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Removal Of Lead From An Aqueous Solution Using River Sediment From Kashere, Gombe State, North Eastern Nigeria.

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ABSTRACT
The removal of lead by river sediment was done under laboratory stimulated condition and experimental parameters such as temperature, time, pH, concentration and dosage were carefully tested. pH of 7 was maintained and kinetics models such as pseudo first order and pseudo second order were applied and also isotherms like Longmuir and freundlich adsorption isotherms were used.
The result of the experiment showed that the removal of lead followed pseudo second order due to highest value of correlative coefficient R^2 ranging from 0.9998. Also adsorption capacity of lead at equilibrium q_e was high with value of 8.3700 in pseudo second order compared with 7.4664 of pseudo first order and the R^2 value of Langmuir is 0.9998 and value of R^2 from fruindlich 0.9424 which is lower than that of Langmuir and so the adsorption process followed Langmuir because it showed monolayer adsorption process due to the high value of R^2.
Keywords: Lead, sediments, Adsorption.

I. INTRODUCTION

Heavy metals are conventionally defined as metallic elements an atomic number greater than 20. The most common heavy metal contaminants are Cd, Cr, Cu, Hg, Pb, and Zn. It was reported by many authors that heavy metals are a term which applies to the group of metals and metalloids with atomic density greater than 4 g/cm3, or 5 times or more, greater than water (Duruibe, Ogwuegbu, & Egwurugwu, 2007).

Lead is one the major metal ions hazardous to the human body through inhalation, skin contact or with diet, and can produce adverse effects on virtually every system in the body. Low levels of Pb(II) have been identified with anemia while high levels cause severe dysfunction of the kidneys, liver, the central and peripheral nervous system (Eren, 2009) The maximum concentration in drinking water standards identified by 0.05 mg. L−1 for lead (Bala, 2008).

Several treatment processes are used for removing heavy metals from wastewater include reduction, precipitation, ion exchange, electrochemical reduction, and reverse osmosis (Annadurai, 2002) These processes are expensive, not eco-friendly, high power requirement, incomplete metal removal (Sabat, 2012).

Adsorption technique is successively alternative process that utilized for removing heavy metals from industrial wastewater, which can be performed in batch mode or continuous process. Adsorption processes have offered flexibility in design and operation and in many cases will produce high-quality treated effluent. Also adsorption is sometimes reversible process, adsorbents can be reformed by the suitable desorption process therefore adsorption mostly method applied to remove metals (Fu.F, 2011).

(Matei, G.M., Kiptoo, & O.A, 2015) Propose the use of carbon nanotube and Biosorption as absorbent for removing lead ions from waste water. Biosorption which applies biological materials, thus process can have considered as a relatively modern technology for removing even trace concentrations of heavy metals from wastewater (Matei, G.M., Kiptoo, & O.A, 2015) Agricultural and plant waste based by-products have good demonstrated bio-sorption potential for heavy metal ions (Gupta, 2015) CNTs as a good adsorbent have attracted increasing attention of many researchers because of their highly porous and hollow structure, large specific surface areas, capable of π-π electrostatic interaction, light density and strong interaction between CNTs and heavy metal ions and organic compounds (Eren, 2009)(Cheng, 2009)and (Augusta, 2010).

II. METHOD/PROCEDURE

SAMPLING

The river sediment was collected from a portion of a river course in Kashere ward in Akko Local government area of Gombe state of Nigeria, as such the river sediment was collected from the river at20cm down using Ekman dredge.

SAMPLE PRE-TREATMENT

The sediment was brought to the laboratory and washed with a distilled water for about 10 times until the river sediment was completely clean which was later subjected to dryness at room temperature for four days. The sample was Sieved using a 1mm sieve to remove big stones, plants roots, and other large particle that may contaminate the analyte. 200g of the sediment was taken and subjected to further washing with 0.5M sodium hydroxide (NaOH) and 0.1M hydrochloric acid solution (HCL) and afterwards the sediment was thoroughly with a distilled water to remove any metal or oxyanion from the surface of the sediment. Finally was allowed to dry for a period of 48 hoursin the laboratory at room temperature.

