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Comparative Test Analysis of Petroleum (Diesel and Gasoline) Soots as Potential Sources of Toxic Metals from Exhausts of Power Plants

***F. A. Atiku[1], P. O. Ikeh[2], U. Z. Faruk[2], A. U. Itodo[1], A. Abdulhamid[3] and I. I. Rikoto[4]**

[1]*Department of Chemistry, Kebbi State University of Science and Technology, Aliero, Nigeria*
[2]*Department of Pure and Applied Chemistry, Usmanu Danfodiyo University, Sokoto, Nigeria*
[3]*Department of Biochemistry, Kebbi State University of Science and Technology, Aliero, Nigeria*
[4]*Sokoto Energy Research Centre, Usmanu Danfodiyo University, Sokoto, Nigeria*

ABSTRACT

Soot samples from Diesel (D_{1-6}) and Gasoline (G_{1-6}) based engines were investigated for the presence of occluded toxic metals which may fragment or volatilizes into the near atmosphere through air current. AAS analysis revealed that while the Cd^{2+} level in raw Gasoline (Gr) amount to 10.708ppm, over 90% could have volatilized out, leaving an estimated value of 0.932±2.852ppm in the soot. Almost all available Cd^{2+} escaped leaving a non detectable limit as against 3.316ppm in raw diesel. The sources of the estimated lead (Pb) in the soot could not be traced to the original gasoline (Gr =0.00ppm). Other investigated parameters include acidic pH for both samples, High conductivity for diesel soot and fairly high bulk density for Gasoline soot. Generally presumed volatility level of some of these metals in the soot is an indication that fragmented soot could contribute to environmental pollution of heavy metal.

Key words: Soot, Petroleum, Heavy Metals, Exhausts, Diesel and Gasoline.

INTRODUCTION

Hundreds of elements and compounds such as lead, cadmium, chromium, benzene and formaldehyde are known to be emitted during the combustion of fuel in electric power plants, engine of vehicles, furnaces and even fire places. Some compounds are added to liquid fuels for various reasons (such as MTBE, TEL, etc) to rise the octane no of the fuel and also to oxygenate the fuel in winter months to reduce urban smog).The largest source of air pollution is the automobiles and the pollutants released by the automobiles and cars are usually grouped as hydrocarbons (HC), Nitrogen oxides (NOx), carbon monoxide (CO) and heavy metals some of which resulted from additives during petroleum refining and blending.

Metals occur in air in different phases, as solids, gases or absorbed to particles having aerodynamic sizes ranging from below 2.5 mm (fine particles) to 100 mm and larger (coarse particles). Two major categories of particulate matter are fine particles and coarse particles. Fine particulate matter (FPM) comprises of particles with aerodynamic diameters 2.5mm or less. They are emitted from fossil fuel combustion, motor vehicle exhausts (including diesel) and wood burning. Several toxic metals, including arsenic, cadmium, lead, zinc, antimony, and their compounds are associated with (FPM) in ambient air [1]

"Heavy metals" are terms given to the group of metals and metalloids with atomic density greater than 5g/cm^3, usually associated with pollution and toxicological problems [2]. [3] Stated that "heavy metals" are a group of metals and semimetals associated with contaminations and are potentially toxic. [4] indicated that even light metals may cause health problems while [2] indicated that metals heavier than vanadium could be heavy metal. Based on these definitions and observations, heavy metals are therefore classified as essential (if they play basic role as components of vital biochemical or enzymatic activities in human body e.g Fe, Mn, Mo, Cr, V, Zn) and as non-essential (if the metals are classified as with no biological, chemical and physiological importance in man. Deficiency or high concentrations of these metals may have detrimental effect on health [5]. Once liberated into environment, man-made chemicals and products of heavy metals are taken up into the body via inhalation, ingestion and skin absorption. Heavy metals on exposure may not necessarily produce a state of toxicity in the body as they accumulate in the tissues over time until they reach toxic concentration [6]

When inhaled, very small particles containing metals or their compounds deposited beyond the bronchial regions of the lungs into the alveoli region. Epidemiological studies have established relationships between inhaled suspended particulate matter and morbidity/mortality in populations [7].The localized release of some heavy metals from inhaled particulate matter has been hypothesized to be responsible for the lung tissue damage [8]. Environmental contamination and explosion to heavy metals such as mercury, Cadmium and Lead is a serious growing problem throughout the world. Human exposure to heavy metals has risen dramatically in the last 50 years as the result of exponential increase in the use of heavy metals in industrial processes and products [1].

