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A STUDY ON UTILIZATION OF GROUNDNUT SHELL AS BIOSORBENT FOR HEAVY METALS REMOVAL

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Abstract:

Heavy metals are toxic and harmful water pollutant. Their presence not only affects the human being but also affects the animals and vegetation because of their versatility in aqueous ecosystem. Biosorption process has attracted attention of many researchers because low cost, design flexibility and efficiency.The main objective is to study the effectiveness of groundnut shell as biosorbent for lead and copper removal from the wastewater for batch adsorption study. An investigation was carried out to identify the effect of pH, contact time and dosage for the same sieve size of ground shell at standard temperature condition. Biosorption parameters were determined using both Langmuir and Freundlich isotherms, but the experimental data were better fitted to the Langmuir equation than to Freundlich equation. Results showed that the maximum removal efficiency of lead and copper 68.2% and 77.8% respectively.

Key words: heavy metals, biosorption, groundnut shell.

INTRODUCTION

Contamination of heavy metals present in aqueous waste outflow from multiple industries such as mining, Tanneries, metal plating, paints, car radiator manufacturing moreover agricultural origin whereas fertilizers and fungicidal spray laboriously used. Heavy metal ions are present in the form of transition series such as copper, iron, nickel, lead etc., in the environment is vital concern due to their noxious for many living life. Heterogeneous organic pollutants, most of which are adoptable to biological deterioration, metal ions do not degrade into unobjectionable end products. However Heavy metal removal from aqueous solution can be reached by conventional methods, such as oxidation/reduction, evaporative recovery, filtration, chemical precipitation, ion exchange and membrane technologies, electrochemical treatment, inefficient or cost-expensive

In recent study, adsorption technology has one of the different technology, extremely for the widespread industrial use. The most widley used adsorbent as activated carbon. However prolific use, it is found that the carbon always remains expensive materials where as carbon remains higher the quality the cost is also increases. Activated carbon also requires heterogeneous materials to upgrade the removal performance of inorganic matters. Accordingly, this situation made it no longer attractive to be used in small scale industries because inefficient in cost inefficiency

Nowadays, biological adsorbents are being used effectively and efficiently. It is observed that appropriated modification of the raw biosorbents by crown esters and sulphur bearing groups like sulphides, thiols, dithiocarbamates and dithiophosphates can eliminate the drawbacks and improve their performances significantly.

Biosorption is a process that utilizes low-costbiosorbents to sequester toxic heavy metals. Biosorption has distinct advantages overthe conventional methods which include: reusability of biomaterial, low operating cost, selectivity for specific metal, short operation time and no chemical sludge.

This work includes the utilization of groundnut shell which is a low cost biosorbent for the removal of heavy metals from aqueous solutions. Equilibrium studies and kinetic studies are conducted by varying parameters like pH, dosage, concentration

I. MATERIALS AND METHODS

A. METHODOLOGY

For single metal system solutions, a determined quantity(100ml) of stock solution of different concentration in a conical flask were rigorously mixed with 5 g of biosorbent dose at 30°C and 100 revolution per minute (RPM) for 12h.A contact period of another 12h for sorption experiment will be done to get equilibrium. The pH range will be varied from 1 to 9 by using 0.1 M HNO3 and 0.1 M HCl solutions. The solution will be separated by filtration method from biomass by using wattman filter paper. Filter from the SMS will be mixed to 10 to 20 mg/L with distilled water4 and analyzed for concentration of metal using Atomic Absorption Spectrometer (AAS). Metal uptake capacity(q) against residual concentration of metal(Cf) in the solution were plotted for equilibrium isotherms of biosorption

B. ISOTHERM EXPERIMENT

In batch mode demonstration were carried out. Metal ions of aqueous solution of different concentrations (10-1000mg/L) of 100 ml samples were taken and pH as adjusted then transferred to 250 ml conical flask. For the solution Predetermined amounts of bisorbent were added. After 24h,filtered solution and concentrations of heavy metal in the filtrate will be determined. Flame Atomic Adsorption Spectroscopy (FAS)was used for the determine of amount of concentration of metal ion in the sample. Concentrations of metals are detained in the phase of sorbent (qe, mg/g) were calculated from the expression

$$q_e = \frac{(C_o - C_e)V}{m}$$

Where,

Co=initial metal ion absorption in solution (mg/L),
Ce= Final (equilibrium) metal ion absorption in solution (mg/L),
V = solution volume (L), and
m = sorbent mass (g).

