*Available online at* **www.derpharmachemica.com**

ISSN 0975-413X
CODEN (USA): PCHHAX

**Der Pharma Chemica, 2016, 8(10):230-235**
*(http://derpharmachemica.com/archive.html)*

# Purification of Cr (VI) Contaminated Water Using FRBAC as Low Cost Adsorbent

**Donadkar D. K.[1], Rahangdale P. K.*[2] and Gour K.[3]**

[1]*Department of Chemistry, Priyadarshini College of Engineering, Nagpur-440019*
[2]*Department of Chemistry, Bhawabhuti Mahavidyalaya, Amgaon-441902*
[3]*Department of Chemistry Priyadarshini J. L. College of Engineering, Nagpur-440009*

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**ABSTRACT**

*Purification of Chromium (VI) contaminated water is essential as it is toxic. The present study deals with the removal of Chromium (VI) using activated carbon derived from Ficus racemosa bark (FRBAC) as low cost adsorbent. The adsorption technique is effective and economical for practical applicability. The influence of contact time, adsorbent dose, Cr (VI) ion concentration and pH on adsorption phenomenon have also been investigated and reported. The maximum adsorption capacity of the adsorbent under study for Cr (VI) was found to be 92.3% at optimum pH 5. The results indicate that the adsorption process is favorable for Frendlich and Langmuir models.*

**Key words**: *Ficus racemosa*, Chromium (VI) toxicity, Langmuir and Frendlich adsorption isotherm, activated carbon.

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## INTRODUCTION

Environmental pollution is, now days, one of the most alarming problems facing by human beings. The presence of heavy metals in water sources and in edible agricultural crops can be harmful to human. It is well known that heavy metals are toxic and they can damage nerves, liver and bones, and they can block functional groups of vital enzymes too [1]. Metal ions such as Cd, Cr, Co, Cu, Zn, Pd, Hg, Ni, Ag, and Sr and metalloids such as Se, As, and Sb are toxic if consumed beyond permissible limits. Strong exposure to Cr (VI) causes cancer in the digestive tract and lungs. It may also cause gastric pain, nausea, vomiting, severe diarrhea, and hemorrhage [2,3]. The conventional methods for metal removal from water include reduction, precipitation, ion exchange, electrochemical reduction and reverse osmosis. Most of them involve high capital costs with recurring expenses, which are not suitable for small-scale industries. Adsorption method is considered to be one of the preferable methods for the removal of heavy metal ions from aqueous solution due to its significant advantages such as low operational cost, wide applicability and creation of relatively low sludge. Wide range of adsorbents has been reported in the literature that shows different characteristics depending upon their chemical constituents and the synthesis techniques adopted [4-8].

The present research article reports the removal of Chromium (VI) by adsorption on to low cost material *Ficus racemosa* bark based activated carbon (FRBAC).

## MATERIALS AND METHODS

All the chemicals used during this investigation were of analytical reagent or chemically pure grade**.**

### Preparation of Adsorbent

*Ficus racemosa* bark was collected from the nearby local forest area and it was cut into small pieces. It was wash with distilled water and dried in sunlight to remove the moisture. Then it was treated with formaldehyde to avoid the release of color by bark into the aqueous solution during the adsorption process. The above treated bark was carbonized by slow heating over a wide range of temperature (400-700$^{o}$C) in the absence of air in a muffle furnace. The char obtained was subjected to thermal activation in the absence of air at elevated temperature 900$^{o}$C and held at that temperature for 1½ hour. The adsorbent so obtained was ground and sieved through 200 mesh sieves. The dried sample was stored in airtight bottles for further use.

Concentrations of Cr (VI) ion in solutions were estimated calorimetrically applying standard methods [9, 10]. Standard Cr (VI) solution was prepared by dissolving 0.2829 g of potassium dichromate crystals in distilled water and making the volume up to 100 $cm^3$. Exactly 50 $cm^3$ of this solution was transferred into a 500 $cm^3$ volumetric flask and made up using distilled water to get a solution containing 0.1 mg of Cr (VI) ions per $cm^3$. Solutions of various required concentrations were prepared by diluting suitable aliquots of the above solution with distilled water.

## RESULTS AND DISCUSSION

### Effect of contact time

For a fixed concentration of heavy metals and a fixed adsorbent mass, the retention of heavy metals increased with increasing contact time before equilibrium is reached. It can be seen that Cr (VI) removal efficiency of activated carbon derived from *Ficus racemosa* bark increased from 43% to 96%, when contact time was increased from 10 min to 120 min. Thus optimum contact time was found to be 120 min.