Cadmium (Cd): The cadmium that industries use is extracted during the production of other metals like zinc, lead and copper. Cadmium does not corrode easily and has many uses. In industry and consumer product, it's used for batteries (Ni-Cd batteries of mobile phones), pigment, metal coatings, and plastics. A constituent of easily fusible alloys, soft solder and solder for aluminum; used in electroplating and as deoxidizer in Nickel plating ;used in process engraving, in electrodes for cadmium vapour lambs, photoelectric cells, photometry of ultraviolet sun rays; filaments for incandescent lights. The powder is also used in dentistry, as an amalgam (1 Cd:4 Hg) [1]. Cadmium enters air from mining, industry, and burning coal and household wastes, cadmium particles in air can travel long distances before falling to the ground or water. It enters water and soil from waste disposal and spills or leaks at hazardous waste sites. Its bind strongly to soil particles. Some cadmium dissolves in water. It does not breakdown in the environment, but can change forms. Fish, plants, and animals take up cadmium from the environment).

Cadmium stays min the body a very long time and can build up from many years of exposure to low levels. Breathing contaminates workplace air (battery manufacturing, metal soldering, or welding) [9].Eating foods containing it, low levels in all foods (highest in sellfish, liver, and kidney meats).Breathing cadmium in cigarette smoke (doubles the average daily intake) Drinking contaminated water. Breathing contaminated air near the burning of fossil fuels or municipal waste [1]. Acute effects of cadmium occur by breathing high levels dust or fumes and may cause throat dryness, cough, headache, vomiting, chest pain, extreme restlessness and irritability, pneumonitis, possibly bronchopneumonia and can cause death due to severe lung damage .Eating food or drinking water with very high levels (metal and compounds) increase salivation, severely irritates the stomach, leading to vomiting and diarrhea. Skin contact with cadmium is not known to cause health effects in humans or animals. Long-term exposure to lower levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease [1].

Chromium (Cr): Chromium is a naturally occurring element found in rocks, soil, plants, animals, and then in volcanic dust and gasses [1]. In the beginning of life, the mineral chromium is important from the very earliest stage of life. Conception of new life begins a process of rapid cell duplication by division (mitosis) repeatedly. This requires lots of energy [10]. A substance named adenosine triphosphate (ATP) provides energy in human cells. ATP is the basic energy unit of the cell. If there is no ATP then there is no cell duplication. It is just that simple. That makes ATP a very simple priority for the health formation of life. Combining glucose (blood sugar) and oxygen produces ATP. Therefore, it is of utmost importance that glucose is efficiently provided for life to flourish. Chromium is essential for the insulin molecule to bring glucose into the cells for glycoloysis—the first step in ATP production [11].

Breathing contaminates workplace air (stainless steel welding, chromate or chrome pigment production, chrome plating, leather tanning).handling, or breathing sawdust from chromium treated wood. Breathing contaminated air, or ingesting water, or food from soil near waste sites or industries that use chromium are all sources of exposure to chromium. Very small amounts of chromium (III) are in everyday foods. All forms of chromium can be toxic at high levels, but chromium (VI) is more toxic than chromium (III). Acute toxic effects occur when breathing very high levels of chromium (V) in air, which can damage and irritate your nose, lungs, stomach, and intestines. People who are allergic to chromium may also have asthma attacks after breathing high levels of either chromium (VI) or (III) [10].

