ADSORPTION OF LEAD (II) ION FROM DYE EFFLUENT USING RICE HUSK (ORYZA GLABERIMMA)

BY

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A RESEARCH DISSERTATION SUBMITTED TO THE
DEPARTMENT OF CHEMISTRY
NIGER STATE COLLEGE OF EDUCATION MINNA

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IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF NATIONAL
CERTIFICATE IN EDUCATION

120

SEPTEMBER, 2015

CERTIFICATION

This is to certify that this project was carried out by **ADEJUMO OLADELE WILLIAMS, MOSES OLAMIDE MERCY, HARUNA ABDULKAREEM and OBARO OGENEKARO BLESSING** in the Department of Chemistry Niger state College of Education, Minna.

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DEDICATION

We dedicate this project work to God Almighty, our parents and to all our lecturers of the Department of Chemistry.

ACKNOWLEDGMENT

All praises is due to God Almighty who has guided us to path of felicity. It is necessary to assert that our dream comes true by His grace and assistance. In fact at initial stage, it was tedious but at the end we have many reasons to thank God Almighty. Hence, we are using this opportunity to acknowledge the accomplishment of this project work.

Our appreciation goes to our immaculate supervisor who is also our lecturer in our department in person of Mr. Kazeem Amuzat, whose guidance and timely advice has helped us tremendously in completing this study at the schedule time for kindness in the course of supervising the work.

Our profound gratitude goes to our beloved parents who supported us in one way or the other. We pray your effort should not be in vain.

Finally, we have to give thanks to all lecturers in the department in persons of, Mallama habiba Yarima, Mr. Monday Musa, Mall. Baba Haruna, Mall. Yusuf Auna and all those we could not mention in the department for their sacrifice all by duties and services to sustain our choice.

May God Bless us all.

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ABSTRACT

Activated carbon has been produced form rice husk, via two step (i) carbonization and activation with HNO3. It was then interacted with dye effluent. This analysis estimated the concentration of lead in dye effluent solution before and after interaction with the absorbent (Rice's husk).The result indicate that different time of adsorbent had its highest adsorption (91.67%) when 5.Og of the adsorbent at 150 minutes and the least was 5.Og of the adsorbent at 30 minutes (66.67%) of the lead (ii) ion. This shows that the higher the contact time, the higher the percentage adsorption.

CHAPTER ONE

0 BACKGROUND OF THE STUDY

1 WATER

Water pollution, contamination of stream, lake, underground water, oceans by harmful substance are dangerous to living thing, water is necessary to life on earth. All organisms contains some live in it, some drink it, plants and animals requires water that is moderately pure and they cannot survive if their water is toxic chemicals like heavy metal. Brazil (Wikipedia 2012)

Water pollution can kill large numbers of fish, birds and other animals. Pollution can make stream, lake and coastal water unpleasant to smell and to swim in, (fish and shell). Fish harvested from polluted water may be unsafe to eat and so as to health. People who take polluted water can become ill and prolonged exposure may develop cancer and children with birth defect. The issue of sewage disposal is assumed to be increasing on earth and the problem of pollution of the human environment, the contamination of the atmosphere, lake, river, ocean and ground water by domestic municipal, agriculture and industrial waste is also a general concern worldwide.

Waste water originates mainly from domestic and industrial source and is commonly referred to as effluents. Domestic sewage result from people is day to day activities, such as bathing body elimination, food preparation, the quantity of industrial waste water is highly varied depending on the type of industry, the management of its water usage and the degree of treatment of the waste water receives before it is discharged. (David 2011)

.2 RICE HUSK (ORYZA SATIVA)

Rice husks are the hard protecting coverings of grains of rice. In addition to protecting rice during the growing season, rice husks can be put to use as; **BUILDING MATERIALS, FERTILIZER, INSULATION MATERIAL OR FUEL.** (Volesky, 2012)

Rice husks are the coatings of seeds or grains of rice, to protect the seed during the growing season; the hull is formed from hard materials including opaline silica and lignin. The husk is mostly indigestible to humans (Joseph 2013). Winnowing, used to separate the rice from husks, is to put the whole rice into a pan and throw it into the air while the wind blows. The light husks are blown away while the heavy rice falls back into the pan. Later, pestles and a simple machine called a **RICE POUNDER** were developed to remove husks. In 1885, the modern rice husking machine was invented in Brazil (Wikipedia 2012). During the milling processes, the husks were removed from the raw grain to reveal whole brown rice, which may then sometimes be milled further to remove the bran layer, resulting in white rice.