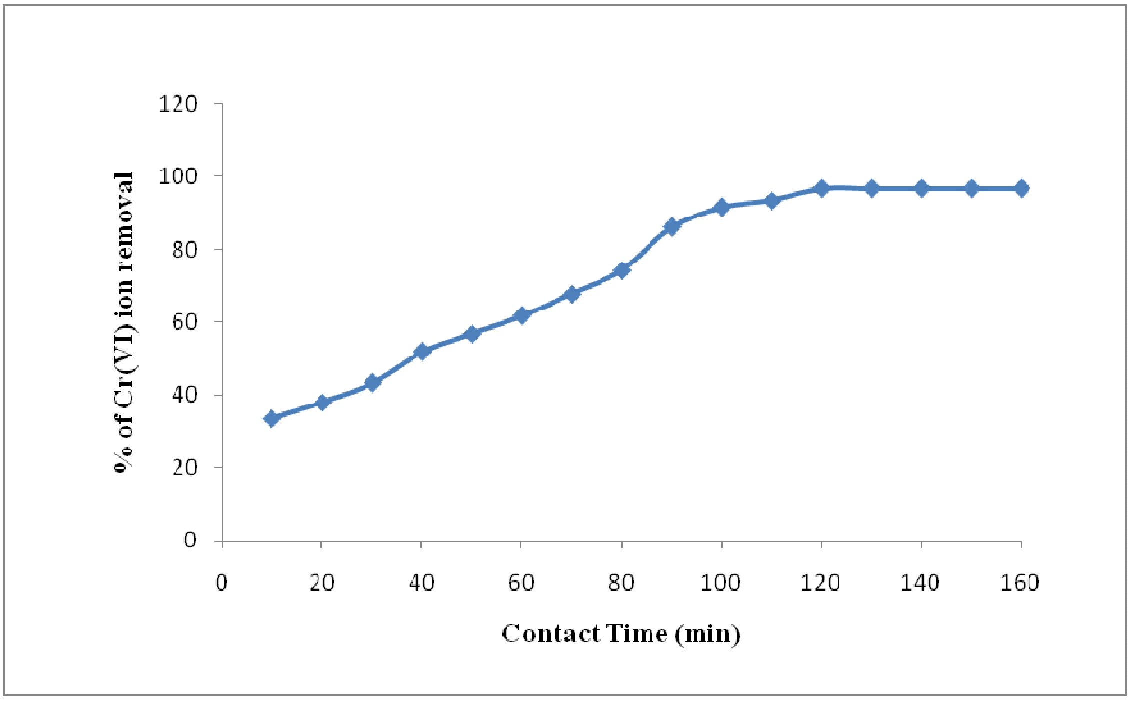


**Fig. 1: Effect of contact time on Cr (VI) ion removal byactivated carbon derived from *Ficus recemesa bark***

### Effect of pH

The pH of the aqueous solution is one of the key factors that control the adsorption process of Cr (Vl) ion because it controls the electrostatic interactions between the adsorbents and the adsorbate. Cr (VI) ion removal efficiency was found 92.3% at pH 5. Maximum adsorption of Cr (VI) ion was observed at the acidic pH. This is because at lower pH there is increase in concentration of $H^+$ ions on the carbon surface.