Long-term exposures to high or moderate levels of chromium (VI) cause damage to nose (bleeding, itching, sores) and lungs, and can increase your risk of non-cancer lung diseases. Ingesting very large amounts of chromium can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact with liquids or solids containing chromium (VI) may lead to skin ulcers. Some people have allergic reactions including severe redness and swelling. The American Department of Health and Human Services has determined that certain chromium (VI) compounds are known carcinogens. This is based on increased lung cancer in some workers who were exposed to chromium. Animal studies also indicate chromium (VI) is a carcinogen [1].

Lead (Pb): Lead is use as a construction material for equipment used in sulfuric acid manufacture, petrol refining, halogenations, sulfonation, extraction, and condensation. It is used in storage batteries, alloys, ceramics, and plastics .It also used in the manufacturer of pigments, tetraethyl lead and other lead compounds, in ammunition, and for atomic radiation and x-ray protection. Lead is used in aircraft manufacture, building construction materials (alloyed with copper, zinc, magnesium, manganese, and silicon), insulated cables and wiring, household utensils, laboratory equipment, packaging materials, reflectors, paper industry, printing inks, glass industry, water purification and waterproofing in the textile industry. Lead itself does not break down, but lead compounds are changed by sunlight, air and water [12].When released to the air industry or burning of fossil fuels or waste, it stays in air about 10 days. Most of the lead in soil comes from particles falling out of the air. City soils also contain lead from landfills and leaded paint. Lead sticks to soil particles it does not move from soil to underground water or drinking water unless the water is acidic or “soft”. It stays a long time in both soil and water [1]Acute exposure to lead is also more likely to occur in the workplace, particularly in manufacturing processes that include the use of lead (e.g., where batteries are manufactured or lead is recycled). Even printing ink, gasoline, and fertilizer contain lead. Symptoms include abdominal pain, convulsions, hypertension, renal dysfunctions, headache, numbness, arthritis, and vertigo [12].

Chronic exposure to lead may result in birth defects, mental retardation, autism, psychosis, allergies, dyslexia, hyperactivity, weight loss, shaky hands, muscular weakness, and paralysis (beginning in the forearms). Children are particularly sensitive to lead (absorbing as much as 50% of the ingested dose) and are prone to ingesting lead because they chew on painted surfaces and eat products not intended for human consumption (e.g., hobby paints, cosmetics, hair colorings with lead-based pigments, and even playground dirt). Addition to the symptoms found in acute lead exposure, symptoms of chronic lead exposure could be allergies, arthritis, autism, colic, hyperactivity, mood swings, nausea, and numbness, lack of concentration, seizures, and weight loss [12].

Petroleum: is a naturally occurring complex mixture made predominantly of hydrocarbons and other compounds of carbon and hydrogen, frequently containing significant amounts of nitrogen, sulfur, and oxygen as well as smaller amounts of nickel, vanadium, and other elements. It can occur in solid, liquid, or gaseous from as asphalt, crude oil, or natural gas, respectively [13]. Petroleum products are bulk fractions that are derived from petroleum and have commercial value as a bulk product.

Gasoline: is a complex mixture of hydrocarbons that boils below 200^{o}C. The hydrocarbon constituents in this boiling range are those that have 4-12 carbon atoms in their molecular structure. Gasoline can vary widely in composition; even those with the same octane number may be quite different. For example, low-boiling distillation with high aromatics contents (above 20%) can be obtained from some crude oils. The variation in the aromatics content, as well as the variation in the content of normal paraffins, branched paraffins cylopentanes, and cyclohexanes, involve characteristics of any individual crude oil and influence the octane number of the gasoline [13]. Up to the first decades of the twentieth century, gasoline was produced from crude oil or natural gas. However, it was soon discovered that if the heavier portions of petroleum (such as the fraction that boiled at a higher temperature than kerosene, for example gas oil) were heated to much higher temperatures, thermal degradation (or cracking) occurred, producing smaller molecules than were within the range suitable for gasoline. Thus it became possible to manufacture gasoline that was not originally in the crude petroleum [7]. Because of the differences in composition of various gasolines, gasoline blending is necessary. The physical process of blending the components is simple, but determination of how much of each component to include in a blend is much more difficult. The operation is carried out by simultaneously pumping all the components of a gasoline blend into a pipeline that leads to the gasoline storage, but the pumps must be set to deliver automatically the proper proportion of each component. Baffles in the pipeline are often used to mix the components as they travel to the storage tank [13].

