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A COMPARATIVE STUDY ON THE CHROMIUM REMOVAL EFFICIENCY OF FLYASH AND COMMERCIAL ACTIVATED CARBON

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ABSTRACT

A study on the removal of Cr (VI) by adsorption on flyash and commercial activated carbon (CAC) was attempted. In order to understand the adsorption behavior and adsorption potential of flyash and CAC, batch type experiments were conducted on adsorbent- adsorbate system with different concentration of chromium (10-50 mg/L) for 6 hours. The metal removal efficiency of 21% was achieved with interminttent hand shaking condition with flyash as an adsorbent. The results were compared with activated carbon (CAC). The adsorption data followed the Freundlich model. The adsorption plots gave identical slope values indicating similar type of adsorption mechanism were involved for the removal by both adsorbents.

INTRODUCTION

The rapid industralisation in developing countries has resulted in accelerating the flux of heavy metals, chromium being one of it, into the surfacial environment. Some of the major industries discharging Cr(VI) bearing waste waters are chemical manufacturing units, leather, textile, dye-ink manufacturing units, photographic material plants etc. The accumulation of Cr (VI) through waste discharge into the natural water bodies poses serious problem due to its possible entry into the food chain. Though chromium is an essential nutrient for plant and animal metabolism (Glucose metabolism, animo acid and nucleic acid synthesis), when accumulated at high level it can cause serious disorders and diseases (Nausia, skin unceration, lung cancer, etc) and it can ultimately become lethal (Pathe *et. al*., 1995). Consequently it's removal has assumed importance in the recent years.

Numerous work have been reported on the treatment of Cr bearing waste. These include hydroxide precipitation, flocculation- clarification- sand filtration, chemical reduction, precipitation, biosorption, ion-exchange, evaporation- concentration, electrolysis & electroplating, inflotation and carbon adsorption,. (Rai and Surendrakumar 1999). Many of these require high capital and recurring expenditure and consequently they are not suitable for small scale industries.

TABLE -1

Data for the Freundlich plot for the removal of chromium using flyash

Concentration (ppm)	% removal	qe	ce	logce	logqe
10	20.9	0.418	7.91	0.898	0.621
20	18.9	0.756	16.22	1.2101	0.878
30	16.1	0.966	25.17	1.4009	0.985
40	12.3	0.984	35.08	1.5451	0.993
50	9.9	0.99	45.05	1.6537	0.9956

R	0.941
1/n slope	0.5063
n	1.9751
Intercept, log Kf	0.2153
Kf	1.6417

TABLE - 2

Data for the Freundlich plot for the removal of chromium using CAC

Concentration (ppm)	% removal	qe	ce	logce	logqe
10	72	1.44	2.8	0.4472	0.1584
20	59.3	2.372	8.14	0.9106	0.375
30	41.3	2.478	17.61	1.2458	0.394
40	31.6	2.528	27.36	1.4372	0.403
50	26.2	2.62	36.9	1.5670	0.418

R	= 0.9055
1/n slope	= 0.2171
n	=4.6062
Intercept log Kf	= 0.1062
Kf	= 1.277

Among all the above mentioned methods, adsorption is highly effective, inexpensive and less trouble some. Hence adsorption has been tried as method for the removal of Cr using rice husk, bone powder, human hair (Mehrotra and Dwivedi, 1988), activated charcoal (Nagesh and Krishnaiah, 1989), lignite coal (Kannan and Vanagamudi, 1991), lime activated charcoal, washing soda (Kannan and Vijayragavan, 1992), rice husk ash (Bansal and Sharma, 1992), saw dust (Singh *et. al*., 1992) waste tea leaves (Singh and Lal, 1992), Magnifera indica leaves (Singh *et. al*., 1993), Albizia lebbeck pods (Verma and Rehal, 1996), rice straw (Ali and Deo, 1992), *Ablesmoschus esulentus* (Jasuja *et. al*., 1997), coconut fiber pith (Manju and Aniruthan, 1997) flyash, brick kiln ash (Rai and Kumar, 1999) etc have been attempted as possible substitute for activated carbon with varying degree of success.

