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Removal of Chromium from Tannery Effluent Using Flyash

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Abstract:
Chromium is highly toxic metal ions and considered as a priority pollutant released from various chemical industries like electroplating mixing activities, smelting, battery manufacture and tanneries etc. Effluents have been excessively released in to the environment due to rapid industrialization and have created a global concern. Unlike organic wastes, chromium (VI) effluents are non biodegradable and they can be accumulated in living tissue, causing various diseases and disorder. Therefore it must be removed before discharge. In the present study, experiment results carried out in batch adsorption process by using fly ash for removal of chromium (VI) were studied. The various parameters such as solution pH, initial chromium, and adsorbent dosage on the adsorption chromium concentration were studied and presented. The maximum removal of chromium (VI) at 92% was observed at pH of 8.0, adsorbent dosage of 10g/25ml and contact time of 48 hours in tannery effluents.

Keywords*: Chromium (VI), Fly ash, adsorption, tannery effluent, % removal*

1. Introduction

Industrial activities continuously release heavy metals to the aquatic environment which are considered to be highly toxic and may seriously damage natural aqueous environment.

Among the toxic metal ions chromium is one of the common contaminants which gains importance due to its high toxic nature even at very low concentration[1].

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Water pollution by chromium is one of environmental concern, as this metal has found widespread use in electroplating, leather tanning, metal finishing, textile industries and chromium preparation[2].

Tanning process is one of the major sources of chromium pollution at global scale. In the chromium tanning process leather takes up only 60 to 80% of the applied chromium, and the rest is usually discharged in to waste water [3]

Chromium exists in two oxidation states as Cr (III) and Cr (VI). The hexavalent form is 500 times more toxic than the trivalent [4] Chromium (VI) is a cancer causing agent and can cause health risks for humans

The conventional methods used to remove Cr (VI) from aqueous effluents include ion exchange, Electro flotation, membrane separation, reverse osmosis, electro dialysis, solvent extraction, etc. However, these approaches have proved to be costlier and difficult to implement. Adsorption is one of the physico-chemical treatment process found to be effective in removing heavy metals from aqueous solutions

The aim of this study is to detect the efficiency of fly ash on chromium (VI) removal from the tannery effluent

2. Materials and Methods

2.1. Tannery Effluent

The tannery effluent was taken from tannery industry located in and around Erode, Tamilnadu. The collected effluent was kept in the closed air tight container.

2.2. Analysis of Physical- Chemical Parameters of Tannery Waste Water

The tannery waste water sample was analyzed for determining the physicochemical properties using standard analytical method .The characteristics of the waste water such as pH, temperature, turbidity, conductivity, TDS, DO, BOD, COD, chlorides, calcium, hardness and magnesium were analyzed. All analyzed were performed thrice and average values were used.

2.3. Estimation of Chromium Metal Concentration in Tannery Waste Water

Cr (VI) concentration in the waste water was estimated using UV spectrophotometer at 641 nm wavelength.

2.4. Collection and Preparation of Adsorbent

Fly ash was obtained from combustion of pulverized coal in Neyveli Lignite Corporation Limited (NLC).

2.5. Batch Experiments

Removal of chromium Cr (VI) using fly ash was carried out by batch method. The influence of various parameters such as effect of pH, adsorbents dosage and contact time were studied. The batch experiments are carried out in 100ml borosil beaker by pre-weighed amount of fly ash with 25 ml of the waste water. At the end of predetermined time interval and adsorbent was separated by filtration. Chromium (VI) concentration in the filtrate was estimated using UV spectrophotometer at 641 nm wavelength. The effects of various parameter on the rate of adsorption process were observed by varying contact time (24 hours and 48 hours), adsorbents dosage (2 to 10 g/25 ml) and pH (6.8 to 8.8).

2.6. Column Experiments

Column test were carried out to determine the efficiency of fly ash in removal of chromium by different bed heights and flow rates. A vertical with diameter 2.5 cm and 20 cm length was used. The sample was fed in to the column from the top as the downward gravity flow and effluent were collected at the bottom

2.7. Seed Germination Tests

For the germination test, 25 seeds of Vigna radiata (green gram) were placed in sterilized petridishes of uniform size lined with two filter paper discs. These filter discs were then moistened with 5ml of distilled water for control and with the same quantity of untreated tannery effluent and treated tannery effluent. There were three replications for each treatment. The seeds that germinated were counted and removed from the petridishes at the time of first count on each day until there is no further germination. The criterion of germination which we took was the visible protrusion of radical through seed coat and it was expressed in percentage.

