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Adsorption studies of acetic acid on Jute surface

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ABSTRACT

The aim of present investigation is to study adsorption of acetic acid on *Jute* having botanical name *Corchorus sp.* The effect of certain parameters on adsorption has been studied. Applicability of Freundlich adsorption isotherm, Langmuir adsorption isotherm has been tested. Various thermodynamic parameters such as ΔG, ΔH, and ΔS are reported. The adsorption power of *Jute* is calculated the experiments are earned out using batch adsorption process.

Key words: Acetic acid, *Corchorus* sp. (Jute).

INTRODUCTION

Removal of unwanted substances from the waste water is of prime environmental importance The presence of excess amount of undesirable constituents causes water pollution, it is established fact that polluted water is harmful to human and aquatic life. There are various adsorbent available for the removal of inorganic and organic substances from the polluted water. Various researchers are reporting low cost adsorbent for pollution control. Acetic acid is used in the manufacturing of vinegar, cellulose acetate, perfumes, and dyes, plastic and pharmaceutical companies. It occurs in fruit juices which become sour as a result of fermentation. It is chief constituents of vinegar. It is corrosive liquid, the vapors are suffocative and causing a damage to lungs.

Various researchers used plant materials as adsorbent, plant materials are used as a cheap and low coast material for adsorption for example modified corn[1] starch, modified onion skins[2] Saw dust[3], Phosphate treated saw dust[4], water lettuce[5] , algae material[6] etc. Adsorption of different metal ions[7-8] and organic compound onto solid surfaces has immersed as a promising field of great application value and has been extensively studied in the recent past.

Jute having Botanical name *corchorus sp.* with family Tiliaceae is the most important bast fiber and among natural fibers it is only second to cotton. The fiber is obtained from the steam. Jute was used to India since very ancient time but it became important as sackcloth in the late sixteenth century and first shipment of Jute fiber from India to England was made in 1791.

The surface of the fibers is smooth and the fibers appears Polygonal in outline in transactions the fibers are stiff, brittle and coarse with low stretchability and elasticity jute fibers contain on an average 63% cellulose, 22 to 26% hemicellulose, 10 to 12% lignin and small quantities of fats, waxes gums and minerals.

Jute is important bagging materials and is extensively used for gunny bags and also for coarse cloth, twin, ropes, etc. it is also used in the manufacture of curtain, carpets, blankets, linolum, oil cloth etc. an infusion of leaves is tonic and

febrifuge and is also used as demulcent in cystitis and dysuria.

MATERIAL AND METHODS

Acetic Acid, NaOH, Phenolphthalein were supplied by S.D. Fine Chemicals Ltd and were used without any purification.

Preparation of powder

Filaments of *Jute* were collected from Harsool reservoir of Aurangabad city. Bold's Basal medium was used for cultivation. Pure filaments were transferred to 200ml liquid medium in 500ml Borosil flask. This procedure was performed under aseptic conditions. The flasks were then incubated under static condition in culture chamber at 25 ± 1^{O}C for 15 to 20days. After sufficient growth pure algal sample was harvested and air dried on filter paper in shadow at room temperature. Fine powder of algal sample was prepared in grinder[9].

The amount of Acetic Acid was determined volumetrically using Phenolphthalein as a reagent. Effect of contact time, temperature, and effect of initial concentration was also determined.

RESULTS AND DISCUSSION

On the surface of substance there are free valencies. When adsorbate comes in contact with the surface, each valiancy satisfied by a weak bond formed. The adsorption of solute from solution takes place due to the decrease in the interfacial tension or clue to solid surface acquiring electrostatic charge in solvent. This charged surface of the adsorbent then attain oppositely charged ions from the solution. During the formation of solid such as zeolites gases are evolved and solid becomes porous, such solids can be used as selective adsorbent and can be used for ion exchange. Same logic can be extended to the coal formation. During incomplete burning of algae material CO or CO_2 gets evolved and porosity may be formed. Hence charcoal obtains from the plant materials are more effective adsorbent.

In the present paper we want to study the adsorption behavior of acetic acid on the charcoal obtained from plant *Plectonema gracillimum* (zopf) Hansgirg. It is important to know adsorption capacity

Table 1: Adsorption capacities (Initial Concentration Co = 5.6 gm/ Ltr.)