C. ISOTHERM AND EQUILIBRIUM MODELING

- **ISOTHERM MODELS**

Number of model described by the equilibrium of sorption In this work, two different models are considered: ·

- Freundlich; and ·
- Langmuir

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Freundlich isotherm is one of the empirical formula, it takes into account that the surface is heterogeneous in nature and adsorption is multilayer to the binding sites located on the sorbent surface. The model of freundlich is expressed as:

$$\frac{x}{m} = Kf \cdot Ce^{1/n}$$

Where,
$\frac{x}{m}$= Amount of solute adsorbed per unit weight of adsorbent.
K_f=Freundlich capacity factor.
1/n = Freundlich intensity parameter.
C_e = Equilibrium concentration of adsorbate (solute) in solution after adsorption.

Langmuir model is assumed to be a monolayer adsorption of solutes on to the surface which is comprised of finite number of similar sites with the homogeneity in adsorption energy. The model of Langmuir is expressed as

$$\frac{x}{m} = \frac{abC_e}{(1 + bC_e)}$$

Where,

$\frac{x}{m}$= amount of solute adsorbed per unit weight of adsorbent.
a= empirical constant.
C_e= equilibrium concentration of adsorbate (solute) in solution after adsorption.
b = constant that represents the affinity between the biosorbent and the metal ion.

D. EQUILLIBRIUM MODELS

Examination & initial testing of solid–liquid system of sorption which are based on 2 types experiments.

- Batch sorption test which is in equilibrium.
- Continuous flow which is in dynamic.

II. RESULTS AND CONCLUSIONS

From graph 1, it was noticed that for a period of contact of 12h, the efficiency of removal and specified uptake of copper depends on the quality and type of the adsorption. The removal % of copper using powder of ground nut shell as a adsorbent of varied amount from 5 to 50g/L was 30.4 %to 68.2 % as represented in graph 1

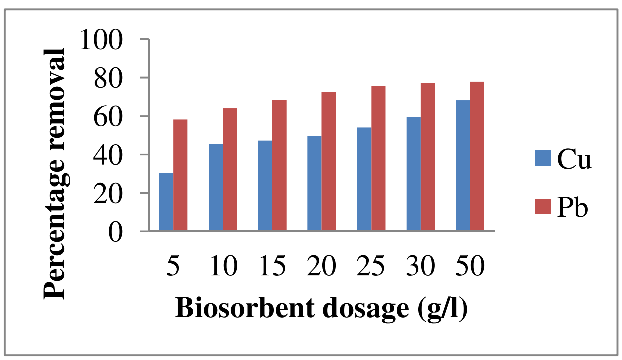

Fig.1 Percentage removal of Cu (II) and Pb (II) using groundnut shell for varying biosorbent dosage

One of the most important characteristic of heavy metal adsorption is pH and the metals undergo evolution in the solution which is pH dependent. In the solution pH was varied from 1.0 to 6.3 by using acid and base of 0.1N and a graph 2 is plotted using groundnut shell for pH variation Maximum removal of Cu(II) was achieved at pH 5±0.01,whereas Pb(II) had an optimum pH of 5±0.02. both metals undergo precipitation when pH is higher , so that adsorption was not studied under pH 6.5

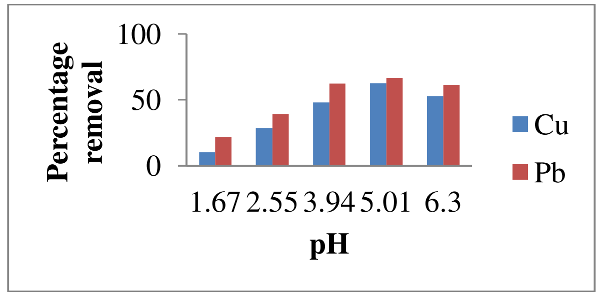

Fig. 2 Percentage removal of Cu (II) and Pb (II) using groundnut shell for pH variation

