABSORPTION SPECTROPHOTOMETER (AAS)

The technique was introduced in 1955 by Walsh in Austria and by Alkemade and Milatz in Holland. The first commercial atomic absorption spectrophotometer was introduced in 1959 and it grew explosively. Skoog, (2007) Atomic Absorption Spectroscopy can be simply defined as the absorption of radiant energy by atoms. The production of atoms from a chemical compound requires the absorption of energy; the energy is usually supplied in form of heat from a flame. The compound introduced into flame after vaporization is partially or wholly dissociated into its elements in a gaseous form and some of these atoms absorb radiant energy of a characteristic wavelength and become excited to a higher energy state. Atomic absorption spectroscopy makes use of the fact that free atoms of an element absorbs light at wavelength characteristic of that element and determined by its outer electronic structure. It has high specificity making it possible for elements to be determined in the presence of each other. The extent of absorption is the measure of the number of atoms in the light path. Figure 1.2 below illustrates the schematic diagram or sequence through which atomic absorption spectroscopy operates (Figure 1).

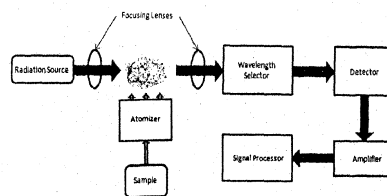


Figure 1: Atomic Absorption Spectroscopy

Operation or Procedure

Because of difference among makes and models of AASs, it is not possible to formulate instructions applicable to every instrument. Follow the manufacturer's instructions, but in general proceed as follows:

- Install hollow cathode lamp for the desired metals.
- Set wavelength dial as specified by the analytical methodology.
- Set slit width according to manufacturer's suggested setting.
- Turn on instrument, apply the hollow cathodes lamp current suggested by the manufacturer, and let the instrument warm up until energy sources stabilizes, usually about 10 to 20 minutes.
- Readjust current if necessary after warm-up. Adjust wavelength dial until optimum energy gain is obtained.
- Align lamp in accordance with manufacturer's instructions.
- Install suitable burner head and adjust its position. A 10cm, single — slot burner head is recommended for air — acetylene flames.
- Turn on air, and adjust flow rate according to manufacturer's instructions to give maximum sensitivity for the metal been measured.
- Turn on acetylene and adjust flow rate to value specified.
- Ignite flame and let it be stabilize for few minutes
- Aspirate a standard solution and adjust aspiration rate of nebulizer to obtain maximum sensitivity
- Adjust burner both vertically and horizontally to obtain maximum response.
- Aspirate blank again and re-zero instrument.
- Aspirate a standard with a concentration near the middle of the linear range and record absorbance.
- The instrument is not ready to operate.
- When analysis are finished, extinguish flame by turning off acetylene first and then air.

RESULTS AND DISCUSSION

The determination of heavy metal concentration in soot is important to know, because of the public health implications. The results of lead (Pb) in soot sample from Atomic Absorption Spectrophotometer determination showed a concentration of 0.86mg/kg for classroom and 0.011mg/kg for business centre. The concentration of Arsenic (As) in both soot samples were found to be 0.0623 and 0.0400mg/kg for both the classroom and business centre soot respectively. The results of Mercury (Hg) indicated a value of 0.0762mg/kg and 0.0001mg/kg for both classroom and business centre soot respectively as seen as in the (table 1 and 2).

The presence of heavy metals as trace metals are components of human living system although results reveals that the quantity of Lead (Pb) in classroom is high when compared to that of business centre as shown in the

Table 1: Concentration of the three Heavy Metal in soot found in classrooms and Business Centre.

Heavy Metals	Soot (mg/kg) concentration	
	Classroom	Business centre
Lead (Pb)	0.864mg/kg	0.011mg/kg
Arsenic (As)	0.0623mg/kg	0.0400mg/kg
Mercury (Hg)	0.0762mg/kg	0.0001mg/kg

Table 2: Percentage composition of the three heavy metal in soot (classrooms and business centre)

Heavy metals	Percentage of heavy metal in soot			
	Classroom soot (mg/kg)	Percentage (%)	Business centre (mg/kg)	Percentage (%)
Lead (Pb)	0.864mg/kg	86.18	0.011mg/kg	21.53
Arsenic, (As)	0.0623mg/kg	6.21	0.0400mg/kg	78.28
Mercury (Hg)	0.0762mg/kg	7.60	0.0001mg/kg	0.20
Total	1.0025	100	0.0511	100

table likewise that of Arsenic (As) and Mercury (Hg). This could be as a result of accumulation of incomplete combustion in vehicles parked or that are constantly moved around the school premises, it can also be associated to indiscriminate burning of both organic and inorganic substances that may result to the release of carbon(ii)oxide and smoke. Activities are mainly carried out in the school premises than that of the business centre, such activities includes vehicle engine combustions, machines, generators and other heavy equipments used in the school premises, also the illegal and burning of natural resources or crude (gas flaming) around Rumuola and Rumuokwuta axis may also affect the accumulation of soot in the classrooms, since it can be transmitted through the air, also increase the concentration of heavy metals in soots. The heavy metals studied are not quite environmentally friendly because of the hazardous nature. Lead is commonly known for its poisonous nature as its high concentration can result to respiratory problems, anaemia, heart attacks etc, Arsenic and Mercury are also heavy metals that are carcinogenic in high concentrations either in soot or any other substance. Very high concentration of these metals on skin, lungs, nostrils etc can result to skin cancer, lung cancer and also heart attack according Adiele and Edward (2015). The illegal or incomplete combustion of crude can lead to increase in concentration of these heavy metals in our environment which makes it unsafe for our health and habitation according to Andrew and Khalid (2008).

Conclusion

The research carried out indicates that heavy metals were found in the soot present in both class rooms and business center. The Lead concentration in the classroom is very high compared to other metals which are not helpful to human and can cause neurotoxin that accumulates both in tissues and the bones. High concentration of these heavy metals can impose a health risk.

Recommendation

The Nigeria government should work in hand with the oil/mining industries to switch away from diesel fuels or use more efficient, low-emission diesel engines. Stop illegal gas flaring, indiscriminate burning of materials. Reduce or totally eradicate smoky vehicles, stop illegal refining popularly known as Bunkering. Localizations of industries should be without the residential areas.

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