Diesel Oil: The principal end use of gas oil is as diesel fuel for powering automobile, truck, bus, and railway engines. In a diesel engine, combustion is induced by the heat of compression of the air in the cylinder under compression. Detonation, which leads to harmful knocking in a gasoline engine, is a necessity for the diesel engine. A good diesel fuel starts to burn at several locations within the cylinder after the fuel is injected. Once the flame has initiated, any more fuel entering the cylinder ignites at once. Straight-chain hydrocarbons make the best diesel fuels. In order to have a standard reference scale, the oil is matched against blends of octane and alpha methylnaphthalene, the latter of which gives very poor engine performance. High-quality diesel fuels have octane ratings of about 50, giving the same combustion characteristics as a 50-50 mixture of the standard fuels. The large, slower engines in ships and stationary power plants can tolerate even heavier diesel oils. The more viscous marine diesel oils are heated to permit easy pumping and to give the correct viscosity at the fuel injectors for good combustion [13]

Energy and Environment: The conversion of energy from one form to another often affects the environment and the air we breathe in many ways, and thus the study of energy is not complete with-out considering its impact on the environment, fossils fuels such as coal, oil and natural gas have been powering the industrial development and the amenities of modern life that we enjoys since the 1700s, but this has not been without any undesirable side effect. From the soil we farm and the water we drink to the air we breathe, the environment has been paying a heavy toll for it. Pollutants are emitted during the combustion of fossils fuels are responsible for smog, acid rain, and global warming and climate change. The environmental pollution has reached such high level that it became a serious threat to vegetation, wild life, and human’s health. Air pollution has been the cause of serious numerous health problems including asthma and cancer. It is estimated that over 60,000 people in the united state alone die each year due to heart and longs diseases related to air pollution [12].

Soot: New techniques using heavy metal tracers were able to distinguish the area emitting the pollution by its distinctive chemical signature. The soot picks up special signatures known as the “soot prints” from the way it’s burned (there are roughly 20 class of soot). Smog also contains suspended particulate matter such as dust and soot emitted by vehicles and industrial facilities. Such particles irritate the eyes and the lungs since they may carry compounds such as acids and metals. Analytical data on the levels of trace metals and forms in which they exist in crude petroleum are very useful in deducting the source and the geothermal origin of crude oils. Such data on petroleum products are useful in assessing the impact of metals such as Ni, Cu, Fe, Zn. Sb which are deleterious to oils, on the refining or processing of these products. Often, organometallics such as tetraethyl lead and zinc dialkyl dithiophosphate are added to petroleum products such as gasoline and lubricating oils respectively to improve automobile engine performance [13].

This research work compares two petroleum products soots for the analysis of metals, using flame AAS. Three divalent metals;Cr^{2+}, Cd^{2+} and Pb^{2+} were determined in Diesel and Gasoline soots from the exhaust of automobile engines. Selection of elements was partially based on environment consideration and facilities available in our laboratory.

MATERIALS AND METHODS

Petroleum soot from the exhaust of different power generating plant was randomly obtained at different location within sokoto metropolis including residential. 50g of each sample was randomly procured from the exhaust of each power plant generator into clean sample holders with seals they were level and stored at room temperature. Samples were obtained at specific location from five zones based on population index as related to generator operations. The zones are: 1.UDUTH (Uduth, Kware road, and Gawon Nama), 2.Emir Yahya (Emir Yahaya Market, Sahara Mechanic village and Buzaye), 3.Rima Bassin (Rima basin, Kwarnawa, Barracks and Old air port),4.Tudun Wada (Tudun Wada area, Kofar rini, Sokoto Cinema and Kofar Tarauniyya) and 5.Main Markete Zone (Market gate Aliyu Jodi and Dandima).The most notable soot generating area were identified and the soot were collected from the specified location and the information of the sample are presented in Table 1.

