

Research Paper :

## A study on adsorption of Fe (ii) by Accacia bark

■ ALKA SINGH

Author for Correspondence:

**ALKASINGH**

Department of Chemistry,  
Feroze Gandhi College,  
RAE BARELI (U.P.) INDIA  
Email : as\_ub98@yahoo.  
co.in

### ABSTRACT

The present paper deals with adsorption of Fe (ii) on Accacia bark. The variation in pH of the solution has no effect on the basic nature of time growth or adsorption time or saturation period. The adsorption was initially rapid and finally became constant due to slow removal near saturation. The extent of adsorption varies significantly with change in pH of the solution and attained a peak level to 74 per cent at pH 5.5 and thereafter decreased to 56.4 per cent at pH 9.5. It is obvious from results that pH of the medium plays an important role in adsorption of Fe (ii) from metallic solution.

**KEY WORDS :** Adsorption, Fe (ii), Accacia Bark

**How to cite this paper :** Singh, Alka (2011). A study on adsorption of Fe (ii) by Accacia bark. *Asian J. Exp. Chem.*, 6 (2): 58-60.

**Received :** 18.05.2011; **Revised :** 02.08.2011; **Accepted :** 02.10.2011

Waste containing metals may arise from a variety of individual operations such as chemical, metal processing, electroplating, metal polishing and cleaning, paints, battery manufacturing etc. Metals are available in suspension to metal ions and complexes in solution. Organometallic compounds in the environment are often produced by biomethylation where the transfer of methyl groups is biologically mediated from a donor molecule to the inorganic form of elements. Once added to the environment they are often accumulated in tissues. Several mishaps due to heavy metal contamination in aquatic environment increased the awareness about heavy metal toxicity and draw attention towards the studies

Removal of metals from wastes is a challenging problem and has been practiced for several decades. The conventional methods are usually expensive and sometime not effective. Therefore, there is a need for some alternative technique which should be efficient and cost effective. Adsorbents based on living and non living microorganisms and plants are one of promising tools for the adsorption of heavy metals from water and waste water (Lee and Davis, 2000, Bhattacharya *et al.*, 2004, Abia and Asuquo, 2006; Pehlivan *et al.*, 2006; Gupta and Sharma, 2010; Geetha and Belagali, 2010; Singh and Pandey, 2010). The present work is devoted to study the effect of pH on the adsorption of Fe (ii) from aqueous solution in order to find out the appropriate pH range for the maximum efficiency of the process by using Accacia Arabica (Babool) bark as an adsorbent.

### EXPERIMENTAL METHODOLOGY

#### Processing of Accacia bark:

*Accacia Arabica* (commonly known as babool), bark was collected locally and sieved to particle size  $>53\mu\text{m}$  pore size sieves, after drying and grinding. Two parts of material was treated with 0.5N  $\text{H}_2\text{SO}_4$  and one part with 39 per cent HCHO. The mixture was kept at  $50^\circ\text{C}$  for 4 to 6 hours under shaking condition. HCHO insolubilised the coloured water soluble tannins from bark. It was washed with remineralized water for several times. The treated bark was sun dried for two days and preserved in a plastic container.

#### Preparation of metal solution:

Ferrous ammonium sulphate was dissolved in one litre distilled water and finally prepared  $1.07 \times 10^{-4}\text{M}$  solution for stock solution for batch adsorption experiment.

#### Adsorption rate constant:

From liquid phase to solid phase ion can be considered as reversible reaction under equilibrium between two phases. First order reaction kinetics was used for the rate of reaction (Hellferich, 1962) by using the following equation

$$K_c = \frac{C_{BO}}{C_{AC}}$$

where  $K_c$  = Equilibrium constant

$C_{BO}$  = Initial concentration of adsorbate on adsorbent

**Table 1 : Time variation of adsorption of Fe (ii) on Accacia bark at different pH (particle size <53µm, temperature 35±1<sup>0</sup>C, concentration 1.07×10<sup>-4</sup>M)**

Time (min)	pH									
	4.5		5.5		7.0		8.5		9.5	
	Amount adsorbed mg-g <sup>-1</sup>	% Adsorption	Amount adsorbed mg-g <sup>-1</sup>	% Adsorption	Amount adsorbed mg-g <sup>-1</sup>	% Adsorption	Amount adsorbed mg-g <sup>-1</sup>	% adsorption	Amount adsorbed mg-g <sup>-1</sup>	% Adsorption
10	0.035	6.0	0.145	29.8	0.115	23.2	0.104	15.8	0.08	17.0
30	0.062	12.0	0.244	49.6	0.195	40.0	0.164	32.8	0.154	30.8
60	0.085	19.0	0.318	63.6	0.260	53.0	0.239	47.2	0.210	42.8
90	0.106	21.2	0.348	69.6	0.318	63.6	0.280	58.0	0.252	50.4
120	0.126	25.2	0.370	74.0	0.350	70.0	0.320	64.0	0.282	56.4
150	0.126	25.2	0.370	74.0	0.350	70.0	0.320	64.0	0.282	56.4
180	0.126	25.2	0.370	74.0	0.350	70.0	0.320	64.0	0.282	56.4