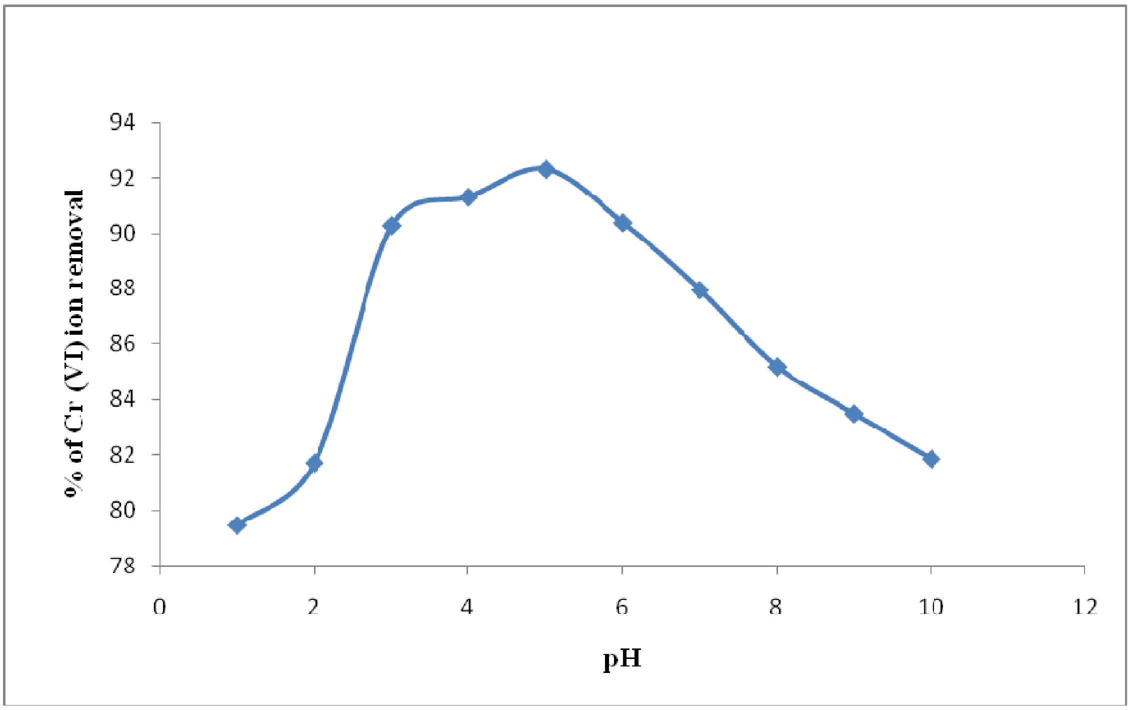


**Fig. 2: Effect of pH on Cr (VI) ion removal byactivated carbon derived from *Ficus racemosa bark***

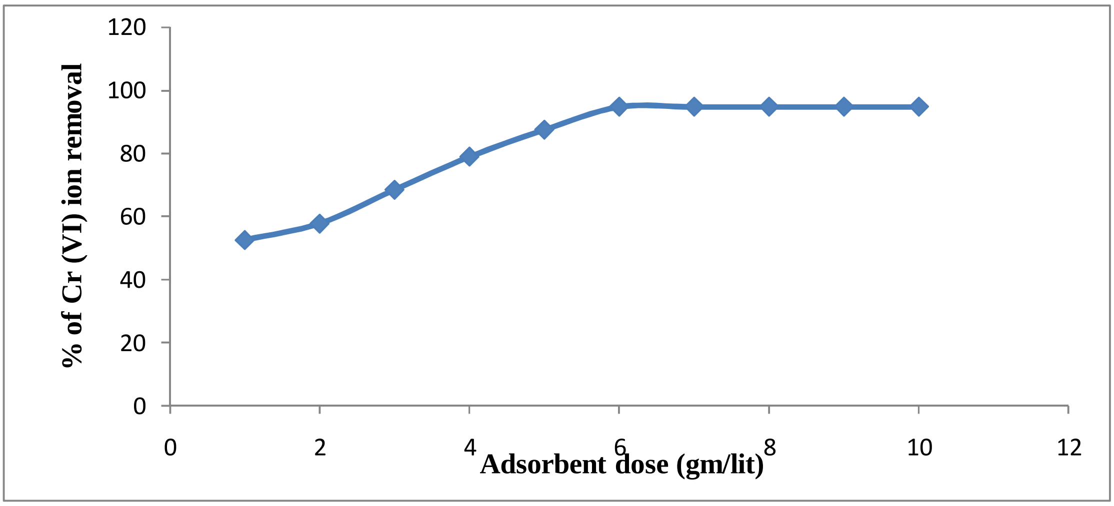


**Fig.3: Effect of adsorbent dose on Cr (VI) ion removal by activated carbon derived from *Ficus racemosa* bark**

**Effect of adsorbent dosage**

The obtained results reveal that the percentage removal of Cr (VI) ions increased with an increase in the adsorbents dose because of more availability of number of active sites and more surface area. Maximum adsorption was observed at 6 gm/lit i.e. 94.8 %. But after 6gm/lit of dose, it remains constant

**Adsorption isotherm**

Adsorption isotherms can be generated based on numerous theoretical models where Langmuir and Freundlich models are the most commonly used.

