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FERRONIA ELEFUNTUM FRUIT SHELL : A CARRIER FOR SCAVENGING THE BISMUTH FROM AQUEOUS SOLUTION

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ABSTRACT

The studies on removal of Bismuth were conducted using *Ferronia elefuntum* Fruit shell. Adsorption efficiency has been evaluated. The effect of pH, contact time, adsorbent dose, concentration of metal, particle size and temperature were studied. The results reveal that Langmuir and Freundlich isotherms are followed during adsorption process. Thermodynamics parameter indicate the feasibility of the process. Kinetic studies have been performed to understand the mechanism of adsorption. Column studies have been carried out to compare these with batch capacities.

INTRODUCTION

The Twentieth century started with an extensive damage to the natural resources (Tomer, 1999). Unplanned industrialization, urbanization, pollution explosion, change in life-style, over exploitation of natural resources, commercial establishment and modern agricultural practices have degraded the quality of environment. The main effects being faced are :

- Continental invasion of air and water.
- Marine pollution through waste discharges.
- Release of variety of chemical and biological con taminants into the water bodies, on land and in air.
- Ground water pollution.
- Acid rains and nuclear fallout.

These effect are not only covering the pollution of environment but also are responsible in creating genetic erosion in plant, animals including human beings and microorganisms. Water is a prime natural resource and is a basic human need. The availability of adequate water supply in terms of its quality and quality is essential for the existence of life.

Water is available in nature as surface water and ground water through the selfpurification mechanisms like physical, chemical and microbiological process at natural bodies, are carried out in nature. However, natural water is rarely suitable for direct consumption to human beings. Rapid industrialization and population growth resulted to generation of large quantities of wastewater and causing problem of their disposal. Industrial waste constitutes the major source of various kinds of metal pollution in natural water. The presence of heavy metals in the environment has been of great concern because of their increased discharge, toxic nature and other adverse effects on the receiving streams. When the concentration of toxic metal ions exceed tolerance limit, they may become real health concern (Singh and Lal, 1992). There is an immediate need to introduce cleaner technologies to minimize the pollution and to protect the degrading environment. It is not possible to achieve zero waste discharge but it is an

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essential to treat the waste.

Among the toxic heavy metal ion which present in potential health hazard to aquatic animals and human like Pb, Cd, Cr, V, Bi and Mn are important.

The maximum tolerance limit for Bismuth (III) for public water supply are 0.5 mg/L. Toxicity of metal depends on the type of metal, doses & the ionic form.

Toxicity of Bismuth [III] and its salt include malaise, kidney damage, albuminuria, diarrhea, skin reactions, tremor of the finger and hands and sometimes serious exodermatitis.

Literature survey reveals that, there are many methods namely coagulation, precipitation, ion exchange and adsorption, for removal of Bismuth (III) metal ions from aqueous medium. However, adsorption is an easy and economical process for removal and retrieval of cation from aqueous medium. Efficiency of adsorption process mainly depends on nature of absorbent, absorbate, pH, concentration, temperature, time of agitation etc.

These cheap and efficient absorbents can carry to cater the need of population in the rural areas and the population in the industrial area where safe drinking water is not available. In the present study, Bismuth (III) is removed by using *Ferronia elefuntum* Fruit (Gharde *et al.* 2004; Shukla and Shkhardande, 1992; Lhagan *et al.* 1992; Rampure and Patilk, 1996) as a adsorbent.

Adsorbent

The *Ferronia elefuntum* fruit shell was first dried at a temperature of 160^{0}C for 6 hours. After grinding it was sieved to obtain average particle size of 200 mesh. It was then washed several times with distilled water to remove dust and other impurities. Finally it was dried again in an oven at 50^{0}C for 6 hours. The adsorbent was then stored in desiccator for final studies.

Batch study

The dried amount of 0.5 g of Ferronia fruit shell was taken in 250 mL reagent bottle and synthetic solution (200 mL) containing various concentration of Bismuth (III) ion was added and system is equilibrated by shaking the contents of the flasks at room temperature so that adequate time of contact between adsorbent and final concentration of metal ion. Bismuth (III) was determined by spectrophotometry (Lagergren and Bil, 1998) using Hypo-phosphorus acid and potassium iodide method and measured absorbance at 460 nanometer. The spectrophotometer, Systronic (model 104) was used to measure the concentration of Bismuth (III) ions.