3. Result and Discussion

3.1. Physical and Chemical Parameter

The physiochemical parameters of effluent are determined are pH-4.0, COD-450 mg/l, BOD-36 mg/l, DO-16.4 mg/l, TDS – 16 mg/l, chloride – 41mg/l, Hardness-152 mg/l, Chromium- 277.31mg/l.

3.2. Batch Experiment

3.2.1. Effect of pH

The effect of pH on the batch adsorption studies on 25ml of effluent and adsorbent dosage 2 to 16 g/25ml, Figure 1 shows the removal of chromium in different pH.

The percentage removal of chromium are 61%, 68%, 73%, 90%, 87% ,78 in 6.8, 7.2, 7.6, 8,8.4,8.8 pH.

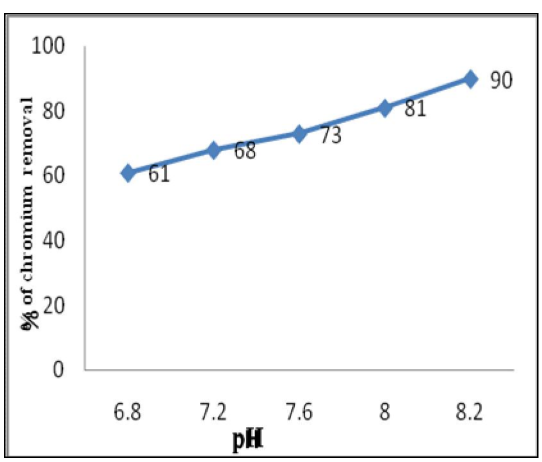

Figure 1: Effect of pH

3.2.2. Effect of Adsorbent Dosage

To study the influence of the adsorbent dosage on the removal of Chromium (VI) ions, different values have been taken by varying the adsorbent concentration ranging from 2 to 16g/25 ml by keeping the volume of the effluent solution constant.

3.2.3. Effect of Contact Time

The influence of contact time on the removal of Chromium in 24 hours time interval while keeping the volume effluent constant and adsorbent dosage 10g/25 ml was studied. Figure 2 shows that effect of contact time for 24 hours. The maximum removal of Cr (VI) was 90%.

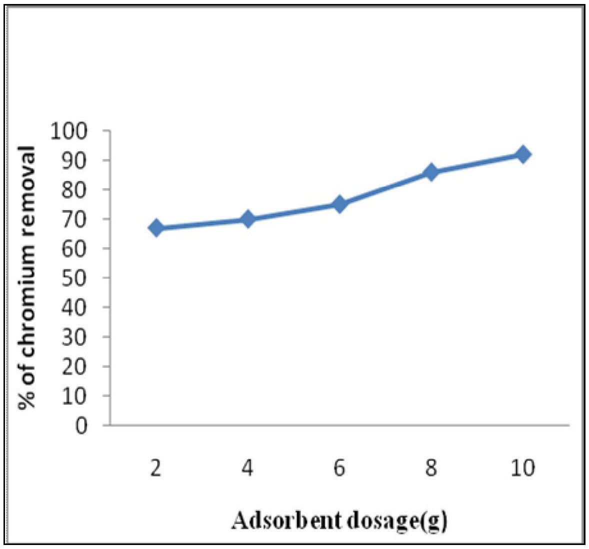

Figure 2: Effect of contact time for 24 hours

The influence of contact time on the removal of Chromium in 24 hours time interval while keeping the the volume effluent constant and adsorbent dosage 10g/25 ml was studied. Figure 3 shows that effect of contact time for 48 hours. The maximum removal of Cr (VI) was 92%.

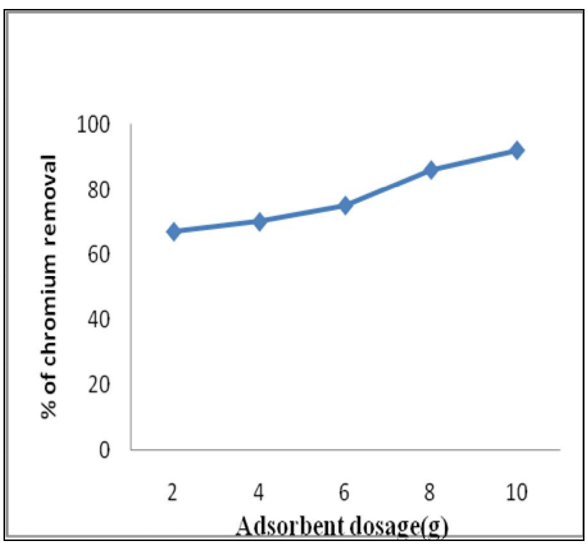

Figure 3: Effect of contact time for 48 hours

3.3. Column Experiment

3.3.1. Effect of Bed Height

The study was conducted for different bed heights of 1, 3, 5, 7, 9, and 11 cm respectively using 3, 9, 15, 21, 27 and 33g of fly ash respectively. A flow rate of 5 ml/min of tannery effluent with an initial concentration of 300 mg/l was fixed as the feed conditions for the column studies.