Combustion of rice husks affords rice husk ash (acronym RHA), this ash is a potential source of amorphous reactive silica, which has a variety of applications in materials science. Most of the ash is used in production of Portland cement. More specialized applications include the use of this material as a catalyst support (J Chumee et al 2008).

In Kerala, India, Rice husks (Umikari in Malayalam) were universally used for over centuries in cleaning teeth, before toothpaste replaced it. Rice husks can be used in brewing beer to increase the lautering ability of a mash.

Rice husks can be composted, but their high lignin content can make this a slow process. Sometimes, earthworms are used to accelerate the process (David 2011). Rice husks are coated with fine grained gunpowder and used as the main bursting charge in aerial fireworks shells. With proper techniques, rice husks can be burned and used to power steam engines. Some rice mills originally disposed of husks in this way (Todd 2012). Rice husks are used as a "press aid" to improve extraction efficiency of apple pressing. Rice husks are the outermost covering of the rice and come as organic rice husks and natural rice husks.

Rice husks are an inexpensive byproduct of human food processing, serving as a source of fiber that is considered a filter ingredient in cheap pet foods. Rice husks are used as pillow stuffing. The pillows are loosely stuffed and considered therapeutic as they retain the shape of the head.

Rice husks themselves are a class A thermal insulating material because they are difficult to burn and less likely to allow moisture to propagate mold or fungi. Rice husks are low-cost material from which silicon carbide "whiskers are then used to reinforce ceramic cutting tools, increasing their strength tenfold (SiC 2013). Goodyear announced plans to use rice husks ash as a sources for tire additive (Otto W. 2012).

3 DEFINITION OF TERMS

- **ADSORPTION:** In chemistry, adsorption is a physical or chemical phenomenon or a process in which atoms, molecules or ions enter some bulk-gas, liquid or solid material (Wikipedia 2008).
- **ADSORBENT:** Adsorbent (liquid) is a substance that is usually porous in nature with high surface area that can adsorb substance onto its surface with the help of intermolecular force (Wikipedia 2008).
- **ADSORBATE:** Is a substance that is adsorb on a surface of another substance (Wiki; 2012).
- **TOXICITY:** Is the degree to which a substance can damage an organism.
- **CARCINOGENIC:** Is any substances radionuclide or radiation that is an agent directly involved in causing cancer.
- **HEAVY METAL:** Heavy metal refers to any metallic chemical element that has relatively high density and is toxic or poisonous low concentrations.

.4 AIM AND OBJECTIVE OF THE STUDY

The principle aim and objectives of this work is to remove heavy metal from dye effluent using rice husks and to create awareness on the use of rice-husk as adsorbent for removal of heavy metals from industrial waste. (Dye effluent).

.5 SIGNIFICANT OF THE STUDY

The project work is relevant and significance to chemistry student who might want to do project work on eliminating heavy metal in the environment. It is also crucial to the environmentalist and Dietetics on how to set awareness to people to avoid being exposed to higher concentration of "heavy metals".

CHAPTER TWO

0 LITERATURE REVIEW

1 HEAVY METAL

A heavy metal is any metal of environmental concern. The term originated with reference to the harmful effects of cadmium and lead, all of which are denser than iron. It has since been applied to any other similarly toxic metal or metalloid such as arsenic, regardless of density (Hogan 2010).