KINETIC ADSORPTION STUDIES

10g of treated sediment was added into a $400cm^3$ of 0.1M NaCl and the solution was left hydrated for 24hours time. 0.95g of Lead nitrate $Pb(NO_3)$ was added into the suspension using 500 cm^3 conical flask and agitated with a magnetic stirrer for a Period of four hours at a temperature of 25^oC.After the agitation the solution was allowed to settle for 20minutes followed by withdrawing 20ml and placed in container. The 20ml was taken trice at 20minutes interval and also twice at 30minutes interval and finally the samples was subjected to AAS analysis to detect the concentration of lead present in solution. The quantity of lead absorbed at equilibrium and the removal efficiency of the adsorbent was calculated using equations.

$$q_e = (c_i - c_e)\frac{v}{w}$$

Where q_e is the lead concentration in adsorbent at equilibrium,c_i is the initial concentration of lead,c_e is the equilibrium concentrations of lead in liquid phase, V is the volume of lead solution and w weight of sediment.

$$\text{Removal\%} = \left(\frac{(c_i - c_e)}{c_i}\right) \times 100$$

PREPARATION 0F 2mg/l,4mg/l,6mg/l,8mg/l AND 20mg/l LEAD NITRATE $Pb(NO_3)$

2.278g lead nitrate $Pb(NO_3)$ was dissolved in $500cm^3$ of distilled water in $500cm^3$ volumetric Flask making 500mg/L stock solution.$10cm^3$ of the stock solution was taken and diluted in $100cm^3$ of Distilled water making 100mg/L stock solution.Afterwards $24cm^3$,$6cm^3$,$8cm^3$and $20cm^3$ of each was diluted in $100cm^3$ of distilled water making 2mg/L, 4mg/L, 6mg/L, 8mg/L and 20mg/L solutions and finallythe solutions were taken for AAS analysis as a calibration curve data is shown below:

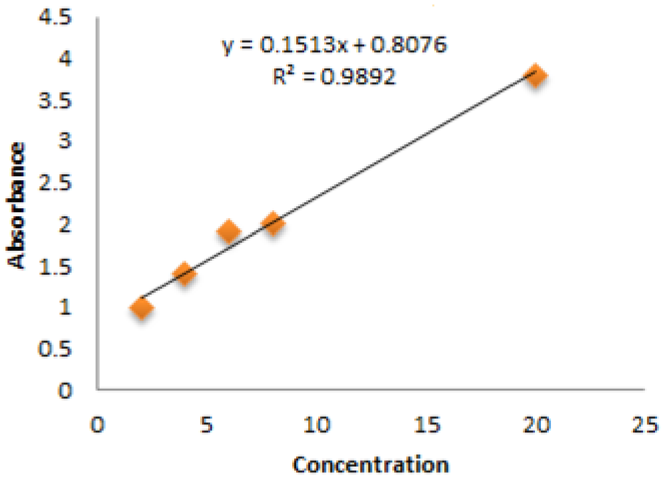

Figure 1: Calibration curve of $Pb(NO_3)_2$

EFFECT OF DOSAGE

0.01g, 0.025g and 0.05g of adsorbent wasdissolved in 80ml of 0.1M NaCl Solution each and 0.05g of lead in three different conical flask for the three respective masses was putted in the solution and were agitated with a magnetic stirrer for two hours, finally the absorbance for each was taken after allowing the solution to settle for 20 minute before taking 20ml of each concentration for AAS analysis. From the figure below showed that % removal of lead was optimum at 0.05g and therefore the removal of lead goes with increase of dosage.

