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Removal of Toxic Metal Cr (VI) from Aqueous Solutions Using Low Cost Adsorbent

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Abstract: *The consumed coffee powder and tea leaves (CTL) of local produce as low cost adsorbent (LCA) were found to be able to remove substantial amounts of Cr(VI) ions from aqueous solutions. Columns packed with low cost adsorbent (LCA) have been utilized for the removal of Cr(VI) from aqueous solutions. Breakthrough behaviour of Cr(VI) has been studied. It was found that the Cr(VI) uptake was dependent on pH and metal concentration. The degree of uptake increases with pH and pH range for the maximum uptake was found to be 2.5 for both wastes. .*

1. Introduction

Toxic metals like Hg, Pb, Cr, Cd etc. are the necessity of many industries.

These are common pollutants in industrial effluents and are hazardous if present in higher concentration than the limit permitted. The hazardous effect of heavy metal ions on public health, aquatic animals, and environment has prompted governments to implement legislation enforcing the treatment of effluent from toxic heavy metal based industries.

The removal of toxic metals from industrial waste effluents has been a major concern in recent years. It is introduced through industrial discharge from paint and pigment, chrome and leather tanning, electroplating, glass, ceramic, photography, textile, dyeing, and tanning industries. A number of methods, such as chemical treatment, adsorption, ion – exchange etc. have been developed to remove toxic metals from waste.

In past years, removal of heavy metal ions from aqueous solutions has been a major concern (Deshkar et.al; 1990^[1], Huang; 1977^[2], Srivastava et al; 1989^[3] and Zhong et. al; 1987^[4]). Water, being an excellent solvent is more severely threatened by pollution due to industrial waste and excessive inputs of population.

Pandey et.al; 1984^[5] have studied the removal of Cr(VI) from aqueous solution using fly ash and china clay. Adsorption of Cr(VI) on coal fly ash has been reported by Nadar and Parvathy; 1982^[6], Chinese peats^[7], activated carbon^{[8][9]}, alumina^[10], clay rich soil^[11] and iron (III) hydroxide^[12] have

been utilized as adsorbent for the removal of Cr(VI) from aqueous solutions.

Low cost adsorbents are preferred at industrial level. In present study, a method has been developed to remove Cr(VI) using consumed coffee powder and tea leaves as a low cost adsorbent and the optimum parameters have been investigated.

2. Experimental Procedure

2.1 Reagents and Methods

Solutions of Cr(VI) were prepared in tap-water using K₂Cr₂O₇ (BDH, India). The pH was adjusted with HCl. Presence of Cr(VI) in the effluent was determined spectrophotometrically using diphenyl Carbazide^[15]. All other reagents used were of analytical grade.

Locally available coffee and Tea leaves, sieved by ENDECOTTS sieve (60 – 100 mesh) was treated with water to remove impurities, Then, water was filtered off using cloth bag and the Coffee Tea Leaves (CTL) were dried.

2.2 Breakthrough Capacity

Break through capacity of Cr(VI) was determined by passing solution through a glass column (length 30 cm. and i.d 1.2 cm) packed with 5g CTL. The flow rate was maintained at 135 ml/h.

3. Results and Discussion

The breakthrough behaviour of Cr(VI) (5 ppm) as a function of pH has been studied (Table – 1). The results of breakthrough capacity reveal that the adsorption of Cr(VI) on CTL is almost nil at pH between 5.8 and 4.0 while at pH 2.5, maximum adsorption of Cr(VI) on CTL was found and further decrease in pH does not result any change in adsorption capacity. The breakthrough capacity observed at pH 2.5 is 97.80 mg/5g dry CTL. This adsorption capacity of Cr(VI) on CTL can be

explained mainly due to the presence of caffeine and other organic proportions.

The results of concentration effect on Cr(VI) solution (pH 2.5) reveal that the variation in concentration (5ppm to 50 ppm) has no significant effect on breakthrough capacity.

Flow rate was varied from 130 ml/hr to 325 ml/hr. It was found that breakthrough capacity remains almost same upto flow rate 210 ml/hr. However further increase in flow rate resulted in earlier breakthrough due to decreased contact time.

The breakthrough capacity of CTL treated with 0.1 N NaOH is less than that of untreated CTL (pH 2.5). This decrease may be explained on the basis of the fact that probably caffeine and other organic proportions present in CTL, adsorbs Cr(VI) resulting higher breakthrough capacity. Cr(VI) can be eluted from the exhausted columns of CTL using 0.1 N NaOH as an eluent. However, the cost of adsorbent is minimal.

4. Table

Breakthrough Capacity of Cr(VI) (5ppm) as a function of pH

pH of solution	Breakthrough Capacity (mg / 5 g dry CTL)
5.8	0.18
4.0	0.48
3.0	62.94
2.5	97.80
2.0	97.80
2.5	70.50*

* Breakthrough capacity of CTL with 0.1 N NaOH

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