**Table 2 : Overall rate constant (K<sup>1</sup>), adsorption rate constant (K<sub>1</sub>) and rate constant of desorption(K<sub>2</sub>) for Accacia bark- Fe(ii) system at different pH**

Adsorbate	Adsorbent	Concentration	Temperature <sup>0</sup> C	pH	Overall rate constant K <sup>1</sup>	Adsorption rate constant K <sub>1</sub>	Rate constant of desorption K <sub>2</sub>
Fe(ii)	Accacia bark	1.07×10 <sup>-4</sup> m	35±1	4.5	0.025	0.0082	0.0195
				5.5	0.032	0.0104	0.0191
				7.0	0.037	0.0301	0.0075
				8.5	0.040	0.0334	0.0662
				9.5	0.033	0.0212	0.0114

$C_{AC=}$  Equilibrium concentration of adsorbate in the solution

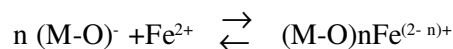
On plotting the value of  $\ln(1-ut)$  vs 't', a straight line plot indicates the validity of the above equation for the first order kinetics model for the present adsorbate-adsorbent system. The value K<sup>1</sup> (overall rate constant) was calculated for the slope of plot. The value of rate constant (K<sub>1</sub>) and rate constant description were calculated for the plot of  $\ln(1-ut)$  vs 't'.

## EXPERIMENTAL FINDINGS AND ANALYSIS

The results on the adsorption of Fe (ii) by Accacia bark at different pH(5.5 to 9.5) is given in Table 1. The variation in pH of the solution has no effect on the basic nature of the time growth adsorption curve or saturation period (Table 1). The time growth adsorption of Fe (ii) by Accacia Bark suggested that the removal was initially rapid and finally became constant due to slow removal near saturation. However the extent of adsorption varies significantly with change in pH of the solution (Table 1). The adsorption of Fe(ii) increased from 25.2 per cent (0.126mg-g<sup>-1</sup>) to 74 per cent (0.370mg-g<sup>-1</sup>) with increase in pH from 4.5 to 5.5 and thereafter it decreased to 56.4 per cent (0.282mg-g<sup>-1</sup>) at pH 9.5 at temperature 35±1<sup>0</sup>C concentration 1.07×10<sup>-4</sup>. Overall rate constant (K<sup>1</sup>), adsorption rate constant of desorption(k<sub>2</sub>) at different pH is given in Table 2. It is obvious from results that pH of the medium affected these rate constants in accordance

with the extent of adsorption.

The adsorption of cations may be explained on the basis of surface hydroxylation of oxides present on the adsorbent at the solid solution interface. The removal of Fe (ii) at low pH is an interesting phenomenon. The predominant species of Fe<sup>2+</sup>, Fe (OH)<sup>2+</sup> and Fe(OH)<sup>2+</sup> is the range of pH 4.5 to 9.5. pH max(5.5), maximum iron adsorption seems to be the results of following interaction;



The reason for the better adsorption capacity observed at low pH may be attributed to the large number of H<sup>+</sup> ions present which in true neutralize the negatively charged adsorbent surface, thereby, reducing hindrance to the diffusion at higher pH. The reduction in adsorption may be possible due to abundance of OH<sup>-</sup>, causing increased hindrance to diffusion of Fe<sup>2+</sup> ions. The present observation is in agreement with earlier report of Rai and Kumar (1999) for chromium (VI)

## REFERENCES

- Abia, A.A. and Asuquo, E.D. (2006). Lead (ii) and Nickle (ii) adsorption kinetics from aqueous metal solutions using chemically modified and unmodified agricultural adsorbents. *African J. Biotech.*, 5(16): 1475-1482.

- Bhattacharya, A.K.**, Das, S.K. and Mandal, S.N. (2004) Removal of zinc from waste water *Res. J. Chem & Environ*, **8**(4) 77-79
- Geetha, K.S.** and Belagali, S.L. (2010). studies on the adsorption of heavy metals on chewing tobacco. *Indian J. Environment Ecoplan*, **17** (3) : 509-576.
- Gupta, V.** and Sharma, M. (2010). Adsorption analysis of Cr (VI) by material polymer tamarind kernel pander (TKP) in aqueous solution. *Res.J.Chem. & Environ.*, **14** (1) 41-45.
- Helfferich, F.** (1962). *Ion-Exchange. Mc Graw Hill New York.*
- Lees and Davis, A.P.** (2000). Removal of copper and cadmium from aqueous solution by sea food processing waste sludge. *J. Water Res.*, **22** : 651-658.
- Pehlivana, E.**, Cetina, S. and Yan, K.B.H. (2006). Equilibrium studies for the sorption of zinc and cadmium from aqueous solutions using sugarbeet pulp and flyash. *J. Hazard. Mat.*, **135** (1-3) : 193-199.
- Rai, A.K.** and Kumar, S. (1999). Treatment of chromium bearing waste water by adsorption on brick kline ash and fly ash. *Ind.J. Environ. Health*, **41** (1) : 65-73.
- Singh, N.B.** and Pandey, Shivani (2011). Biosorption of Cd<sup>2+</sup> from aqueous metal solutions by Cyano-bacterial biomass. *The Asian J. Exp. Chem.*, **6** (2).

\*\*\*\*\*  
\*\*\*\*\*  
\*\*\*