MATERIALS AND METHODS

Flyash : Flyash, a waste was collected from the cement factory situated near to Ariyalur.

Reagents: In the present investigation, analytical reagent grade chemicals were used.

Stock chromium solution : (1000 ppm)
The stock chromium solution was prepared by dissolving accurately 2.829 gm of $K_2Cr_2O_7$ in 1000 ml of distilled water.
Standard chromium solution. (1000 ppm)
Accurately 100 ml of stock Chromium solution was diluted to 1000 ml to get standard chromium solution.
Sulphuric acid (1+1)
Diphenyl Carbazide solution.
About 250 mg of 1,5-diphenylcarbazide was dissolved in 50 ml of acetone and was stored.

Estimation of Chromium (APHA, 1989)

Required quantity of the standard solution was taken in a nessler's tube. And 1 ml of H_2SO_4 (1+1), 5 drops of phosphoric acid were added into it. Following which 2 ml of di-phynel carbazide was added and was made upto 100 mL. After 5 minutes before 10 minutes the reading were taken at 540 nm in a spectrophotometer (Spectronic- 20)

Batch type experiments

Effect of adsorbents, initial metal concentration and still, intermittent hand shaking condition on the removal of chromium.

A series of 100 ml solutions containing 10-50 mg/L of chromium were taken in a 250 mL conical flasks. 500 mg of flyash and CAC were added to separate flasks and was shaken every half an hour for 6 hours, so as to reach the adsorption equilibrium. Similarly one set was maintained is still condition. Appropriate control flasks without adsorbent was also maintained.

After treatment, the solutions were filtered using whatman number 41 filter paper and the amount of chromium was determined.

The percentage removal of chromium was calculated using the following formula.

Percentage removal of chromium = (initial OD- final OD)

Initial OD x 100

Adsorption Isotherms

The extent of adsorption can be correlated by means of the Freundlich isotherms (Eckenfelder, 1989).

Freundlich Adsoprtion Isotherms

The isotherm has been proposed by Freundlich for dilute and moderately dilute solutions. It is represented experimentally by the expression,

qe = Kce 1/n .... (Lin, 1993)
qe = Amount of metal adsorbed at equilibrium (mg/g)
Ce = equilibrium concentration of metal (mg/L)
The modified eqution is
Log qe = logkf+1/n log ce.

Where qe is the amount of Cr (VI) ions sorbed per init weight of sorbent (mg/g), kf is the measure of sorption capacity and 1/n is sorption inteasity. Ce is equiibrium concentration of residual Cr(VI) in solution.

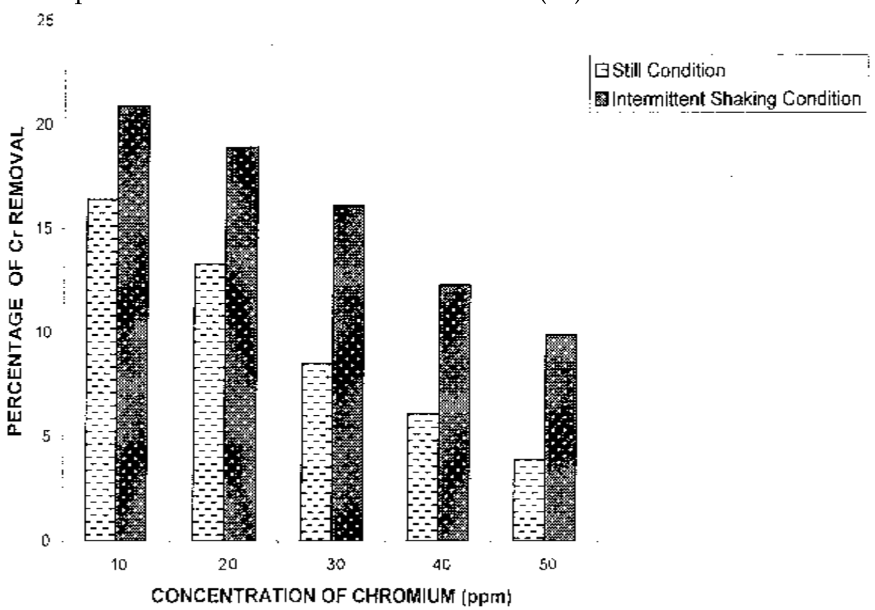

Fig. .1- Effect of still and shaking condition on the percentage removal of chromium using flyash.