Maximum removal of Cu(II) was attain at pH 5±0.01,whereas Pb(II) had an optimum pH of 5±0.02. when pH is higher of about 6.5 r both the metals undergo precipitation occurred, because of this reason adsorption was not measured beyond pH of 6.5.Percentage removal of Cu (II) and Pb (II) using groundnut shell powder gradually decreased when the percentage dilution concentration of stock solution increased as shown in graph 3.

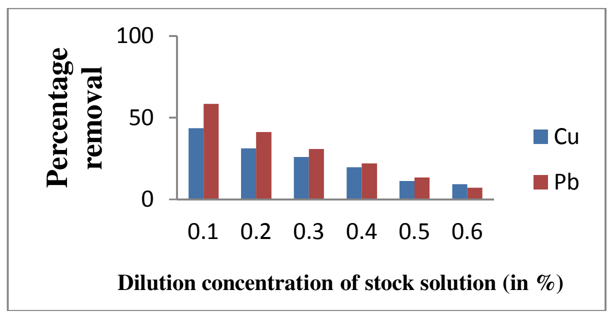

Fig. 4 Percentage removal of Cu (II) and Pb (II) using groundnut shell for variation in dilution concentration of stock solution

The Freundlich isotherm plotted using x/m vs. C_e resulted in a linear plot as shown in graph 4. The $\mathbf{k_f}$ values determined from the plot for Cu (II) and Pb (II) were found to be 2.738 and 1.03 respectively. The **n** values determined from the plot for Cu (II) and Pb (II) were found to be 7.69 and 2.78 respectively.

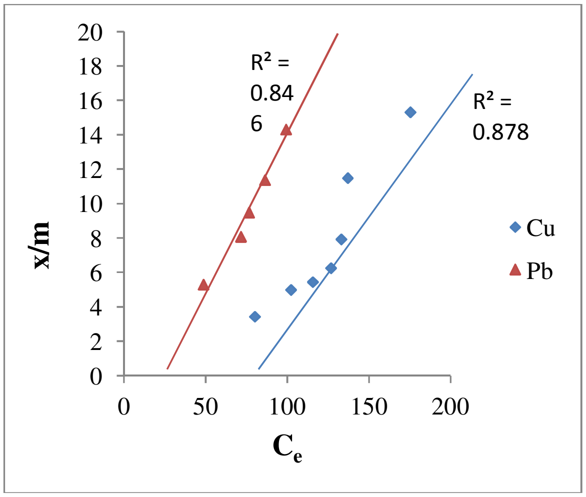

Fig. 4 Freundlich isotherm using groundnut shell

The Langmuir isotherm plotted using C_e/(x/m) vs. C_e resulted in linear plot as shown in graph 4.5. The Langmuir isotherm parameters a and b were obtained from the plot. The values of **a** for Cu (II) and Pb (II) were found to be 15.994 and 40.61 respectively. The values of **b** for Cu (II) and Pb (II) were found to be 0.13 and 0.07 respectively.

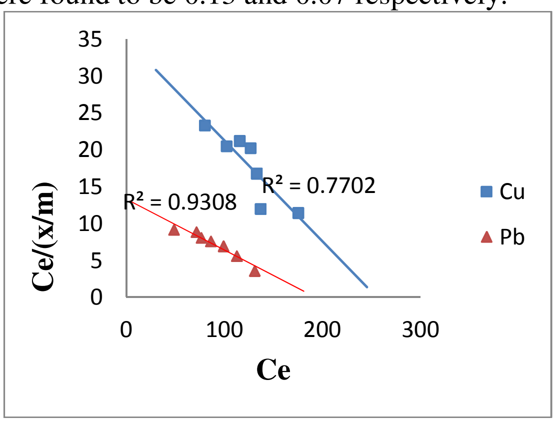

Fig 5: Langmuir isotherm using groundnut shell

In order to obtain the biosorption kinetics for Cu (II) and Pb (II), the Lagergren first order and pseudo second order kinetic models were applied