Bed height (cm)	Concentration of tannery effluent(mg/l)	Amount of fly ash (g)	Flow rate(ml/ min)	Concentration of Chromium before treatment(Co)	Concentration of Chromium after treatment(Ci)	Removal efficiency %
1	300	3	5	1.004	0.292	70
3	300	9	5	1.004	0.238	76
5	300	15	5	1.004	0.216	78
7	300	21	5	1.004	0.102	89
9	300	27	5	1.004	0.016	98
11	300	33	5	1.004	0.017	98

Table 1: Effect of bed height

3.3.2. Effect of Flow Rate

The adsorption capacity of fly ash is studied for various flow rates in the range of 5 to 10 ml/min for the initial concentration of 300 mg/l and bed height of 9 cm. Figure 10 shows effect of flow rate on % of Chromium removal.

Bed height (cm)	Flow rate (ml/min)	Concentration of Chromium before treatment(Co)	Concentration of Chromium after treatment(Ci)	Removal efficiency %
9	5	1.004	0.017	98
9	7	1.004	0.090	91
9	9	1.004	0.180	80
9	11	1.004	0.270	73

Table 2: Effect of flow rate

3.3.3 Breakthrough Profile

Small scale column test for chromium with Fly ash as adsorbents were run for 24 hrs at which 98 % of the breakthrough was obtained. At 98% of breakthrough , was obtained in 27 g of fly ash and 9 cm bed height was shown in Fig. (4).

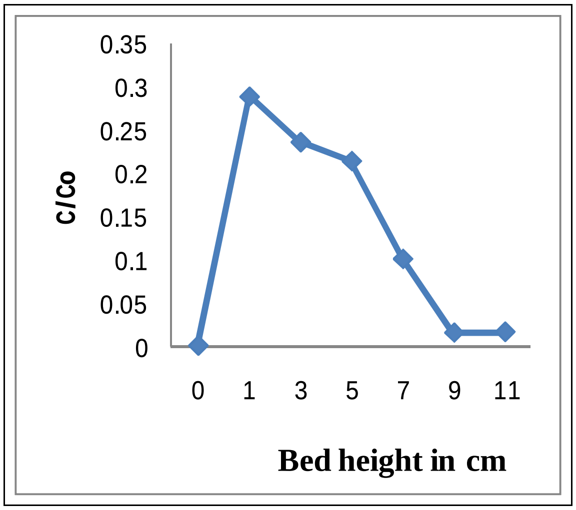

Figure 4: Breakthrough profile for Cr (VI) with Fly ash as adsorbents

3.3.4. Seed Germination Test

Success of removal of Chromium from tannery effluent has been evaluated through the study of percentage of Seed germination of Vigna radiate (green gram) before and after treatment, which is given in Table 3.

Name of the sample	Percentage of seed germination
Distilled Water	97
Untreated tannery effluent	20
Treated tannery effluent using fly ash	75

Table 3: Percentage of seed germination test for Treated sample

4. Conclusion

In Batch experiment, at 10g/25 ml the maximum of 92% removal of Chromium (VI) was obtained. In the effect of pH, the maximum removal of chromium (VI) occurs at pH 8.0.In contact time, the maximum removal of chromium (VI) ions was observed at optimum time of 48 hours.

In column experiments maximum removal of Chromium obtained at 9 cm bed height at 300 mg/l concentration of tannery effluent with a flow rate of 5ml/min showed a maximum efficiency of 98%

Column Experiment can be effectively used for removing of Chromium from tannery effluent compared to batch experiments

Success of the study has been evaluated through the study of percentage of Seed germination of Vigna radiata (green gram) before and after treatment.

In seed germination test, the percentage of seed germination after treatment was75% and before treatment was 20%.The Percentage of seed germination test in distilled water was 97%

These values show that the percentage of seed germination of Vigna radiata (green gram) was increased after the treatment of tannery effluent when compared to untreated tannery effluent.

It was concluded that, Fly ash as a carbonaceous has also been proved to be an efficient adsorbent for the removal of chromium (VI).

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