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UTILIZATION OF AGROWASTE MATERIAL AS POTENTIAL ADSORBENT FOR WATER TREATMENT AT DIFFERENT TEMPERATURE

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ABSTRACT

The present paper discusses the kinetics of Cr (VI) adsorption from aqueous solution using chemically unmodified (USB) and modified (MSB) sugarcane bagasse at different temperature (20, 30 and 40 ±0.5°C). The adsorption of Cr (VI) by MSB increased nearly 11.25% against USB of temperature 20 ± 0.5°C. Low temperature (20 ± 0.5°C) promoted the rate of Cr (VI) adsorption in comparison to 30 and 40 ± 0.5°C. The decrease in rate of adsorption might be due to change in chemical potential which alters the solubility of adsorbate.

KEYWORDS : Agrowaste, Adsorbent, Water Treatment, Temperature

Most of the effluents discharged by different industries are contaminated with metals which pose environmental and public health problems. Thus the need of improved management of these waste are imperative. Most contaminated waste water treatment techniques viz. coagulation, ion-exchanging, advanced oxidation process etc. require high capital and operating cost and may produce large volume of wastes (Aksu, 2005). Therefore, adsorption process is considered better because of convenience, ease of operation and simplicity of design (Faust and Alg, 1987). Adsorption process using agricultural waste products or biosorption are becoming the new alternative for waste water treatment.

The role of temperature is of paramount importance in the studies of the removal of pollutants from water and waste water. Adsorption is normally an exothermic, thus the extent of adsorption, generally, decrease with increase of temperature (Sharma et al., 1991) while reports are also available for a direct relationship adsorption and temperature (Pandey et al., 1986).

Biosorption is a promising technique for the removal of metals from aqueous environment due to lignocellulosic material (Coelho et al., 2007). Sugarcane industries produces large amount of sugarcane bagasse although it is burned to produce energy to sugar mills, leftover still significant sugarcane bagasse as around 50% cellulose 27% polymers and 23% lignin (Caraschi et al., 1996). In this work the potential for the use of unmodified sugarcane bagasse (USB) and modified (MSB) as biosorbent for Cr (VI) removed from aqueous solution were investigated under different temperature condition.

MATERIALS AND METHODS

Preparation of Adsorbent

Sugarcane bagasse was collected from local juice centre and boiled for 30 minutes to remove the soluble sugar of washed bagasse was dried in a hot air oven at 70°C for 24 hrs and grounded into fine particles. It was sieved to pass uniform size of less than 53 μm. A part of sieved bagasse was treated with O.1M citric acid, stirred for 30 minutes and left for 24 for hrs for chemical modification. After treatment it was washed with double distilled water to remove excess acid and other soluble substances until natural and dried till a constant weight modified sugarcane bagasse, (MSB)

Batch Experiment

100 ml of 50mg el chromium solution was taken in 250 ml flask at temperature 20, 30 and 40 ± 0.5°C in two sets. A known amount of USB and MSB was added in each of flask containing chromium (VI) solution and agitated in a shaker for different contact time. After each agitation time, the content from each flask was taken separately and filtered. The residual concentration of each 20 ml of filtrate of each metal solution was analyzed spectrophotometrically against blank. pH, particle size and solution concentration was kept constant at different temperature. Selected pH and absorbent particle size was based on highest adsorption

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Table 1:Time Variation of Adsorption of Cr (VI) on Sugarcane Bagasse At Different Temperature

Time	Temperature					
	20.0 ± 0.5^0C		30.0 ± 0.5^0C		40.0 ± 0.5^0C	
	Amount adsorbed mg g^{-1}	% Adsorption	Amount adsorbed mg g^{-1}	% Adsorption	Amount adsorbed mg g^{-1}	% Adsorption
10	0.16	32.0	0.11	22.0	0052	10.4
20	0.25	50.0	0.17	34.0	0.11	22.0
40	0.285	57.0	0.20	40.0	0.14	28.0
60	0.32	64.0	0.28	56.0	0.18	360
80	0.35	70.0	0.30	60.0	0.22	44.0
100	0.37	74.0	0.32	64.0	0.25	50.0
120	0.39	78.0	0.34	68.0	0.261	52.2
140	0.40	80.0	0.36	72.0	0.28	56.0
160	0.40	80.0	036	72.0	0.28	56.0

