

“REMOVAL OF CHROMIUM FROM AQUEOUS SOLUTION BY USING LOW COST ABSORBENTS”

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ABSTRACT

The present study provides the removal of chromium from drinking water by absorption phenomenon. Chromium is found in all natural water bodies in hexavalent (Cr VI) as well as trivalent (Cr III) form. It has been proved to be hazardous, even fatal to human being, plants, and animals and to microorganisms. It creates risk of cancer, eye damage, kidney damage etc. As per Environmental Protection Authority (EPA) the permissible limit of chromium is 0.1 mg/l while the World Health Organization has set the limit as 0.05 mg/l. In absorption, the absorbent absorbs the traces of, which requires a simple physical process. The objective of this study is to examine the feasibility of different types of low cost absorbents, to check their efficiency in removal of chromium and the variation in parameters associated with it.

Keywords: - hexavalent, colorimetric, absorption, spectrophotometer, efficiency.

1. INTRODUCTION

Water is one of the most essential elements for life on the Earth. Without water there would be no survival of life on earth. Water is odorless, colorless and tasteless in its purest form. But due to human and animal activities it is usually contaminated. The sources of contamination of water are human waste, effluents from chemical industries and dissolved gases. Now a days the major problem being faced by major metropolitan cities is environmental pollution due to toxic metals. It has become an ever increasing problem. Bio-accumulation, geo-accumulation and bio magnifications are the result of toxic metals entering the ecosystem. The metals which are important for proper functioning of biological systems are iron, copper, zinc, chromium, cadmium, fluorides and other trace metals. The deficiency or excess concentration of these metals could lead to a number of disorders.

Chromium is a transition metal. Atomic number and average atomic weight of chromium is 24 and 52 respectively. Chromium belongs to group VI B in the periodic table with molybdenum and tungsten. The electronic configuration is [Ar] 3d⁵ 4s¹. Chromium is a redox active-elements. Its oxidation states range from -2 to +6, but in aqueous phase only 3 and 6 states are prevalent. Trivalent [Cr(III)] and hexavalent [Cr(VI)] are environmentally stable oxidation states which exhibits different toxicities and mobilities. Comparatively Cr(III) are less soluble (relatively insoluble) and exhibits little or no

toxicity. In contrast chromium 6 usually occurs as highly soluble and comprises toxic chromate anions which are suspected carcinogens and mutagens.

Chromium is a heavy metal which is toxic and carcinogenic in nature. It is non-biodegradable and leads to bioaccumulation in living organisms, resulting in various diseases and disorders. The excess of chromium causes diarrhea, nausea, low blood pressure, lung irritation, CNS diseases, cancer, dermatitis, etc.in human beings. Also the serious effects of chromium are mutation of cells, chromosomal disorders and genetic disorders. It also affects plants (yellowing of leaves) and animals.



Fig-1: Effects of chromium on human beings

2. OBJECTIVES

1. To study the efficiency of removal of chromium by using different types of absorbent.
2. To study the economic feasibility of absorption phenomenon for removal of chromium by using Ocimum sanctum (tulsi) and Tectona Grandis (Sagwan).

3. METHODOLOGY

- 1) Studying literature related to absorption phenomenon.
- 2) Calibration of spectrophotometer for checking the absorption capacity.
- 3) Carrying out jar test for checking the removal efficiency of the absorbents used like Tulsi and Sagwan.
- 4) Examining the trends in parameters like pH and conductivity.

4. EXPERIMENTAL WORK

4.1 Calibration process

Principle

Chromate combine with diphenyl carbazide in strong acidic solution to produce red-violet complex, which is determined by colorimetrically at a wavelength of 540 nm.

Interference

The reaction with diphenyl carbazide is nearly specific for Cr⁺⁶. Molybdenum and mercury salts will react to form colour with the reagent but the intensities are much lower than that from Cr⁺⁶ at the specific pH.

Apparatus

- Spectrophotometer for use at 540 nm with a light path of 1 cm or longer
- Nessler's tube of 100 ml capacity with lid
- Acid washed glassware

Reagents

- a) **Stock Chromium Solution.** Dissolve 141.4mg K₂Cr₂O₇ in distilled water and dilute to 100ml, 1ml=500µg Cr.
- b) **Standard Chromium Solution.** Dilute 1.0ml stock chromium solution to 100ml, 1.00ml=5.0µg Cr.
- c) **Sulphuric Acid, H₂SO₄, 5%.** Carefully 50ml H₂SO₄ to 950 ml distilled water.
- d) **Diphenyl Carbazide Solution.** Dissolve 250mg 1, 5 diphenyl carbazide (1,5 diphenyl carbohydrazide) in 50ml acetone. Store in a brown bottle.
- e) **Phosphoric acid H₃PO₄ Conc.**