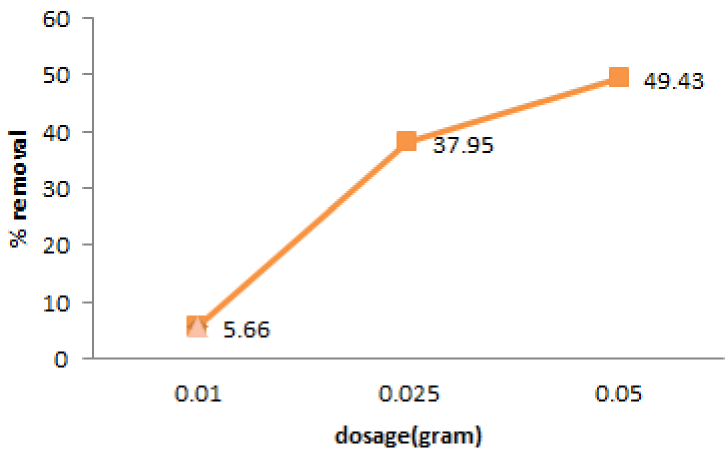

Figure 2: Effect of dosage on removal efficiency of $Pb(NO_3)_2$

EFFECT OF TEMPERATURE

2g of river sediment was added into three beakers containing 80ml 0f 0.1M sodium chloride in the Beakers, 0.19g of lead nitrate $Pb(NO_3)$ was also added to each beaker containing 2g river sediment and the temperature was varied at 25, 35 and 50^0C. Finally it was agitated for two hours and the absorbance was taken from each beaker. The figure below showed that the removal of lead increase with the decrease in temperature and it indicated that the removal of Leadis optimum at room temperature under stimulated environmental condition.

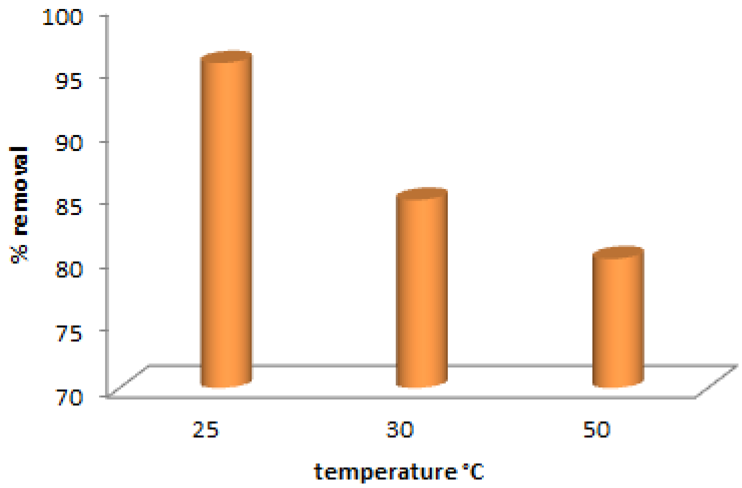

Figure 3: Effect of temperature on adsorption capacity of$Pb(NO_3)_2$

EFFECT OF CONTACTS TIME

After the suspension was agitated for a period of four hours, it was allowed to settle for 20 minutes and Followed by pipetting 20cm^3 from the suspension using a pipette and transferred into a special sample bottle, another 20cm^3 of the suspension was taken after next 20minutes until 1 hour making three samples. 20cm^3 of the suspension was pipetted after 30minutes and another was also withdrawn after 30minutes making it one hour, making a total of two hours' time and five samples respectively were taken for AAS analysis. From the figure below showed that the removal of lead increase with increase in time at 20 to 40 minutes but it was slightly decreased from 60 to 120 minutes due to behavior of heavy metals adsorption on external surface of adsorbent.

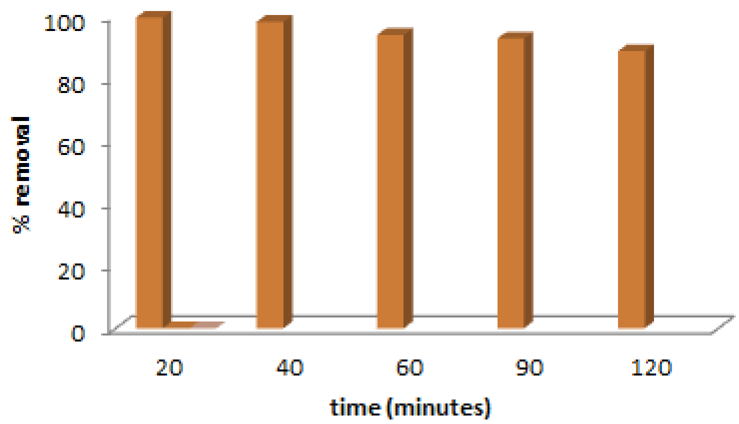

Figure 4: Effect of contact time on removal of $Pb(NO_3)_2$

ADSORPTION ISOTHERM MODELS

The adsorption isotherm of lead onto kashere river sediment was studied at 25°C and initial solution pH of 7. Two commonly used adsorption isotherm models were used in this study to evaluate the adsorption capacity of sediment. Applicability of the isotherm equation to adsorption data was based on comparison of the correlation coefficients (R^2) values of both models. The Langmuir and Freundlich plots are shown in Figures below while the adsorption parameters obtained from this plots are tabulated in Tables 1 and 2.

