Fixed Bed Column Study for Removal of Hexavalent Chromium From Aqueous Solution by using Denolix Regia Pods (Flamboyant Pods)

Subitha V [1], Vanathi M [2]

[1]PG student, Civil Engineering, DR MGR University, Tamil Nadu, India

[2]Assitant Professor, Civil Engineering, DR MGR University, Tamil Nadu, India

---***---

Abstract - *The contamination of chromium (VI) in water posed severe health issues throughout the world. Several methods are available to remove chromium from aqueous environment but they are not feasible in all places and conditions due to various reasons. Some of the processes are electrochemical precipitation, ion exchange, solvent extraction, reverse osmosis, etc from contaminated water. The development of low cost adsorbent is essential for benefit of the society. In present work, the study on performance of low cost adsorbent such as Denolix regia pods were used in removal of toxic heavy metal hexavalent chromium from aqueous solution was performed. The adsorbent material adopted was found to be efficient media for removal of Chromium (VI) using fixed bed column which was having the total column height of 40cm, diameter of 7cm and a bed height of 30cm. The removal percentage has achieved 49% at optimum condition with the initial concentration of Cr (VI) as 500 mg/ml. The extend of adsorption was investigated as a function of pH, contact time, adsorbent dosage and adsorption of Cr (VI) was found to be time and concentration dependent.*

Keywords: *Adsorption, Chromium (VI), denolix regia pods, optimum pH, adsorbent dosage.*

1. INTRODUCTION

2.2 e

Chromium usually exists in both trivalent and hexavalent form in aqueous systems. The two oxidation states of chromium have different chemical, biological and chemical characteristics [9]. Cr (III) is relatively insoluble and required by microorganisms in small quantities as a essential trace metal nutrient [2], while Cr (VI) is a great concern because of its toxicity. Cr (VI) is reported to be a primary contaminant humans, animals, plants and microorganisms and it is known to be carcinogenic [1,5,7]. Sources of chromium waste leading to water pollution includes electroplating, steel fabrication, paints and pigments, leather tanning, textile dyeing, aluminum conversion coating operations, plants producing industrial inorganic chemicals and wood treatment units [3,4,6]. One of the cost effective method for removal of chromium is by adsorption using economic adsorbents. The advantage of this technique is that adsorbed substance can be recovered in the same form in which they present[8]. In this project we have studied the efficiency of *denolix regia pods powder (*locally known as *flamboyant tree pods)* in removal of hexavalent chromium from aqueous solution.

2. MATERIALS AND METHODS

2.1 Preparation of adsorbent

The pods of *denolix regia* were collected from local area, chennai. Pods were cut into pieces, sun-dried for 5 days and further dried in a hot air oven at 60°c for 24 hours. The completely dried material was powdered well, chemically activated by treating with the concentrated sulphuric acid with constant stirring kept for 24 hours. The obtained material was washed well with water several times to remove excess acid and dried at 105-110°C for 24 hours. The material was ground well and sieved through mesh to get uniform size and stored in airtight container for the future use.

2.2 Preparation of adsorbate solution

The stock solutions of Cr (VI) was prepared by dissolving 14.14 grams of analytical grade of $K_2Cr_2O_7$ (potassium dichromate) in 100ml of RO double distilled water. The stock solution was further diluted with RO distilled water to get desired concentration for absorbance measurements

2.3 Measurement of Cr (VI) in aqueous solution

There are some components within the denolix regia pods that may reduce the Cr(VI)to Cr(III). Therefore, oxidation of

Cr(III) within the samples to Cr(VI) is necessary before the analysis of each sample. Cr ions within the samples were oxidized by using potassium permanganate in acidic medium. The violet color that forms as a result of the reaction between the Cr(VI) ions and 1,5- diphenyl carbazide in acidic medium, was measured by using JASCO V-530 UV/VIS-Spectrophotometer at 540nm. The lowest limit of this method is 0-01mg/L. Therefore, in order to obtain the unknown concentration of treated solutions, the samples were diluted before the measurements and measured values were multiplied by the dilution factor.