Procedure

1. Calibration pipette out measured volume of standard chromium solution (5 µg/ml) ranging from 2.00 to 10.0ml/L to give standards for 10 to 50 µg Cr+6 into 100 ml Nessler's tube, add 0.5ml (10 drops) H₃PO₄. Add 20ml, 50% H₂SO₄ shake the Nessler's tube and dilute to 100ml, add 2ml diphenyl carbazide solution, mix and let it stand for 5 to 10 minutes for full colour development. Transfer an appropriate portion to absorption cell and measure its absorbance at 540 nm, using reagent blank as reference. Draw the calibration curve.
2. Treat the samples in the same way and compare the absorbance from calibration curve and note down the readings of Cr+6 if, any dilution is there, multiply it with final reading.

Note. If the solution is turbid after dilution to 100 ml. take an absorbance reading before adding carbazide reagent and correct absorbance reading of final coloured solution by subtracting the absorbance measured previously.

ABSORPTION

CONCENTRATION

0.084	0.1
0.144	0.2
0.164	0.3
0.256	0.4
0.319	0.5

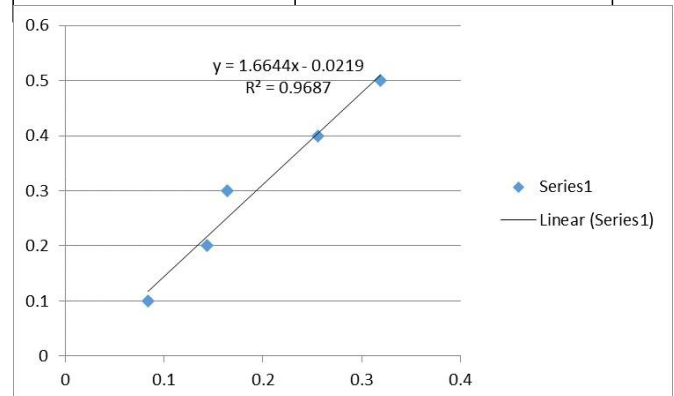


Fig-2: Calibration Curve

4.2 Jar test

- (a) Take 1000ml chromium containing water sample in each one liter jars.
- (b) Measure initial concentration of water by using spectrophotometer.
- (c) Add dose of powder in to the sample of increasing quantity in fixed (2gm, 4gm, 6gm) concentration (0.2mg/lit) and vice-versa.
- (d) Flash mixing of the contents for was done for 30min.
- (e) Flocculate the sample at constant speed of 100rpm for 30min.
- (f) Stop the rotation of paddles. Take out the jar and allow them to set for 20min.
- (g) Check the final concentrations of chromium from water by using spectrophotometer.
- (h) Plot a graph of chromium of concentrations (mg/lit) along Y-axis against powder dose (mg/lit) along X-axis.
- (i) Determine the powder dose corresponding to chromium concentration 5mg/lit.
- (j) In above experiment we take different dose of coagulant material at constant rate of concentration of chromium at 1L of water and rotated the paddles at 100 revolution/min. of about 30min and calculate the concentration.

Experimental condition

- : Chromium concentration: constant rate (1-10mg/lit vary on each new)
- : Doses: 2gm, 4gm, 6gm
- : Volume of water: 1lit
- : Speed: 100revolution/min.

5. TEST RESULTS & DISCUSSION

(a) Tulsi

At constant dosage of 0.2gm/litre.

The optimum dose of powder is 2gm for 0.2gm/litre chromium containing sample. It gives 86.8% removal efficiency. The conductivity decreases from 0.71 to 0.15 seimens indicating that there is reduction in ions. The ph of the solution increases from 5.77 to 6.18 which satisfies the drinking water standards.

Table-1: Time vs concentration

Time	Concentration
70	0.182
120	0.175
170	0.0264

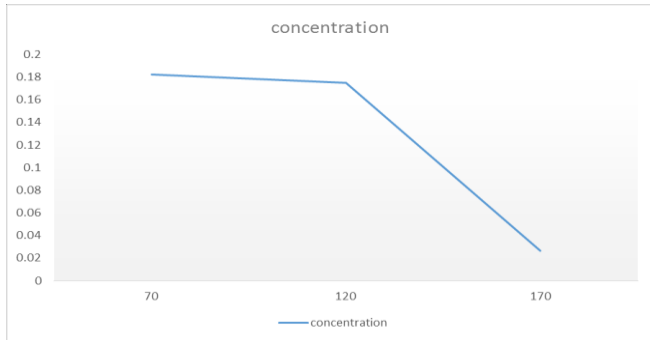


Fig-3: Time Vs Concentration

At constant dosage of 0.2gm/litre.

