EVALUATION OF ADSORPTION EFFICIENCY OF COMMIPHORA WIGHT FOR SCAVENGING CO (II) METAL IONS FROM WASTE WATER

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ABSTRACT

In this research work, activated carbon prepared locally from The   Commiphora Wightii bark(CWB) was examined for the removal of cobalt (II) from aqueous solution. The main parameters, like effect of adsorbent dosage, Co (II) concentrations, effect of contact time and effect of pH was studied in batch experiments. The experimental results were analyzed by using Langmuir, Freundlich, adsorption isotherm models. The kinetic data well described by the pseudo-first-order kinetic model. The various thermodynamic parameters such as and were also determined. The CWB was successfully employed for removal of cobalt (II) ion from aqueous solution and the technique appears industrially applicable and feasible.

Keywords: Adsorption, *Commiphora Wightii* bark, Cobalt (II), Adsorption kinetics, Thermodynamics adsorption isotherm.

INTRODUCTION

The safety our environment has been continuously rapid increase in urbanization, industrialization and human activities Heavy metals are toxic pollutants released into the surface and ground water as a result of various activities such as industries, mining and agriculture. The rapid pace of industrialization has led to severe problem of water pollution. Heavy metal scan easily enter the food chain introduction. The safety our environment has been continuously rapid increase in urbanization, industrialization and human activities . Cobalt, a natural element present in certain ores of the Earth's crust, is essential to life in trace amounts. It exists in the form of various salts. Pure cobalt is an odorless, steely-gray, shiny, hard metal. Everyone is exposed to low levels of cobalt in air, water and food. An average of 2 gdm^{-3} in drinking water has been estimated. Heavy metals are toxic pollutants released into the surface and ground water as a result of various activities such as industries, mining and agriculture . The rapid pace of industrialization has led to severe problem of water pollution. Heavy metal scan easily enter the food chain because of their high solubility in water. These heavy metals may include copper, iron, zinc, cadmium, lead, cobalt etc. Thus taking into account the harmful effect of these heavy metals, that causes a number of health problems, diseases and disorders Cobalt (II) compounds are essential in many industries. Their applications in nuclear power plants, metallurgy, mining, pigments, paints and electronic are only few examples where the presence of cobalt in waste waters represents a major environmental problem. The treatment technologies more frequently cited for removal of heavy metals are carbon adsorption, wet oxidation, solvent extraction, precipitation, ultra filtration, reverse osmosis, ion-exchange, etc. Among these options, adsorption is most preferred method and activated carbon is most effective adsorbent widely employed to treat wastewater containing different classes of metal ions/dyes, recognizing the economical drawback of commercial activated carbon. Activated carbon has been quite successful for removal of impurities from exhaust gas and waste water streams. The highly porous nature of the carbon provides a large surface area for contaminants to get deposited. The adsorption takes place because of the attractive force between the molecules. In this study, the batch experiments were conducted in order to investigate the removal of cobalt (II) ions from aqueous solutions using Commiphora Wightii bark(CWB) prepared.

EXPERIMENTAL

Adsorbent Preparation

Commiphora Wightii bark (CWB)tree bark was collected from a local farm. It was cut in to small segment and dried in sunlight until almost all the moisture evaporated. Then it was ground to get desired particle size of 100 to 200 micron. It was then soaked 2 hours in 0.1M NaOH solution to remove the lignin content. Excess alkalinity was then removed by neutralizing with 0.1 N HCl. The CWB was then washed several times with distilled water till the washings are free from color and turbidity. The washed CWB was oven dried at 200^0 C for 24 hrs and was then stored in desiccators for final studies.

Adsorbate Preparation and Batch study – Stock solution (1000 mg/L) of Cobalt (II) was prepared by dissolving 1 gm of Cobalt (II) in 1000 ml of double distilled water. The stock solutions were diluted with double distilled water to obtain required standard solution. The dried amount of 500mg of Granulated particle of bark was take in 250 ml reagent bottle and standard solution (200ml) containing various concentration of Cobalt (II) was added and system is equilibrated by shaking the contents of the flask at room temperature. The adsorbent and adsorbate were separated by filtration and filtrate was determined by spectrophotometer. The spectrophotometer systronic (model 104) was used to measure the concentration of cobalt (II). Effect of pH on the scavenging the cobalt (II) was studied using 200ml Cobalt (II) solution having 40 mg/L initial concentration. Effect of initial concentration, agitating time and adsorbent dose was also studied.

RESULTS AND DISCUSSION

Effect of contact time and initial Cobalt (II) ion concentration

The effect of contact time on Cobalt (II) adsorption on CWB was investigated to study about the rate of removal of cobalt ion. The percentage removal of Cobalt (II) for various values of initial Co ion concentration ranging from 10,20,30,40,50,60mg/L and batch experiments were carried out by taking 200 ml of this solution with dried 500 mg of the adsorbent and the system is equilibrated by shaking the contents of the flask at room temperature, equilibrium reached in 4hours. Final concentration of Cobalt (II) was determined by spectrophotometer . The percentage removal of Cobalt (II) was observed to be 85%. To establish equilibrium time for maximum uptake and to know the kinetics of adsorption process, the adsorption of Cobalt (II) on adsorbent was studied as a function of contact time. As the concentration of metal ion increases, more and more surface sites are covered and hence at higher concentrations of metal ions the capacity of the adsorbent get exhausted due to non availability of the surface sites .It is therefore evident that at low concentration ranges the percentage of adsorption is high because of the availability of more active sites on the surface of the adsorbent.