The origin of the term "heavy metal" is not clear. An early use dates from 1817, when Gmelin divided the elements into non-metals, light metals and heavy metals (Hebashi 2009). Wanklyn and Chapman speculated on the adverse effects of the heavy metals "arsenic, lead, copper, zinc, iron and manganese" in drinking water. In 1884, Blake described a connection between toxicity and atomic weight of an element. Beryllium and aluminum, although light metals are sometimes counted as heavy metals in view of their toxicity. Beryllium exposure can result in lung and heart disorders and possibly death; aluminum is a major inhibitor of crop growth in acid soils (Saxena 2010).

NATURE OCCURRENCE OF HEAVY METALS

Heavy metals are naturally components of the earth's crust. They cannot degrade or destroyed. To a small extent, they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g. copper, selenium, zinc) are essential to maintain the metabolism of the human body. (Hogan 2010).

However, at higher concentrations they can lead to poisoning. Heavy metals poisoning could result, for instance, form drinking water contamination e.g. (lead, pipes), high ambient air concentrations near emissions sources; or intake via food chain (C. Michael, 2010).

Heavy metals are dangerous because they tend to the three most pollutant heavy metals are lead (Pb), cadmium (Cd) and mercury (Hg). (Hogan 2010).

Bioaccumulation means an increase in the concentration of chemicals in a biological organism over time, compared to the chemicals concentration in the environment. Compounds accumulate in living organism anytime they are taken up and stored faster than they are broken down (metabolized) or excreted.

Heavy metals can enter a water supply by industrial and consumer waster or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers and ground water (Hogan, 2010).

2.3 RELATIONSHIP OF HEAVY METALS TO LIVING ORGANISM

Living organisms required varying amount of "heavy metal". Iron, cobalt, copper, manganese, molybdenum and zinc are required by human. Excessive levels can be damaging to the organisms.

Other heavy metals such as Mercury, Plutonium and Lead are toxic metals that have no known vital or beneficial effect on organisms and their accumulation over time in the bodies of animals can cause serious illness.

2.4 HEAVY METALS POLLUTION

Motivations for controlling heavy metals concentrations in gas streams are diverse. Some of them are dangerous to health or to the environment examples are mercury, cadmium and chromium, lead. (Hogan, 2010).

Elements have been considered highest concern, they are arsenic, cadmium, cobalt, chromium, copper, mercury, manganese, nickel, lead, tin and thallium; they emission of which are regulated in waster incinerations. Some of these elements are actually necessary for humans in minutes amounts (cobalt, copper, chromium, manganese, nickel) while others are carcinogenic or toxic affecting among others the central nervous system. (Manganese, Mercury, Lead, Cadmium, Copper) (Ron Zenvenhoven et at; 2011).

2.5 SOURCES OF HEAVY METAL AND REMEDIATION

Heavy metals pollution can arise from many sources but most commonly arises from purification of metals, e.g. smelting of copper and the preparation of nuclear fuels.

Electroplating is the primary source of chromium and cadmium. Through precipitation of their compounds or by ion exchange into soils and mud.

In humans, heavy metals poisoning is generally treated by the administration of chelating agents (Blann, 2014). These are chemical compounds, such as $CaNa_2$ EDTA (Calcium disodium ethylenediaminetetraacetate) that convert heavy metals to chemically inert forms that can be exerted without further interaction with the body. Chelate are not without side effects and can also remove beneficial metals from the body. Vitamin and mineral supplements are sometimes co-administered for this reason.

Soil contaminated by heavy metals can be one or more of the following technologies isolations; mobilization; toxicity reduction; physical separation or extraction (Evanko, 2007).

2.6 HEAVY METAL TOXICITY

Heavy metals are chemical elements with a specific gravity that is at least 5 times the specific gravity of water

There are 35 metals that concern us because of occupational or residential exposure; 23 of these are “heavy metals” or “heavy elements”: antimony, arsenic, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thalium, tin, uranium, vanadium, zinc (CDC 2012).