**Langmuir isotherm**
The Langmuir model is given by following Eq (1)

**$Ce / Qe = 1/Q_m b + Ce/ Q_m$ ---------------- (1)**

Where, Ce is the equilibrium concentration mg/lit, Qe is the amount of Cr(VI) ion adsorbed at equilibrium (mg/g),$Q_m$ is the maximum adsorption capacity and b is the Langmuir constant (equilibrium constant).

A plot of Ce/Qe versus Ce should indicate a straight line of slope $1/Q_m$ and an intercept of $1/bQ_m$ [12, 13]. The values of '$Q_m$' was found to be 11.286 mg/g while values of 'b' is 0.189 respectively.

The Langmuir parameters can be used to predict the affinity between the adsorbate and adsorbent using the dimensionless separation factor RL.

**RL =1 / (1+bCe) ------------------------ (2)**

The value of $R_L$ lies between 0 and 1 for favorable adsorption, while $R_L$> 1 represents unfavorable adsorption and $R_L$=1 represents linear adsorption while the adsorption process is irreversible if $R_L$ =0.

The dimensionless parameter $R_L$ values lies between 0.0962 to 0.9105 is consistent with the requirement for favorable adsorption [11].

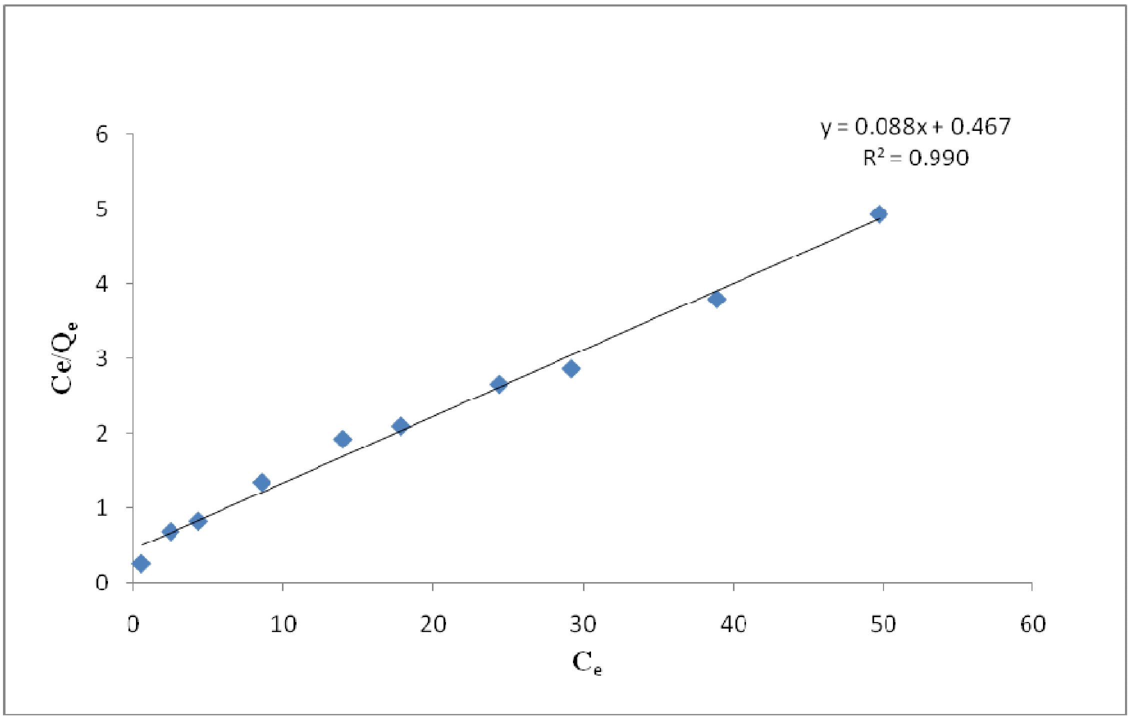


**Fig. 4: Langmuir isotherm for the adsorption of Cr (VI) ion on activated carbon derived from *Ficus racemosa* bark**

**Freundlich isotherm**
Freundlich isotherm model was also used to explain the observed phenomenon [14]. The Freundlich isotherm is represented by Eq. (3)

**$LogQe = \log K_f + 1/n \log Ce$ --------------- (3)**

$K_f$ and n are constant incorporating all factors affecting the adsorption process such as adsorption capacity and intensity, respectively. A plot of log $Q_e$vs log Ce gives a linear trace with a slope of 1/n and intercept of log $K_f$. $K_f$ and n calculated from the intercept and slope of the plots were found to be 1.521 and 2.615 respectively.