2.4 Column studies

The fixed bed column had 7.0 cm internal diameter and was 40 cm in height. The bed length used in every experiment was fixed at 30 cm and for every run the known metal concentration was given to column filled with known bed height of adsorbent. Sample for analysis chromium ion concentration were collected at a regular interval of 30 minutes from bottom of the column reactor till it reaches the saturation point. The adsorbent used inside the fixed bed column was replaced for fresh batch of denolix regia pods powder at the beginning of every run.

The metal uptake capacity (amount of removal of chromium Metal ion) and the adsorption capacity (percentage of chromium ion removal) were calculated using the following equations:

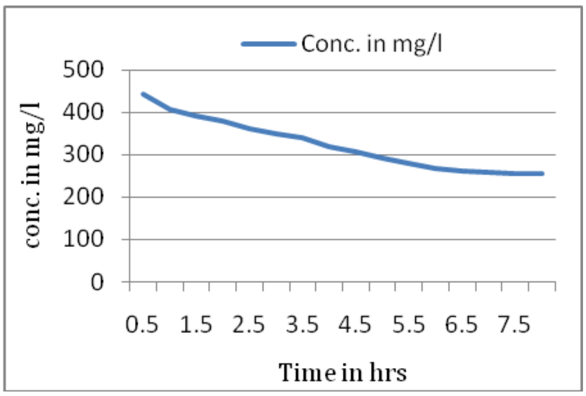
Metal Uptake Capacity = Initial Chromium ion Concentration – Final Chromium ion concentration

Adsorption Capacity (%) = (Metal Uptake Capacity X 100) /Initial chromium ion concentration

3. RESULTS AND DISCUSSIONS

3.1 study of adsorption capacity

First run



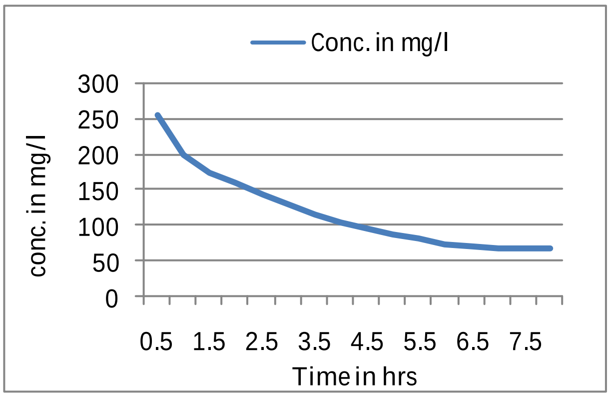
Graph-1 : Chromium concentration Vs Time plot

Calculation:

Metal Uptake Capacity = 500- 255 mg/l = 245 mg/l

Adsorption capacity = (245 X 100) / 500 = 49%

Second run



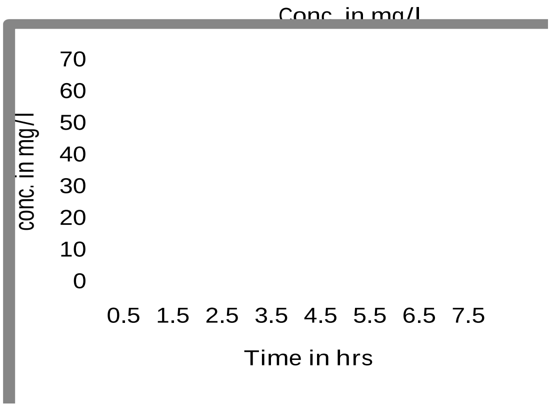
Graph-2 : Chromium concentration Vs Time plot

Calculation:

Metal Uptake Capacity = 255-66 mg/l = 189 mg/l

Adsorption capacity = (189 X 100) / 255= 74.11%

Third run



Graph-3 : Chromium concentration Vs Time plot

Calculation:

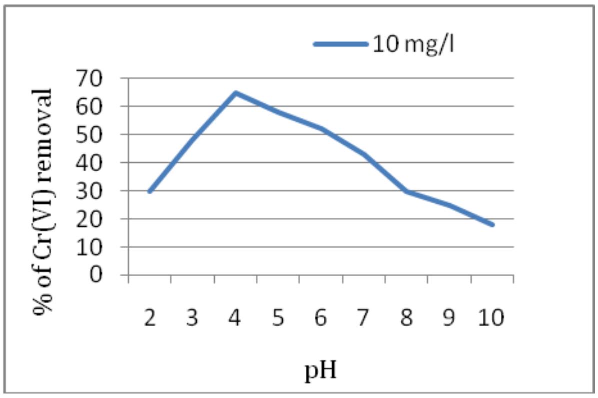
Metal Uptake Capacity = 66- 0.5mg/l = 65.5mg/l