The optimum dose of powder is 4 gm for 0.2 gm/litre chromium containing sample. It gives 86.9% removal efficiency. The conductivity decreases from 0.71 to 0.15 seimens indicating that there is reduction in ions. The ph of the solution increases from 5.3 to 6.2 which satisfies the drinking water standards.

Table-2: Time vs concentration

Time	concentration
70	0.181
120	0.174
170	0.0262

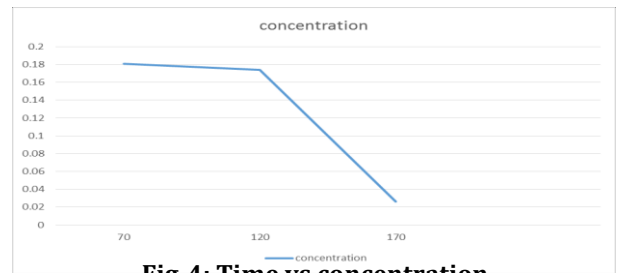


Fig-4: Time vs concentration

At constant dosage of 0.2gm/litre.

The optimum dose of powder is 6gm for 0.2gm/litre chromium containing sample. It gives 87.5% removal efficiency. The conductivity decreases from 0.7 to 0.12 seimens indicating that there is reduction in ions. The ph of the solution increases from 5.4 to 6 which satisfies the drinking water standards

Table-3: Time Vs Concentration

Time	concentration
70	0.18
120	0.172
170	0.025

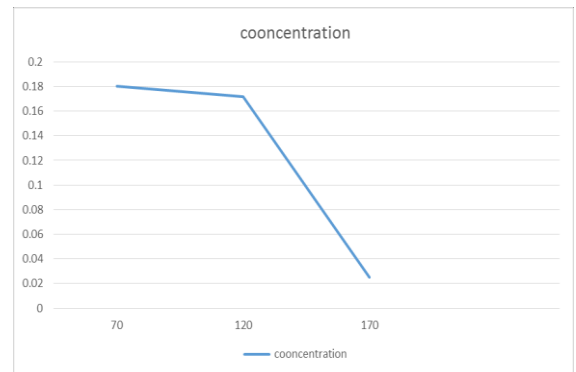


Fig-5: Time Vs Concentration

(b) Sagwan

At constant dosage of 0.2gm/litre.

The optimum dose of powder is 2gm for 0.2gm/litre chromium containing sample. It gives 85.9% removal efficiency. The conductivity decreases from 0.71 to 0.15 indicating that there is reduction in ions. The ph of the solution increases from 5.9 to 6 which satisfies the drinking water standards.

Table-3: Time vs concentration

Time	concentration
80	0.157
140	0.0645
200	0.0283

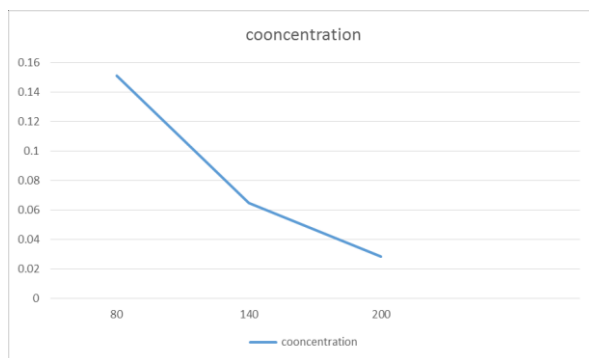


Fig-6: Time Vs Concentration

At constant dosage of 0.2gm/litre.

The optimum dose of powder is 4gm for 0.2gm/litre chromium containing sample. It gives 86% removal efficiency. The conductivity decreases from 0.69 to 0.15 siemens indicating that there is reduction in ions. The ph of the solution increases from 5.8 to 6.5 which satisfies the drinking water standards.

Table-3: Time vs concentration

Time	concentration
80	0.156
140	0.0545
200	0.0282

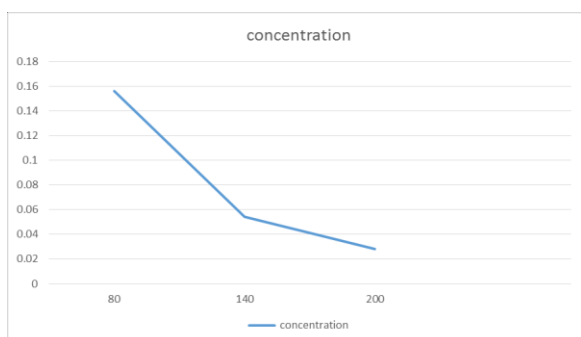


Fig-7: Time vs concentration

At constant dosage of 0.2gm/litre.