Equillibrium adsorption isotherm for Ce verses qe, plotted for *Ferronia elefuntum* fruit shell are shown in Figure 1. The adsorption capacity in mg/L was calculated then the equation.

$$qe = (Co - Ce)\ V/M$$

Where, Co is the initial concentration of Bisbuth (III)
Ce is the concentration at equilibrium in mg/L
V is the volume of solution in litre and
M is the mass of adsorbent in grams.

ADSORPTION ISOTHERMS

Equilibrium isotherms was studied for both Langmuir and Freundlich isotherms. The results are shown in Figure 2 and 3 which, illustrate the plot of Langmuir and Freundlich isotherms of *Ferronia elefuntum* fruit shell of Bismuth (III). The saturated monolayer can be represented by :

$$qe = \frac{QobCe}{1 + bCe}$$

The linearised form of the Langmuir isotherms is

$$\frac{1}{qe} = \frac{1}{Qob} \times \frac{1}{Ce} + \frac{1}{Qo}$$

Where Qo and b are Langmuir constants. The plot of 1/Ce Vs 1/qe was found to be linear, indicating the applicability of Langmuir model. The parameters Qo and b have been calculated and presented in Table 1. The langimuir constant Qo is a measure of adsorption capacity and b is the measure of energy of adsorption. In order to observe whether the adsorption is favourable or not, a dimentionless parameter 'R' obtained from Langmuir isotherm is.

$$R = (1 + b \times Cm)^{-1}$$

Where b is Langimuir constant and Cm is maximum concentration used in the Langmuir isotherm. The adsorption of Bismuth (III) on *Ferronia elefuntum* fruit shell is a favourable precess as "R" values lie between zero to one. Coefficients of co-relation are also shown in Table 1. The applicability of Freundlich isotherm was also tried using the following general equation.

$$qe = k.Ce^{B}$$

lineearised form of this equation is

$$\log qe = B.\log Ce + \log k$$

Wher B and k are Freundlich constants. These constants represent the adsorption capacity and the adsorption intensity respectively.

Plot of log qe Vs log Ce was also found to be linear. The values of B and k are presented in Table 1. Since the value of B are less than 1, it indicates favourable adsorption.

Table 1. Isothermal constants

Langmuir Constants				Freundlich Constants		
Qo	b	r	R2	k	B	R2
7.5721	0.185	0.491	0.9847	0.6134	0.5007	0.9825

RESULTS AND DISCUSSION

Effect of concentration of metal ion and contact time

The response of Adsorbate dose and contact time on the removal of Bismuth (III) is presented in Figure (1). The observations reveal that an increase in the adsorbate dose, rate of adsorption increase upto certain level and then it become constant. Also as the time of contact increase, adsorption increase and then it become constants.

Effect of pH on the removal of bismuth (iii)

The effect of pH on the removal of Bismuth (III) is shown in Figure (4). Experiment were conducted at the constant initial Bismuth (III) concentration, adsorbent dose (*Ferronia elefuntum* fruit shell) of 0.5 gm/100 mL and the contact time of 4 hours. The pH of the aqueous solution is an important controlling parameter in the adsorption process. It was observed that the percentage removal of Bismuth (III) is higher at pH = 1 and then decrease with increase of pH.

Effect of particle size

The adsorbent particle size has significant influence on the kinetics of adsoroption. The influence of particle size furnishes important information for achieving optimum utilization of adsorbent. Four particle size 50, 100, 150, 200 micron size (Indian Standard Services) under optimum condition. It is found that, as the particle size increase the rate of adsorption decrease.