Pretreatment: of sample entails breaking of lumps to powder. The already carbonized sample were homogenized and taken for the preparation of working solutions. High analytical grade purity chemical reagents and distilled water were used throughout the experiments. The preliminary studies carried out sample include; physical examination, Moisture content, Bulk density, pH and conductivity. Apparent colour examination was done with naked eye and were found to be black (Carbonized) powdered samples. Methods by [14], [15], [16]. Were adopted and carefully followed for the estimation of Bulk Density, moisture, pH/Conductivity measurement respectively.

Sample Digestion (Wet Digestion): Sample Digestion using the wet digestion method earlier described by [1], was followed with slight modification.0.2g of each sample was mixed with 0.2g potassium permanganate (Oxidant) after which $2cm^3$ Hydrogen peroxide was added the resulting solution was treated with $10cm^3$ concentrated Nitric acid the sample was allowed to settle for 1 hour followed by heating at 200^0c-300^0c until the content reduces to between $3\text{-}5cm^3$. The process was repeated until substantial quantity was obtained. The mixture was allowed to cool at room temperature. Filtration was done using fitter paper No 42. About $10cm^3$ of each filtrate was diluted to $50cm^3$ with distilled water and the samples were labeled for FAAS Analysis [1]. Blank solution used to eliminate the contamination was prepared, using the preparation procedure which contains sample volume of the entire reagent used excluding the soot sample.

RESULTS AND DISCUSSION

PHYSICOCHEMICAL ANALYSIS: By definition the pH of a solution is given by the equation pH =-log$_{10}$ [H]$^+$. According to the definition, pH is a measure of the hydrogen ion concentration in a solution. This implies that a low pH value indicates a high hydrogen ions concentration. Generally, pH all falls within the acidic range for the analyzed soot samples. The pH also determines the number of replaceable hydrogen in the carbonized sample which is an indication that metals are present in the samples. Hence, the samples were ranked on the pH values obtained in ascending order.For Diesel soot $D_6 > D_5 > D_4 > D_2 > D_3 > D_1$, for gasoline soot; $G_5 > G_6 > G_2 > G_1 > G_4 > G_3$. For kerosene soot; $K_6 > K_4 > K_2 > K_1 > K_3 > K_5$ and for wood soot;$W_6 > W_4 > W_5 > W_3 > W_1 > W_2$. Conductivity values obtained in this analysis are low. This is an indication that the compounds of the samples are mostly covalent with high carbon contents. However the availability of divalent metals could be critical in explanation for fairly high values (92-229µs/cm) conductance of Diesel engine soot. Conductance is a measure of relative ease with which ions migrates. Therefore the movement of these ions i.e. positive ions (metals) will give an insight that heavy metals are present in the solution of the samples. It is well known that the conductivity of an electrolyte decreases as the solution is diluted while the molar conductivity increases upon dilution until a limiting value is reached [17]. This also corresponds to the pH. The conductivity of electrolytes decreases as the pH increases. From the Table it is believed that the statements are true. Hence, these could be a factor to assess the samples and arrange the samples in ascending order; For Diesel soot, $D_1 > D_2 > D_3 > D_6 > D_4 > D_5$. For Gasoline soot; $G_4 > G_1 > G_3 > G_6 > G_5 > G_2$.

Bulk Density is measures of strength / attrition of the soot. In this analysis all the values obtain were less than 1. This is an implication that the soot can be easily and spread by air current to the environment. The Gasoline soot presented higher values (0.590 for G_2 and 0.661 for G_5).The Table shows the values obtained of the above parameters. Based on the result the samples were rank in ascending order. Moisture content; For Diesel soot. $D_6 = D_4 > D_5 = D_2 > D_3 = D_1$. For Gasoline soot; $G_1 = G_2 = G_3 = G_4 > G_5 = G_6$.