Effect of pH

The solution of pH is an important parameter in the adsorption process of metal ions from aqueous solutions, which affect both the dissociation degree of functional groups from adsorbent surface and the speciation and solubility of metal ions. The effect of pH on the removal of cobalt ion using CWB as an adsorbent was studied with initial pH range from 2 to 6. The relation between the initial pH of the solution and percentage removal of cobalt ion is depicted. The percentage adsorption Cobalt ions increased appreciably with increase of pH from 3 to 5.

Effect of adsorbent dose

Batch adsorption studies were performed to determine the effect of sorbent dosage on Cobalt (II) removal. The percent removal increase rapidly and reaches about 85%. For 100% removal of the Cobalt (II), the dosage required is 300mg/50ml for the initial concentration of 50 mg/L at pH = 4.5

Sorption Kinetics

The rate of adsorption of cobalt (II) on Granulated particle of *Commiphora Wightii* bark was studied by using the first order kinetic model, Pseudo second order kinetic are used to test the experimental data.

First order kinetics

The rate of adsorption of Cobalt (II) on Granulated particle of Commiphora Wightii bark was studied by using the first order rate equation proposed by Lagergren. It is found that as initial Cobalt (II) concentration increases, Lagergren rate constant decrease. This indicate that, adsorption does not follow the 1st order kinetics.

Pseudo Second order models

Pseudo second order model showed that, Rate constant K_2 is almost constant at different initial concentration which is shown in Table-1. This indicates that adsorption of Cobalt (II). On Granulated particle of Commiphora Wightii bark obey the 2nd order kinetics. Also the concentration of Cobalt(II) increasing from 20mg/L to 60 mg/L, equilibrium sorption capacity q_e increase.

Table-1: Kinetic model value for adsorption of Cobalt (II) on Granulated particle of *Commiphora Wightii* bark

concentration	I^{st} order			Pseudo second order		
	K_L	q_e	r^2	q_e	k_2	r^2
20mg/L	0.0412	7.70	0.980	8.124	0.0015	0.9786
40mg/L	0.0399	13.21	0.989	13.210	0.0013	0.9760
60mg/L	0.0270	19.15	0.996	18.526	0.0011	0.9770

Isotherm Modeling
Langmuir Adsorption Isotherm

The Langmuir sorption isotherm is shown in Table -2. Q_o values found to be comparable with commercial activated carbon. Value of b lies between 0 and 1 indicate the favorable adsorption. It indicates the applicability of Langmuir adsorption isotherm. The calculated value R^2 confirm the applicability of Langmuir adsorption isotherm.

Freundlich Adsorption isotherm

Freundlich plot for the adsorption of Cobalt (II) on Granulated particle of Commiphora Wightii bark is given in Table-2. It shows that the values of adsorption intensity 1/n < 1, reveal the applicability of Freundlich adsorption.

Table-2: Langmuir and Freundlich isotherm parameters for Pb (II) ions uptake by AETB

Pb(II) Concentration	Freundlich Constants			Langmuir Constants		
Conc.	K	1/n	R^2	Q_0	b	R^2
20mg/L	4.898	1.169	0.923	22.72	0.018	0.944
30mg/L	5.645	1.214	0.958	25.87	0.045	0.978
40mg/L	6.542	1.381	0.989	28.65	0.069	0.981

Table-3: Thermodynamics Parameters

Temperature	ΔH	Δs	ΔG
30 ^{0}C			-15
40 ^{0}C	7.94	0.075	-16.9
50 ^{0}C			-18.3

Thermodynamics Parameters

The influence of temperature upon the adsorption rate was investigated at 30^{0}C, 40^{0}C and 50^{0}C. It is observed that mass of the Cobalt (II), adsorbed per unit mass of adsorbent increase with increasing temperature. The heat of adsorption was calculated and shown in Table-3. The negative value of free

energy change G indicates the feasibility and spontaneous nature of adsorption of Cobalt (II). H value suggests endothermic nature of Cobalt (II) on Granulated particle of Commiphora Wightii bark. Positive value of S is due to increase randomness during adsorption of Cobalt (II).

CONCLUSIONS

1. Granulated particle of *Commiphora Wightii* bark was studied as good adsorbent for removal of Cobalt (II). The removal is found rapid in initial stage followed by slow adsorption up to saturation level. It also depend an initial concentration of adsorbate and agitating time.
2. The present work on adsorption process is in good agreement with Langmuir & Freundlich isotherm indicating monolayer adsorption process.
3. The result of adsorption process reveals that at pH = 4.5Cobalt (II) uptake capacities is better.
4. The adsorption of Cobalt (II) followed the Pseudo second order model.
5. Study of temperature effects on Freundlich parameters reveals increasing trend in adsorption capacity with increase in temperature. It followed the endothermic process.
6. It is calculated that the adsorbent prepared from Granulated particle of *Commiphora Wightii* bark could be exploited for commercial applications. Regeneration studies are not necessary with the view that the cost of the adsorbent is very low and it can be disposed of safely.
7. As the adsorbent dose was increased the adsorption % was increased.

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