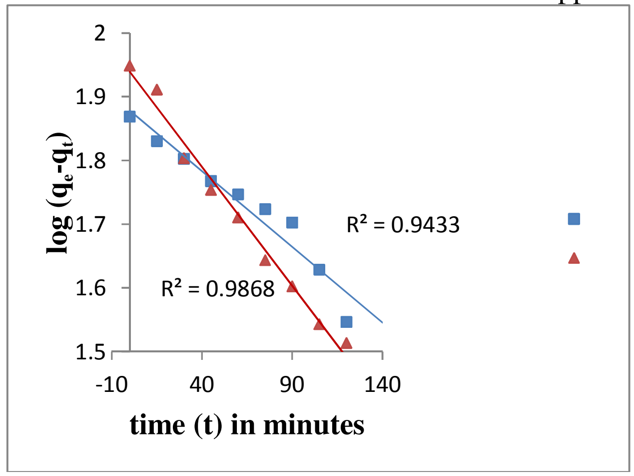

Fig. 6 Lagergren first order model using groundnut shell

The Lagergren first order model plotted using time(t) vs. log(q_e-q_t)resulted in straight lines as shown in graph 6. The value of k_1 and q_e were determined from the slope intercept of line which is as presented in table 4.8.

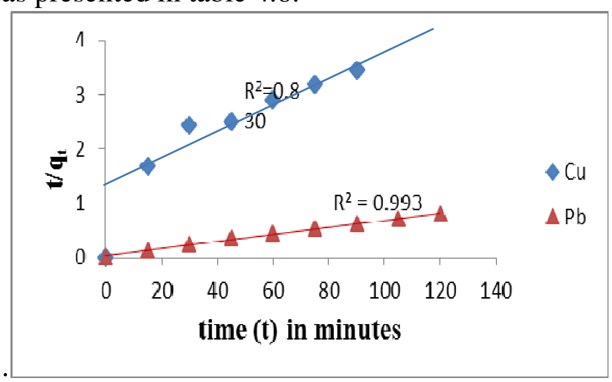

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Fig 7: Pseudo second order model using groundnut shell

Pseudo second order kinetic model plotted using t/q_e vs. time(t) resulted in straight lines as shown in graph 4.7.

When the comparsion of the two kinetic models were conducted, the correlation coefficient (R^2)values for Cu(II) were 0.943 and 0.830 respectively, which best fitted in first order kinetic model.

Whereas the correlation coefficient (R^2) values for Pb (II) were 0.943 and 0.993 respectively. Thus the plot best fitted and followed pseudo second order kinetic model.

CONCLUSIONS

- The removal efficiency for Cu (II) and Pb (II) using groundnut shell powder as biosorbent are 68.2% and 77.8% respectively. The optimum dosage for maximum copper (II) and lead (II) are 50 g and 30 g respectively.
- By comparing the results obtained, for 12 hours contact time with groundnut shell powder showed substantial increase in Cu (II) and Pb (II) removal.
- The pH was found to be the most important factor affecting the biosorption potential. Results obtained showed that, maximum adsorption was achieved in acidic range.
- From adsorption isotherms plotted for the results obtained showed that, the efficient removal of Cu (II) best fitted in Freundlich isotherm rather than Langmuir isotherm. Whereas the efficient removal of Pb (II) best fitted in Langmuir isotherm rather than Freundlich isotherm.
- From the biosorption kinetic study models plotted for the results obtained showed that, Cu (II) and Pd (II) best fitted in Lagergren first order model and pseudo second order kinetic model respectively.
- According to cost analysis done, cost to treat one litre of wastewater containing heavy metals is estimated to be Rs. 3.5/-. Hence, the method is economical
- Heavy metals removal using groundnut shell is a low cost wastewater treatment and can be effectively used in small scale treatment plants.
- Transportation and storage problems for biosorbent are negligible.

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