Conc.: $1.82x10^{-4}$M; Particle size <53 µm; pH: 4.0

Table 2:Time Variation Adsorption of Cr (VI) By Sugarcane Bagasse (modified After Chemical Treatment, At Different Temperatures)

Time (in minutes)	Temperature in ^0C					
	20.0 ± 0.5		30.0 ± 0.5		40.0 ± 0.5	
	Amount Adsorbent mgg^{-1}	% adsorption	Amount Adsorbent mgg^{-1}	% adsorption	Amount Adsorbent mgg^{-1}	% adsorption
10	0.17	34	0.15	30.0	0.07	14.0
20	0.25	50	0.20	40.0	0.125	25.0
30	0.83	66	0.265	5.30	0.16	32.0
40	0.38	72	0.31	62.0	0.21	42.0
60	0.40	80	0.34	68.0	0.245	49.0
80	0.42	84	0.38	76.0	0.26	520
100	0.45	90	0.40	80.0	0.29	58.0
120	0.45	90	0.40	80.0	0.29	58.0
140	0.45	90	0.40	80.0	0.29	58.0
160	0.45	90	0.40	80.0	0.29	58.0

Conc.: $1.82x10^{-4}$M; Particle size <53 µm

efficiency. All experiment were performed is duplicate at least. The adsorption dynamics were calculated by taking adscription rate constant and first order reversible reaction kinetics for the rate of reaction of reaction.

RESULTS AND DISCUSSION

The results regarding the effect of temperature and modification of adsorbent on sorption of Cr (VI) are given in table 1 and 2. The result indicated that adsorption of Cr (VI) at each temperature was rapid enough the initial stage and thereafter become slow in latter stage and finally attain saturation. The data obtained at different temperature suggest that the saturation period was independent of temperature in each of adsorption to different extents. The amount of adsorption of Cr (VI) on USB and MSB was increased from 0.40 mg per gm to 0.45 mg per gm, 0.36 mg per gm to 0.4 mg per gm and 0.28 mg per gm to 0.29 mg per gm at temperature 20, 30 and 40 ± 0.5^0C respectively. The overall rate constant (k1), rate constant of adsorption (k1) and adsorption (k2) (Table, 3), all were found temperature dependent and the rate of adsorption of Cr (VI) decreased with increase in temperature for USB and MSB adsorbate-adsorbent system. The decrease in adsorption with rise in temperature might be due a relative increase in escaping

Table 3: Overall Rate Constant Of Adsorption And Desorption Of Cr (VI) At Different Temperatures

Adsorbate	Adsorbent	Concentration mole l^{-1}	Temp. ± 0.50°C	pH	Overall rate constant min^{-1} (k^1)	Rate constant min^{-1} (k_1)	Rate constant min^{-1} (k_2)
Cr (VI)	Sugarcane bagasse unmodified	1.82×10^{-4}M	20	4.0	0.36	0.027	7.0×10^{-3}
			30	4.0	0.30	0.020	8.95×10^{-3}
			40	4.0	0.26	0.014	12.1×10^{-3}
Cr (VI)	Sugarcane bagasse modified	1.82×10^{-4}M	20	4.0	0.048	0.0421	4.5×16^{-3}
			30	4.0	0.039	0.0303	7.4×10^{-3}
			40	4.0	0.030	0.0184	12.2×10^{-3}

tendency of solute molecules from the solid phase to the bulk phase due o lowering of adsorptive forces between the active sites of adsorbent and adsorbate species and also between the adjacent. More adsorption of Cr (VI) by chemically modified bagasse might be due to increase in surface are which has great effect on sorption capacity of adsorbent (Quadeer ad Akhtar 2005; Singh and Pandey, 2011). From the above findings it may be inferred that temperature is an important parameter governing the uptake of the adsorbates and may help in designing an efficient effluent treatment system for the removal of chromium from water and waste water.

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