Adsorption capacity = (65.5 X 100) / 66 = 99.24%

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 01 | Apr-2015 www.irjet.net p-ISSN: 2395-0072

3.2 Study of effect of pH

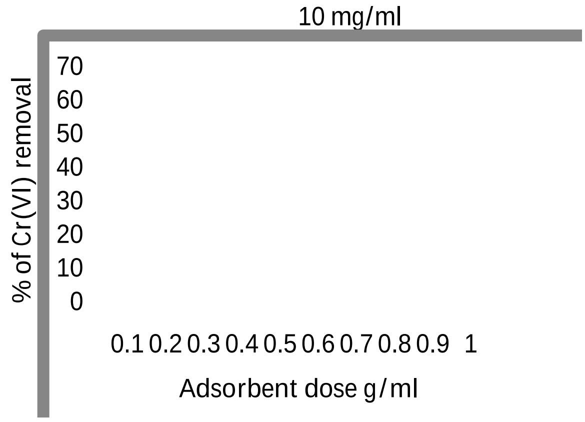
The study was carried out by taking known cconcentration of chromium ion solution 10 mg/l and pH ranges between 2 to10 to know the maximum chromium adsorption with the effect of pH. The maximum adsorption was found to be at the pH of 4.



Graph-4: Effect of pH on Cr (VI) removal % of denolix regia pods

3.3 Study of effect of adsorbent dosage

The varying adsorbent dosage of 0.1 to 1 grams were carried to know the optimum dosage and in the study it was found to be 0.8 gram/100 ml with a percentage of 60% and it started to decrease after that.



Graph-5: Effect of adsorbent dosage on Cr(VI) removal % of denolix regia pods

4. CONCLUSIONS

The study indicated the suitability of the adsorbent for removal of Chromium (VI) from aqueous solution. The selected adsorbent may be viewed as useful material while considering economic aspects of waste water treatment. The obtained results are summarized as follows:

The adsorbents of 3 fresh batches of fixed bed columns were used for each run (8 hours) for removal of Chromium (VI) ion from 500 mg/l to a value of 0.5 mg/l. The Metal uptake capacity and removal efficiency was found to be 49% at an optimum pH of 4. To know the optimum dosage of adsorbent the known concentration of Cr (VI) was taken and it attains 0.8 gm/100 ml , which shows the adsorbent is best suitable for lower concentration of chromium (VI) .

These experimental studies on specified adsorbent would be quite useful in developing an appropriate technology for the removal of Cr (VI) ions from contaminated industrial effluents.

REFERENCES

[1] C Raji, TS Anirudhan, Batch Cr (VI) removal by polyacrylamide-grafted sawdust : kinetics and thermodynamics, water res. 32 (1998) 3772-3780.

[2] G Saner, Chromium in nutrition and disease, Alan R Liss Inc.,New York,1980.

[3] JO Nriagu , E Nieboer, Chromium in the natural and human environment ,Wiley, New York ,1998

[4] LJ Casarett, J Doul, Toxicology the basic science of poisons, 1980.

[5]M Cieslak-golonka, Toxic and mutagenic effects of chromium (VI) , polyhedron 15 (1995) 3667-3689.

[6] MJ Udy, Chromium , Reinhold Publishing Corporation, 1956.

[7] US Department of Health and Human Services, Toxicological profile for chromium, Public Health services agency for toxic substances and diseases registry, 1991.

[8] VP Kudesia, water pollution Pragathi Prakashan Publications 1998,(20), 8-10.

[9]World Health Organization, Environmental health criteria 61, Chromium, WHO, 1988.

BIBLOGRAPHIES

V SUBITHA, PG Student, Department of Civil Engineering, DR MGR Educational and Research Institute, Chennai, India. .Email: subir8491@gmail.com.

M VANATHI, Assistant Professor, Department of Civil Engineering, DR MGR Educational and Research Institute, Chennai, India. .Email: flytovans@yahoo.com