Metal Analysis: Table 3 Present the concentration (ppm) of Pb, Cd, and Cr in diesel soot. Availability flows the trend; Pb (0.006) > Cr (0.023) > Cd. (BDL).The Table revealed that Cd are majorly below detection limit i.e. sample from $D_1, D_2, D_3, D_4, D_5, and D_6$ gave no vales. Generally, the mean value for lead (0.006±0.023ppm) is high in the series. Comparative study revealed that lead and cadmium content in soot are respectively D_2 and D_3 times more than the values in the reference Diesel. Hence volatilization and escape in to the surrounding air could be suspected. Generally, Engines, especially Diesel engines are regulated for smoke capacity, total oxide of nitrogen (NO_X), total particulate matter and total Hydrocarbon. The magnitude of engine emissions depends on fuels consumptions. This present research considers particulate emissions which majorly relies on soot Carbon and deformed as solid materials collected on the appropriate Filter at a given temperature[18], [19]. They could be carrier's toxic metals.

Table 4 shows that the availability of Pb, Cr and Cd concentrations in ppm of gasoline petroleum engine soot. From the result it was found that Cd (0.93±2.85) has higher mean value, with G_1 having below detection limit and Cr having the least value. The level of metals is in the order of; Cd (0.93±2.85)>Pb(0.053±0.023)>Cr(0.00). It also found that in Pb, G_1,G_2,G,$_6$ as well as Gr, gave no value. From the results, Cd in reference gasoline an insight on the fact that the detected Cd in the soot could be linked to the Diesel itself and almost 10th part of escaped the surroundings. Thus reducing the value from 10.708 for Gr to between 0.092 and 1.268 for the soot.

Table 1: sampling and sample information/description

Sampling site	Sample I.D	Fuel Uptake (L)	rated out put	Model/Manufacturers
Uduth	D1	313.8	1500kva	400series/Parkins England.
Uduth	D2	221.4	1000kva	4000 series/Parkins Englands
Kware road	D3	60.5	100kva	200 series/Parkins England
Gawon nama	D4	62.5	200kva ds	dd 200/Parkins England
Rima basin	D5	442.8	500-2000kva	dd 500 Parkins England
Rima basin	D6	30	13.2kw	ll50 China
Kwarnawa	G1	30	6.5 kw sp	ll8gf series Japan
Barracks	G2	4	5.3 sp/400 rpm	yg30 sereis China
Old airport	G3	30	5.5. kw	fpg7800e
EmirYahaya	G4	4	3.8ps/3,400 rpm	yg 30 series China
Sahara	G5	30	7.0 kw	fpg 30 series
Duzaye	G6	4	3.0 kw	llf8gf series China

D-Dieseal soot, G-Gasoline Soot, I.D- Identity,L- Litre .Locations; D1-Uduth, D2-Uduth, D3-Kware road, D4-Gawon nama, D5-Rima basin, D6-Rima basin, G1-Kwarnawa, G2- Barracks, G3-Old airport, G4-EmirYahaya, G5-Sahara, G6-Duzaye.

Table 2: pH, Electrical conductivity, Moisture content, Bulk Density. From Diesel soot engines

Sample I.D	pH	Conductivity(µs/cm)	Moisture (%)	Bulk Density(g/cm^3)
D_1	3.12	229	5	0.160
D_2	3.30	226	10	0.146
D_3	3.16	218	5	0.140
D_4	3.36	096	20	0.543
D_5	3.41	092	10	0.152
D_6	3.55	101	20	0.484
G_1	3.86	063	20	0.395
G_2	4.58	005	20	0.590
G_3	3.61	059	20	0.185
G_4	3.78	066	20	0.365
G_5	5.25	013	10	0.661
G_6	4.86	017	10	0.407