Kinetics of adsorption

0.5 gm of *Ferronia elefuntum* fruit shell and 200 mL Bi+++ solution was taken in 1000 mL R.B. and shaken vigorously for about four hours. After every 15 minutes, 5 mL sample of the solution was withdrawn for the first hour and subsequently the interval between the sample withdrawn was increased to 30 minutes. The concentration of the metal ions in the sample, withdrawn were determined by the spectrophotometry and were designated as Ct and the value of the concentration of the metal ion on the *Ferronia elefuntum* fruit shell at the same time interval estimated using the relation.

$$q = (Co - Ct)\ V/W$$

The rate of adsorption of Bismuth (III) on Ferronia Elefuntum Fruit Shell was studied by using the first order rate equation proposed by Lagergren (10)

$$\text{Log } Ct = \log Co - \frac{K_{ad}}{2.303}\, t$$

$$Kad = \frac{2.303}{T} \log Co/Ct$$

Where Kad is the rate constant for adsorption.
The plote of logCt Vs t is shown in Figure 5.

CONCLUSION

The following conclusions can been drawn from the presents study:

1. The percentage retrieved of Bismuth (III) is formed to be increase with decrease the initial concentration of Bismuth (III). The removal is found rapid in initial stages followed by slow adsorption upto saturation limit.
2. The developed technique of retrieval of Bismuth (III) ions using *Ferronia elefuntum* fruit shell appears to be a cheap and practically viable for the use of semiskilled worker in the villages.
3. The present work on adsorption process is in good agreement with Langmuir isotherm indicating monolayer adsorption process.
4. The result on adsorption process reveals that at pH = 1.0, Bismuth (III) uptake capacity is better.
5. The straight lines plots of logCt Vs t for the adsorption show the validity of Lagergren

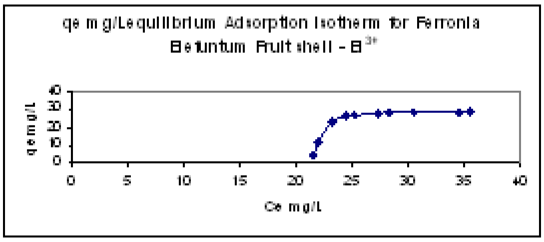

Fig. 1

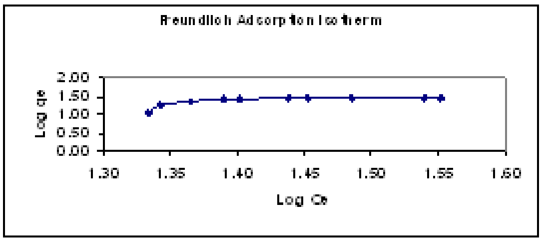

Fig. 2

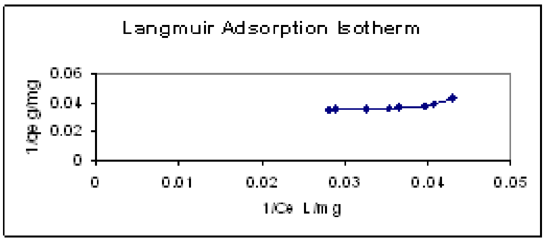

Fig. 3

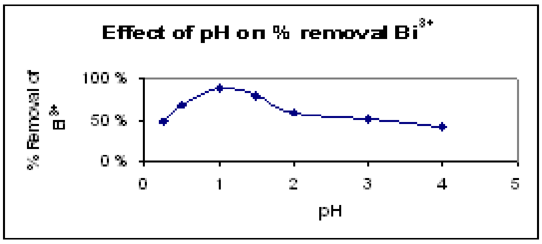

Fig. 4

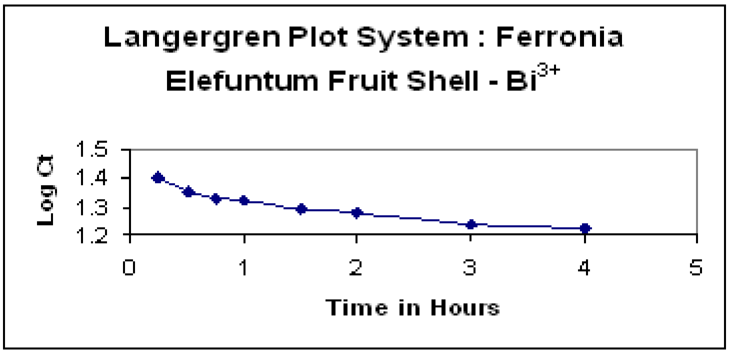

Fig. 5

equation and suggest the first order kinetics.

6. Regeneration studies are not necessary with the view that the cost of the adsorbent is very low and it can be disposed of safely.

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