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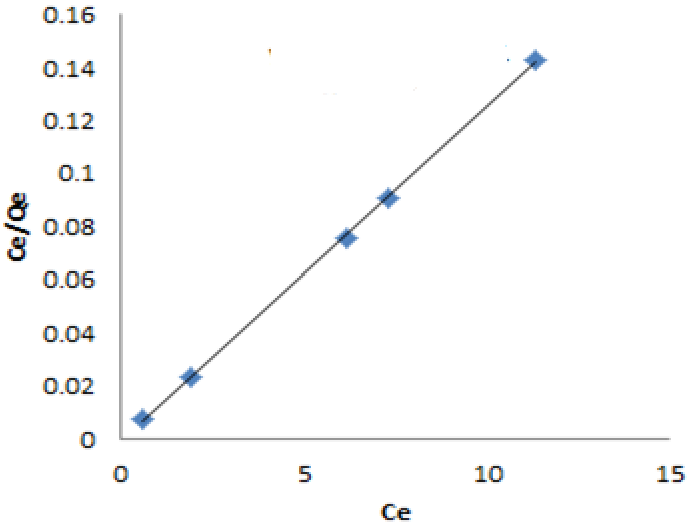

Figure5: Langmuir plot of $Pb(NO_3)_2$ on sediment

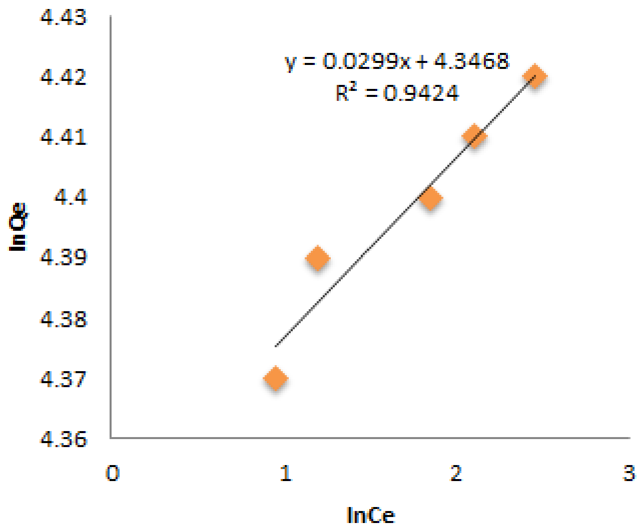

Figure6: Freundlich plot of $Pb(NO_3)_2$ on sediment

From the above figures, the R^2value of Langmuir is 0.9998 and value of $R^2$from fruindlich 0.9424 which is lower than that of Langmuir and so the adsorption process followed Langmuir because it showed monolayer adsorption process due to the high value of R^2.

Isotherm	**parameter**				
Langmuir	T(K)	q_m (mgg^{-1})	KL (Lmg^{-1})	R_L	R^2
	298	9.09	0.793	0.0126-0.011	0.9998
Freundlich	T(K)	K_f(mg/l)($L/mg^{1/n}$)		1/n	R^2

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	298	2.3	0.0299	0.9424

ADSORPTION KINETIC MODELS

The adsorption kinetic models that were used in removal of lead experiment are pseudo first order and pseudo second order kinetic models. The mechanism in removal of lead followed pseudo second order which also have highest R^2 value.

model	parameter				
Pseudo first order	T(K)	$q_{e,cal}$(mg/g)	$q_{e,exp}$(mg/g)	K_1	R^2
	298	0.5290	7.4660	0.1366	0.9980
Pseudo second order	T(K)	$q_{e,cal}$(mg/g)	$q_{e,exp}$(mg/g)	K_2	R^2
	298	1.8900	8.3700	0.012	0.9990

III. CONCLUSION

Our experiment for the removal of lead from aqueous solution using sediment was achieved an optimum removal via adsorption process which is the best method for removal of heavy metals due to its initial cost, simplicity of design, ease of operation, and insensitivity to toxic substances. And also sediment is a good adsorbent due its good absorbing properties such as high porosity of particles, large size and attractive surface.

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