Amount of any of them may cause acute or chronic toxicity (poisoning), heavy metal toxicity can result in damaged or reduced metal and central nervous function lower energy levels and damage the blood composition; lung, kidney, liver and other vitals organs. Long-term exposure may result in slowly progressing physical, muscular and neurological degenerative processes that mimic Alzheimer's disease Parkinson's disease, muscular dystrophy and multiple sclerosis (Loshie, 2012).

Although "heavy metal" toxicities due to lead mercury and cadmium are generally considered rare in mainstream medicine, less well recognized is that chronic accumulation that may not achieve classical acute toxicity thresholds may nevertheless contribute to adverse health effects (Brorstein 2012).

Regarding acute toxicity, according to the 2011 National poison data system annual report, there were 7337 reported unintentional heavy metal exposure in United States, resulting in 26 serious health outcomes and 2 deaths (Bronstein, 2012). While data from the National Health and Nutrition Examination Survey (NHANES) shows a decade of encouraging year-over-year decreases in acutely toxic heavy metal exposure in the United States, there are still a significant number of people without blood levels that may put them at risk for chronic accumulation and therefore toxicity, over time (CDC, 2013).

With several toxic metals lacking robust pathways for elimination or otherwise remaining in the body for a long time, body burdens of some toxic metal. (e.g. lead, mercury, cadmium) may increase with age (Bjermo, 2013).

Symptoms indicative of acute toxicity is not difficult to recognize because the symptoms are usually severe, rapid in onset and association with a known exposure or ingestion (Ferner, 2011).

Sometimes the symptoms of chronic exposure actually abate from time to time, leading the person to post-pone seeking treatment, thinking the symptoms are related to something else.

Heavy metals are chemical elements with a specific gravity that is at least 5times the specific gravity of water. Lide 1992

2.7 BENEFICIAL HEAVY METALS

In small quantities, certain heavy metals that include iron, copper, manganese and zinc are nutritionally essential for a healthy life. These heavy metals are referred to as trace elements. Trace elements or some form of them are commonly found naturally in food stuffs, in fruit and vegetables and in commercially available multivitamin products (Loshec, 2012).

2.8 LEAD IN THE ENVIRONMENT

Lead is a naturally occurring heavy metal that is found in the Earth's crust. Lead can be released into soil, air and water through soil erosion, volcanic eruptions, sea spray and bush fires. The natural concentration of lead in the air is less than 0.1microgram per cubic metre. (Brorsteein 2014).

Humans have used lead in various applications for thousands of years, with some of the past uses having left behind serious environmental and human health problems. There are many sources of lead emission which includes waste incinators, battery recycling the production of lead fishing sinkers, cement, plaster and concrete manufacturing, ceramic products, petroleum and coal products and metal products.

USES OF LEAD IN THE SOCIETY

1. Cable sheathing and bearings.
2. In cars- most cars require a lead battery.
3. Protective shields against x-rays.

4. In older television and personal computers (i.e. not plasma or LED) leaded glass in the cathode ray tube (CRT) and screen protects the user from potentially harmful radiation.

2.9 HEALTH EFFECT OF LEAD

Lead is a highly poisonous metal (whether inhaled or swallowed), affecting almost every organ and system in the body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance. In some tests that measures functions of the nervous system. Long-term exposure to lead or its salts (especially soluble salts or the strong oxidant PbO_2) can cause nephropathy and colic-like abdominal pains. It may also cause weakness in fingers, wrists or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia.

SYMPTOMS OF CHRONIC LEAD POISONING

- Lack of energy
- Learning disabilities
- Behavioural problems

- Impaired growth
- Increased blood pressure
- Heart rate variability
- Fertility issues

METHOD OF REDUCING LEAD

There are two lead hazard reduction methods.

1. Abatement control
2. Interim control

- **ABATEMENT CONTROL:** Is a lead hazard reduction method that is designed to permanently eliminate lead-base paint or lead-based paint hazards.
- **INTERIM CONTROL:** Are lead hazard reduction activities that temporarily reduce exposure to lead based paint hazards through repairs, painting, maintenance, special cleaning, occupant protection measures, clearance and education program (Jagadish Prasad, P. 2010).