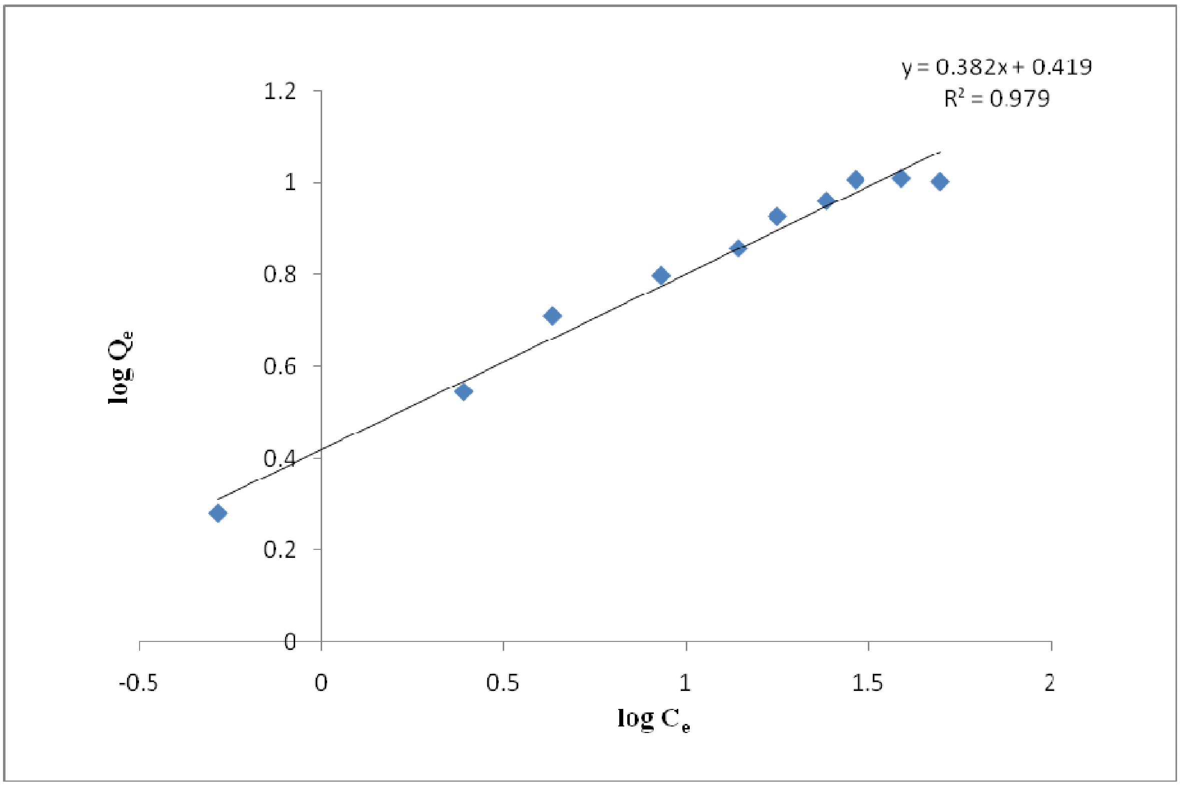


**Fig.5: Freundlich isotherm for the adsorption ofCr (VI) ion on activated carbon derived from *Ficus racemosa* bark**

## CONCLUSION

The results indicated that activated carbon derived from *Ficus racemosa* bark is a promising new low cost adsorbent for removal of Cr (VI) ions from aqueous solutions. From the experiments, it can be concluded that all operational parameters studied such as contact time, solution of pH and adsorbent dosage affect the Cr (VI) ion removal efficiency of adsorbent. The pH selected for an optimal rate of adsorption for Cr (VI) is 5. The experimental data for the adsorption process were well fitted by the Langmuir adsorption isotherm model and Freundlich adsorption model too.

Thus the newly generated *Ficus racemosa* bark based activated carbon (FRBA) has been proved to be an excellent eco-friendly and low-cost adsorbent material which can be successfully used for elimination of Cr(VI) from contaminated water.

**Acknowledgements**
Authors are thankful to the Principal and Head of the Chemistry Department, Priyadarshini College of Engineering, and Nagpur, India for providing the necessary laboratory and library facilities.

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