D-Dieseal soot, G-Gasoline Soot, I.D- Identity,L- Litre

Comparative study: The sampling Table 1 shows that the expected rated output for the Gasoline-based engine is lower (3.0-6.5 kw) compared to the 100-2000kVA expected output for the diesel - run engines. This is in accordance to the quantity of fuel required for efficient run. Table 2 revealed that gasoline soot is denser or bulkier (0.365-0.661 g/cm^3) compared to the Diesel soot. No clear distinctive percentage moisture was observed while the Diesel soot tends to be more acidic (pH; 3.12-3.55) than the Gasoline (pH; 3.61-4.86). Another clear observation is the High conductivity values (92-229 µs/cm) for the Diesel soot as against low values (5.0-66 µs/cm) for the Gasoline soot. AAS analysis revealed that there is a high level of volatilization of Cd^{2+} from Diesel soot into the air current. Raw Diesel (Dr) presented 3.316ppm while zero value was estimated in the soot. On the contrary, Gasoline soot presented up to 0.932 ±2.852 ppm Cd^{2+} value in the soot as against the 10.708ppm in the raw Gasoline (Gr). The low value of Cr

(0.04ppm) has its origin not linked to the raw Gasoline soot (Gr=0.00ppm). No Cr was estimated in most of the Gasoline soot sample. On the other hand, Cr^{2+} in the Diesel ranges from 0.4 in the soot to 0.8ppm in the raw sample. Value of lead (Pb) in raw diesel was quantify as 0.06ppm as against 0.00 ppm in raw gasoline Thus, it implies that the estimated Pb^{2+} in G_3 ,G_4 and G_5 at 0.08,0.04 and 0.04 ppm respectively, could be link to external sources within the engine or exhaust.

Table 3: Lead (Pb), Cadmium (Cd) and Chromium (Cr) concentrations in Diesel Engine Soot

samples	Potentially toxic metals		
	Pb (ppm)	Cd (ppm)	Cr (ppm)
D1	ND	BDL	0.04
D2	ND	BDL	0.04
D3	0.04	BDL	0.04
D4	ND	BDL	0.04
D5	0.04	BDL	0.04
D6	0.08	BDL	0.04
Dr	0.08	3.316	0.08
Mean	0.06	BDL	0.0228594
SD	0.023094	1.2150294	0.0258461

ND-Not Detected, BDL- Below Detection Limit, Dr- Referenced Diesel Soot, D- Diesel Soot and Locations; D1-Uduth, D2-Uduth, D3-Kware road, D4-Gawon nama, D5-Rima basin, D6-Rima basin

Table: 4: Lead (Pb), Chromium (Cr) and Cadmium Concentrations in Gasoline engine soot

Samples	Potentially toxic metals		
	Pb (ppm)	Cr (ppm)	Cd (ppm)
G1	ND	0.04	BDL
G2	ND	ND	1.268
G3	0.08	ND	0.696
G4	0.04	ND	0.62
G5	0.04	ND	0.092
G6	ND	0.04	0.428
Gr	ND	ND	10.708
Mean	0.053333		0.932093
SD	0.023094		2.852126

G-Gasoline, ND-Not Detected, BDL-Below Detection Limit and Locations; G_1-Kwarnawa, G_2-Barracks, G_3-Old airport, G_4-EmirYahaya, G_5-Sahara, G_6-Duzaye

CONCLUSION

Generally, Engines, especially Diesel engines are regulated for smoke capacity, total oxide of nitrogen (NO_X), total particulate matter and total Hydrocarbon. The magnitude of engine emissions depends on fuels consumptions. This present research considers particulate emissions which majorly relies on soot Carbon and deformed as solid materials collected on the appropriate filter at a given temperature. This Comparative study revealed that cadmium and chromium content in soot are respectively lower than that of the reference (raw or original) diesel and gasoline oil. The reduction was linked to fragmentation or volatilization of these metals into the air current, thus, could possibly contribute to heavy metal pollution within the surrounding.

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