CHAPTER THREE

3.0 MATERIAL APPARATUS

3.1 APPARATUS

INSTRUMENT	MODEL	MANUFACTURER	SOURCE
a. Spatula	NA	NA	Chemistry laboratory C.O.E Minna
b. Weighing Machine	TX4202L	Shimadzu	Chemistry laboratory C.O.E Minna
c. Evaporting dish	NA	NA	Chemistry laboratory C.O.E MINNA
d. Aluminium foil	Victory	Lagos Nigeria	Chemistry laboratory C.O.E MINNA
e. Oven	labtek unix 96-AVI29	Saiaho China	Farm Center Tunga Minna
f. Sample Bottle	Sterile	Lagos Nigeria	Chemistry laboratory C.O.E MINNA
g. wash bottle	NA	NA	Chemistry laboratory C.O.E MINNA
h. Conical Flask	GG17	NA	Chemistry laboratory C.O.E Minna
I. Beaker	Approx	England	Chemistry laboratory C.O.E MINNA

j. Funnel	NA	NA	Chemistry laboratory C.O.E MINNA
k. Glass Rod	NA	NA	Chemistry laboratory C.O.E MINNA
l. Volumetric flask	NA	NA	Chemistry laboratory C.O.E MINNA
m. Desiccators	NA	NA	Chemistry laboratory C.O.E MINNA
n. Filter Paper	White Man	NA	Chemistry laboratory C.O.E MINNA
o. Measuring cylinder	NA	NA	Chemistry laboratory C.O.E MINNA

3.2 MATERIALS

S/N	MATERIALS	SOURCE
1.	HNO_3	Chemistry laboratory C.O.E Minna
2.	Dust of rice husk (hull)	Milling industry kpakungu Minna, along Bida road, Niger State opposite police station
3.	Distilled water	Chemistry laboratory C.O.E Minna
4.	Dye effluent	Local dye industry along stadium road, Emir palace

3.3 SAMPLE AND SAMPLE TECHNIQUES

Rice husk or hull (oryza glaberimma) was collected from milling industry kpakungu Minna, along Bida road, Niger State opposite police station. The rice's hull was dried in the sun for a week to moist.

3.4 MASTURATION PROCESS

2.1cm^{3}of solution of HCl was measured using measuring cylinder which was dissolved in 250cm^3 volumetric flask with distilled water, 5.0g of rice husk was weighed into ten (10) different beakers using weighing machine, and 10ml of HCl solution was measured into the beakers that contain 5.0g of rice husk and they were covered with aluminum foil. It was being kept for 48hrs to let it circulate all together and it was put into the oven to dry it up. It was crushed in a mortar using pestle and further dried in an oven at 105^{0}c for about two hours to complete obliterate the moisture.

It was then stored in the Desiccators and allowed to cool in order to prevent it from absorbing the moisture from the surrounding.

The sample was weighed at five (5) different masses which are as 2.0g, 4.0g, 6.0g, 8.0g and 10.0g.

.5 DIGESTION PROCESS

Dye effluent of 10ml was measured into five different conical flask and 2.1cm^3 of HNO_3 was measured into each conical flask that contains dye effluent and it was been stirred, it was put into the oven at 105^{0}c for about 30minutes, after when it forms, it was dropped to complete the process.

.6 PREPARATION OF STANDARD SOLUTION

A stock solution was prepared with distilled water, divided through mass of the compound was determined and divided through by the mass of lead (II) ion.

The result obtained was divided by 4 which is dissolved with distilled water (H_2O) in 250m^3 volumetric flask.

However, dilution factors were used to calculate the volume of stock solution required to represent the 10ppm of the solution in 100cm^3 volumetric flasks.

$C_1V_1 = C_2V_2$

Where C_1 => Initial concentration of Pb^{2+}

C_2 => Concentration of solution required

V_1 => Volume of solution to be taken

V_2 => Volume of solution required

From calculation;

2.1cm^3 of solution was measured using dry measuring cylinder which was dissolved in 250cm^3 volumetric flask with distilled water.