RESULTS AND DISCUSSION

Effect of adsorbent metal concentration and still and intermittent hand shaking condition on the removal of chromium.

The percentage removal of chromium has shown a reduction with an in-

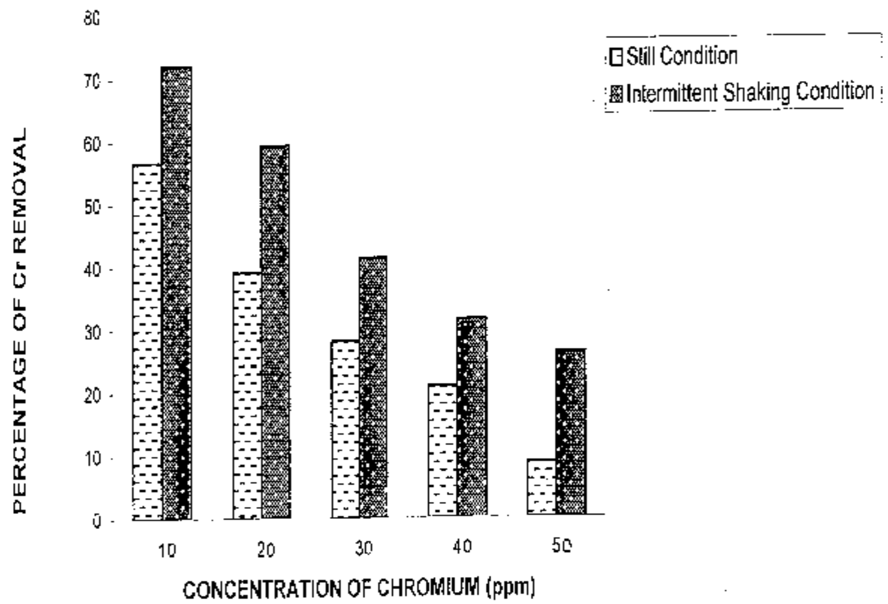

Fig. 2- Effect of still and shaking condition on the percentage removal of chromium using CAC