Mass of Adsorbent	Equilibrium Concentration Ce gm/Ltr.	Log Ce	X=Co-Ce	$y=\frac{(Co-C)V}{M}$	$x=\frac{Co-C}{Co}$	X/ M	Log X/M	Ce/ X/M
250 mg	5.2	0.716	0.4	80	0.0714	1.6	0.2041	3.25
300 mg	4.8	0.6812	0.8	133.3	0.1428	2.6	0.4248	1.84
400 mg	4.6	0.6628	1.0	166.6	0.1785	2.5	0.3978	1.84
500 mg	3.8	0.5798	1.8	180.0	0.8571	3.6	0.5563	1.05
600 mg	3.2	0.5051	2.4	200.0	0.4285	4.0	0.6020	0.80

Table 2: Effect of Contact Time

Time (min.)	$\sqrt{t}$	Ce	q=Co-Ce	qe-q	Log qe-q
5	2.2	5.2	0.4	4.8	0.6812
10	3.1	4.8	0.8	4.0	0.6020
15	3.8	4.6	1.0	3.6	0.5563
20	4.4	3.8	1.8	2.0	0.3018
25	5.0	3.2	2.4	0.8	0.9691

of various adsorbent, because adsorption can be used effectively in the prevention of environmental pollution. It is used for the catalytic processes. Langmuir suggested that the forces operated between adsorbate and adsorbent is mostly short range forces, these may be dispersion forces, the orientation forces and induction forces. Dispersion forces arise from attraction between temporary or instantaneous dipoles. The orientation forces appear upon adsorption of polar molecules earring constant electrical charges. Polar molecules tend to orient themselves with their positive poles towards the negatively charged surface or negative poles toward the positively charged surface. The induction forces also play an important role in the adsorption process. The electric charge present on the surface of adsorbent may induce dipoles in the adsorbate molecule their by attracting them. In addition to these forces hydrogen bonds may also takes place which forms interaction between adsorbate and adsorbent.

Effect of Contact Time:

It was observed that *Jute* can be used as a low coast adsorbent effectively. The maximum time required for adsorption is that 20 minutes for 60% adsorption, after that the amount adsorbed remains constant. (Table No.3)

The removal curve was found to be smooth and continuous indicating the formation of monolayer coverage of adsorbent on the other surface of adsorbate.

Adsorption Isotherm

To study the validity of Fruendlich adsorption Isotherm following equation was used

$x/m = Kc^{1/n}$

The linear plot of log x/m Vs logC indicates the applicability of Freundlich adsorption Isotherm (Table No.1). This shows system which exist monolayer coverage of the adsorbent on the other surface of adsorbate. To verify Langmuir adsorption Isotherm I/ Ce is plotted against 1/q the value of 'b' is calculated graphically which is used to calculate the equilibrium parameter R_L

$$R_L = \frac{1}{1+bco}$$

The range $0< R_L<1$ reflect favorable adsorption.

In the present study the value of R_L was found to be less than 1 (one). The Langmuir adsorption parameters are very useful for predicting adsorption capacities and also for incorporating into mass transfer relationship. The isotherm can be written as

$$\frac{Ce}{Qe} = \frac{1}{K_L} = \frac{q_L}{K_L} Ce$$

Ce is the concentration of the adsorbate at equilibrium, Qe is the amount of metal ions adsorbed per .unit weight of the adsorbent, a_L and K_L are Langmuir constants, qi, indicate the intensity of adsorption and $K_L = q_L b_L$, where bl is the adsorption capacity for the present study we obtained a_L = 2.. 025 L/mg b_L = 0.041 mg/ grm

The rate of acid adsorption (removal) falls off to give a smooth curve; this part of plot is due to intra particle diffusion the initial portion of the plot can be interpreted by supposing a three step model as follows:

1. Mass transfer of acid from the bulk solution to the particle surface
2. Intraparticle diffusion
3. Adsorption at an interior side

It is assumed that step three (3) is rapid with respect to first two steps [10].

The mathematical theory of diffusion is based on Pick's first law, mainly molecular adsorption processes involve diffusive mass transport and the interpretation of over all behaviour in terms of two diffusivity and intrinsic equilibrium sorption properties is difficult.

Intra particle diffusion is an important rate controlling step during adsorption process.