3.7 BATCH ADSORPTION STUDIES

Batch adsorption studies are a techniques used to [illegible] Pb^{2+} from the interaction of the dye effluent and the samples (rice husk).

The samples (dust of rice husk) were weighed at the same masses (gram) into five (5) places as 5.0g each. Each of the samples was poured into five (5) different beakers containing digested dye effluent covered. The mixture was allowed to stand for 30minutes, the process was repeated for 60, 90, 120 and 150 minutes. Each mixture was filtered, the filtrate were collected into ten different sample bottle respectively using whatman filter paper and the filtrate was taken to chemistry laboratory in Federal Poly Bida for Atomic Absorption spectrometer analysis in order to know the initial concentration and the final concentration of Pb^{2+} in the dye effluent at specific contact time interval.

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 THE RESULT ANALYSIS CARRIED OUT ARE PRESENTED IN THE TABLE BELOW:

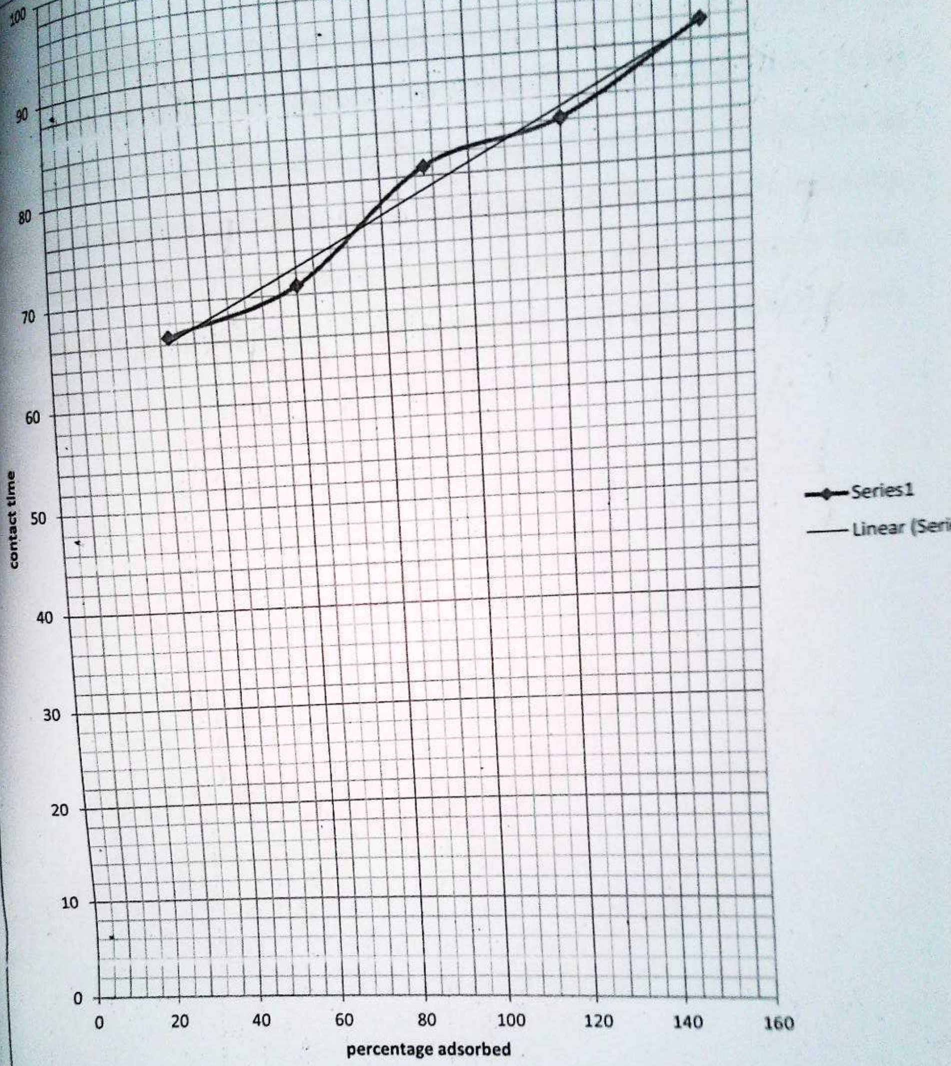
Table 1: Adsorption Pb^{2+} From Solution at Different Times