The optimum dose of powder is 6gm for 0.2gm/litre chromium containing sample. It gives 86% removal efficiency. The conductivity decreases from 0.69 to 0.14 siemens indicating that there is reduction in ions. The ph of the solution increases from 5.7 to 6.2 which satisfies the drinking water standards.

Table-3: Time vs concentration

Time	concentration
80	0.155
140	0.0545
200	0.0280

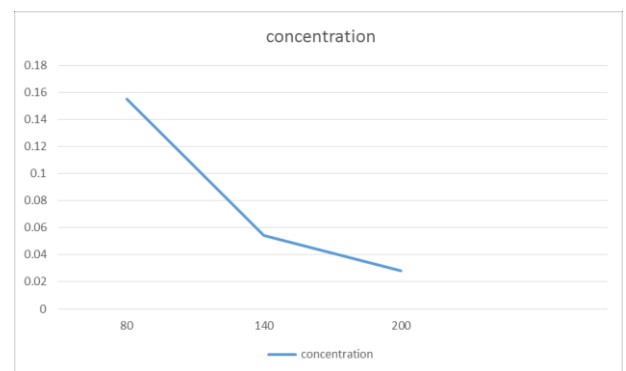


Fig-8: Time vs concentration

6. CONCLUSION

From the experiments done by using low cost absorbents such as ocimum sanctum (tulsi) and Tectona grandis (sagwan) by varying dosages like such as 2gm, 4gm, 6gm, we tested various parameters such as concentration, conductivity and pH.

We concluded that

- 1) Concentration of chromium decreases with increase in time.
- 2) Conductivity decreases with increase in time period which shows that there is reduction of salts.
- 3) PH increases with increases in time period.
- 4) In comparison with tectona grandis (sagwan), ocimum sanctum (tulsi) gave notable results.
- 5) Tulsi is more efficient in removal of chromium traces from aqueous solution.

7. REFERENCES

1. Ashraf Ali, Khalid Saeed, Fazal Mabood (11 May 2016), "Removal of chromium VI from aqueous medium using chemically modified banana peels as efficient low cost adsorbents", Alexandria Engineering Journal.
2. Babita Labh Kayastha (2014), " Queen of herbs tulsi (Ocimum sanctum) removes impurities from water

- and plays disinfectant role”, Journal of medicinal plant studies, vol. 2 issue 2.
3. Chromium in drinking water, WHO guidelines for drinking water quality, vol.2, 2012.
 4. G.Gebrehawaria, A.Hussein, V.M. Rao (March 7,2014) “removal of hexavalent chromium from aqueous solution using bark of acacia albida and leaves of Euclea schimperii”, Int. J. Environ. Sci. Technol.
 5. Geetha K. S., Belagali S.L. (June 2013),“ Removal of heavy metals and dyes using low cost adsorbents from aqueous medium- A review” ,IOSR-JESTFT, vol. 4, issue 3
 6. Journal of central water commission, May 2015.
 7. Khaldoun Al-Sou’od, (January 2012), “ Adsorption Isotherm studies of Chromium VI from aqueous solution using Jordanian pottery materials”, APCBEE.
 8. Kristi Sorsa, (January 2011) “advantages and disadvantages of removing chrome 6 by reverse osmosis”, public health journal.
 9. Mayuri Jain, Suneetha V. (2013), “ Phytochemical screening and bioremediation using Ocimum sanctum collected from VIT university nursery”, Der Pharmacia Lettre, vol. 5, issue 5.sss
 10. Pavel Kocurek, Karek Kolomaznik and Michaela Barinova. (2014) “chromium removal by reverse osmosis, “ WSES TRANSACTIONS on ENVIRONMENT and DEVELOPMENT, 10
 11. Pratima Meshram, Sushanta Kumr, banshidhar Pandey, Vinay Kumar, (August 2011), “removal of chromium III by IR 120 resin”,International journal of non-ferrous metallurgy.
 12. Sabino De Gisi, Guisy Lofrano, Mariangela Grassi, Michele Notarnicola, (June 2016), ‘characteristics of adsorption capacities of low cost adsorbents for waste water treatment : A review, Sustainable materials and technologies.
 13. V .H Waghmare, UE Chaudhari, (March 2014), “removal of hexavalent chromium from aqueous solution by adsorption on commiphora myrrha bark, RASAYAN J. chem,7.