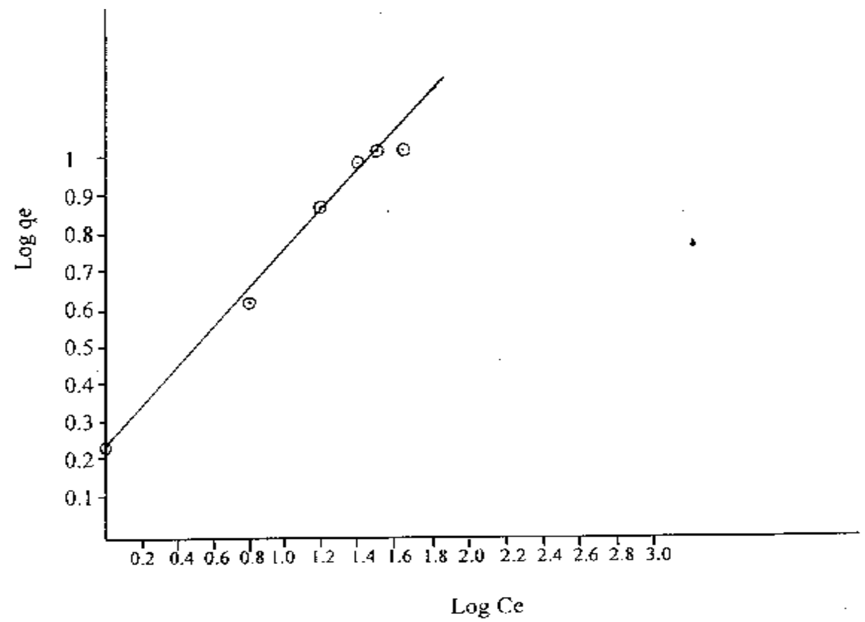

Fig. .3- Freundlich plot for the removal of Chromium using flyash

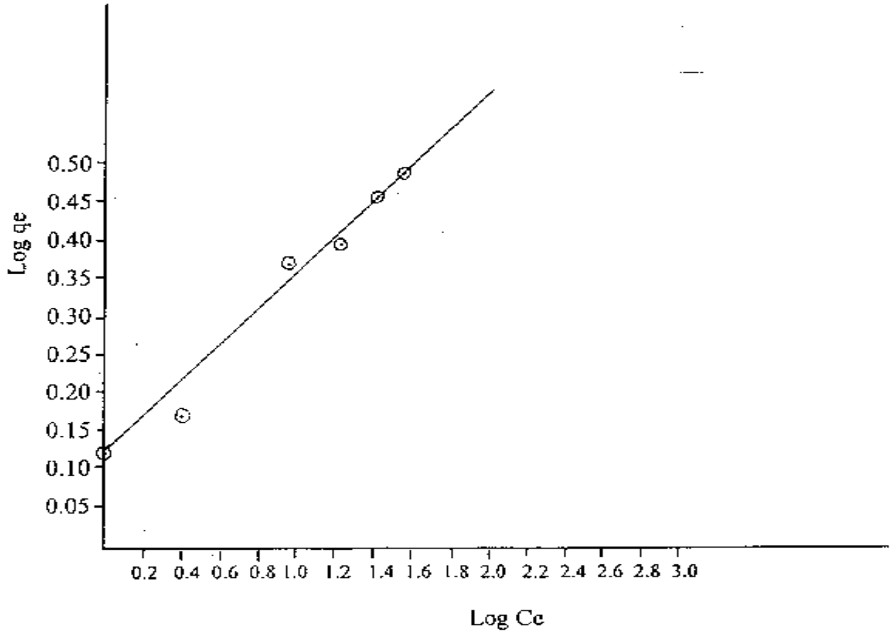

Fig.4 - Freundlich plot for the removal of Chromium using flyash

crease in the initial metal concentration when treated with flyash and CAC. (fig. 1 and 2). With the increase in concentration, the percentage of Cr removal has shown a reduction. Such trend has been reported by Ali and Deo, 1992.

The effect of hand shaking condition on the uptake of Cr(VI) by the mixture of adsorbents for 10-50 mg/L was shown in Fig. 1. The results indicate that there is a gradual increase in the extent of adsorption with intermittent hand shaking condition when compared with still condition. The increase may be attributed to the increased thickness of the surrounding liquid film. The phenomenon of adsorption can be attributed to various mechanisms such as electrostatic attraction and repulsion, Chemical interaction and ion-exchange. Similar results have been reported by Verma and Rehal (1996).

Similar results were reported with the adsorbent CAC which was employed for the chromium removal. In Intermittent hand shaking condition, CAC has shown 72% where as in still condition, the removal was 57% for 10 ppm solution (Fig. 2). Similar results have been reported by Kaliselvi, 2003. Similarly the maximum removal of 21% was obtained when 10 ppm Cr solution was agitated with 500 mg of flyash alone.

Among the above 2 adsorbents commercial activated carbon showed higher percentage removal of chromium.

Adsorption Isotherms

Freundlich adsorption isotherms were plotted for different initial concentration of chromium treated with flyash and CAC, The data are given in Table

1 and 2. The linear plot suggests that the adsorption follows Freundlich isotherms Fig. (3 and 4).

The Kf, 1/n values for removal of Cr using of flyash and CAC were 1.6417, 0.5063 and 1.277, 0.2171 respectively. The removal was found to be favourable as the kf/n values were less than 1 and the values of n were less than 10 which confirms a favourable adsorption. Wheras the Kf and 1/n values for the removal of Cr using the mixture of flyash and CAC were 1.38336 and 0.4914 respectively. (Kalaisalvi, 2003)

The results clearly confirms the efficiency of CAC but the usage of the mixture of flyash and CAC has reduced the removal of Chromium which necessitates further investigations. Optimization of the process would evolve out as an economical method.

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