TIME (mins)	A.C(g)	Pb_i	Pb_f (mg/l)	Pb_i-Pb_f (mg/l)	% of Pb^{2+} adsorbed
30	5.00	12.00	4.00	8	66.67
60	5.00	12.00	3.50	8.5	70.83
90	5.00	12.00	2.30	9.7	80.83
120	5.00	12.00	1.90	10.1	81.47
150	5.00	12.00	1.00	11	91.67

4.2 DISCUSSION

From the table above, the percentage adsorption of lead (II) ion by the rice's husk or hull was highest after One Hundred and Fifty (150) minutes,'there was an increase in the percentage removal of lead ions as time of adsorption increases, from 30 minutes, 60 minutes, 90 minutes, 120 minutes, and 150 minutes was the peak time. From the graph it can be seen that the percentage of Pb^{2+} adsorbed increases as contact time increases

GRAPH OF


100
90
80
70
60
50
40
30
20
10
0
contact time
0
20
40
60
80
100
120
140
160
percentage adsorbed
Series1
Linear (Seri

4.2 DISCUSSION

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CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

From this research work, it was reveled that heavy metals pose high environmental and health risks. Their non-Biogradability makes it operation to device means of removing from the environment where possible. Rice husk, a cheap or waste product of rice plant which can be use to reduce the concentration of Pb^{2+} heavy metals in the environment. From this experiment, rice husk has good ability to remove heavy metals contaminants from polluted water and other solution. Although a bye-product of agricultural processing, it can be useful in environment remediation.

5.2 RECOMMENDATION

The following recommendations were made:

1. Awareness should be created on the use of rice husk and other similar agricultural waste on the removal of heavy metals or toxic metals from polluted water.
2. Effect of pH should be checked on the adsorption capacity.

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APPENDIX

= Activated carbon

= Dillution factor

i = Concentration of lead in dye effluent before interaction

bf = concentration of lead in dye effluent after interaction.

= Interaction time (mins)

mount of lead absorbed = Pbi – Pbf

For Contact Time 30 mins

Amount absorbed = Pbi – Pbf

= 12.00 – 4.00

= 8.00 mg/l

Percentage of lead absorbed= $\frac{\text{Pbi} - \text{Pbf}}{\text{Pbi}}$ X100

$$= \frac{8 - 100}{12} = 66.67\%$$

For Contact Time 60 mins

Amount absorbed = Pbi – Pbf

= 12.00 – 3.50

= 8.5 mg/l

Percentage of lead absorbed= $\frac{\text{Pbi} - \text{Pbf}}{\text{Pbi}}$ X100

$$= \frac{8.5 - 100}{12} = 70.83\%$$

For Contact Time 90 mins

Amount absorbed $= Pbi - Pbf$

$= 12.00 - 2.30$

$= 9.7$ mg/l

Percentage of lead absorbed$= \frac{Pbi - Pbf}{Pbi}$ X100

$$= \frac{9.7 - 100}{12} = 80.83\%$$

For Contact Time 120 mins

Amount absorbed $= Pbi - Pbf$

$= 12.00 - 1.90$

$= 10.1$ mg/l

Percentage of lead absorbed$= \frac{Pbi - Pbf}{Pbi}$ X100

$$= \frac{10.1 - 100}{12} = 84.17\%$$

For Contact Time 150 mins

Amount absorbed $= Pbi - Pbf$

$= 12.00 - 1.00$

$= 11$ mg/l

Percentage of lead absorbed$= \frac{Pbi - Pbf}{Pbi}$ X100

$$= \frac{11 - 100}{12} = 91.67\%$$