Following equations were used to find out adsorption capacity of plant *Plectonema gracillimum*

$$y = \frac{(Co - C)V}{M}$$

$$fr = \frac{Co - C}{Co}$$

Thermodynamic Study

The experiments were earned out at different temperature to study the effect of temperature on adsorption, thermodynamic parameter such as Δ G, ΔH, and ΔS were determined using following equations (Table 2)

1) $ke = \frac{Cad}{Ce}$

2) $VG = -RT\ Ln\ K_c$

$$\log Kc = \frac{VS}{2-303R} \quad \frac{VH}{2-303RT}$$

Kc = Equilibrium constant, Cad = Amt. of metal ion adsorbed per litre of the solution at the equilibrium, Ce = Equilibrium concentration (mg/1) of the metal in the solution.

Kinetics

Kinetics study of the adsorption process of *Acetic Acid* has been studied and it was observed that it obeys Lagergen equation.

Log (Qe-Q) - log Qe - (Kd/ 2.303). t

Qe & Q are the metal ion adsorbed (mg/g) at equilibrium and at time.

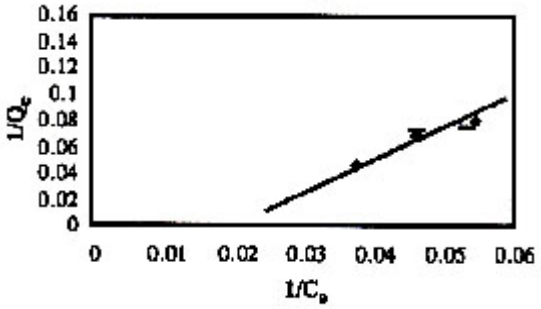

Fig. 1: Langmiur adsorption isotherm

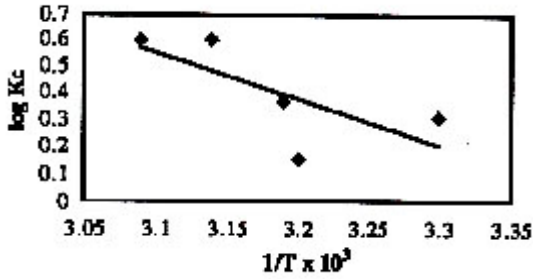

Fig. 2: Effect of temperature

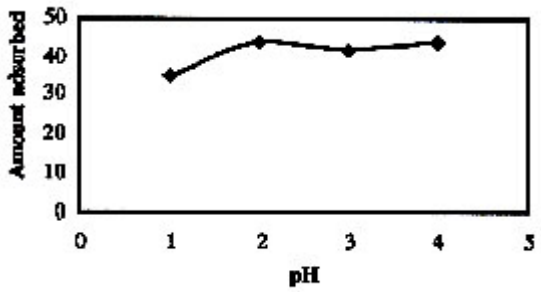

Fig. 3:

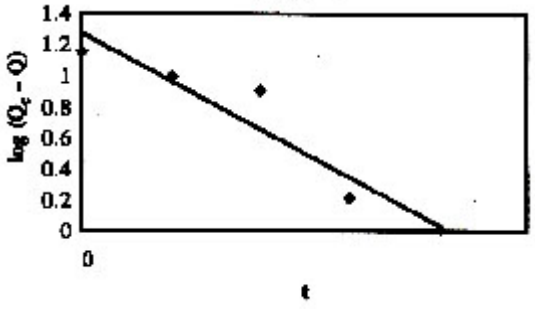

Fig. 4: Lagergen plot

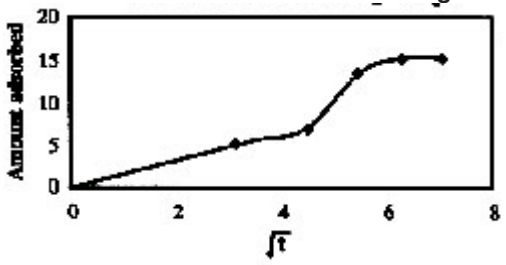

Fig. 5: Plot of amount adsorbed against $\sqrt{t}$

Intraparticle diffusion was also studied by plotting mass of solute adsorbed Vs square root of contact time the plot was linear. From the slope intraparticle diffusion constant was determined.

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