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Adsorption of chromium ion by using neem bark adsorbent

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Abstract
The study was aimed to investigate low cost adsorbents Neem bark for removal of Cr (IV) ion in aqueous solution. Adsorption achieved at 50 ppm initial concentration of Cr (IV), 180 min contact time and 3 pH. Batch mode adsorption study was conducted during experiment to evaluate various parameters by using Neem bark adsorbent. Result shows that that percentage removal increased with adsorbent dose and contact time.

Keywords: Adsorbent, Neem Bark, Adsorption, Aqueous Solution, Chromium

1. Introduction
One of the most important and toxic heavy metals in wastewater is chromium. Cr (VI) is released from different industrial operations, including metallurgy, leather tanning, paint, textile industries, chemical manufacturing, pulp production, ore and petroleum refining, metal corrosion, electroplating and the manufacture of products for corrosion protection. Chromium (VI) has been released to the environment via leakage, poor storage or improper disposal practices. Over the decades, extensive use of chromium in tanning industries have resulted in chromium contaminated soil and ground water at production sites which pose a serious threat to human health, fish and other aquatic biodiversity. Cr(VI) causes skin, lung and throat cancers, infertility, increased incidences of birth and developmental defects among children living around tanneries, leather and chrome industries. The Ministry of Environment and Forest has set the permissible limit of Cr (VI) in industrial effluents to 0.05 mg/L. According to the World Health Organization (WHO) drinking water guidelines, the maximum recommended limit for total chromium is 0.05 mg/L (Khatoon *et. al.*, 2013) [1]. A number of treatment methods for the removal of metal ions from aqueous solutions have been reported, mainly reduction, ion exchange, electrodialysis, electrochemical precipitation, evaporation, solvent extraction, reverse osmosis, chemical precipitation and adsorption. Most of these methods suffer from drawbacks such as high capital and operational costs or the disposal of the residual metal sludge (Demirbas *et. al.*, 2004) [4]. Adsorption is an effective purification and separation technique used in industry especially in water and wastewater treatment (Al-Ashesh *et al.*, 2000). Removal of heavy metals by adsorption is an emerging field of research (Sharma & Bhattacharya, 2004; Gupta & Babu, 2006). The process of adsorption has an edge over other methods due to its sludge free clean operation. Adsorption using activated carbon is an effective method for the treatment of wastewater rich in metals. It completely removes them even from the dilute solutions. However cost is an important parameter when comparing the sorbent materials. Commercial activated carbons are very expensive; therefore various low cost new adsorbents are being studied by researchers which are suitable for water pollution control. The agricultural waste products are much widely being studied for their adsorption efficiency. These products are readily available and low in cost also (S.R and A.P, 2012). The search for alternate and innovative treatment techniques has focused attention on the use of biological materials for heavy metals removal & has gained important credibility during recent years because of the good performance and low cost of these materials. So the efforts are being directed towards the use of natural low cost adsorbents for removal of heavy metals. Use of natural materials which are available in large quantities or certain waste products from industries or agriculture may have potential as inexpensive adsorbents. Recently some of these low cost adsorbent (natural or processed) have been tested as adsorbents for heavy metal removal(Gupta *et. al.*, 2011) [3].

Majority of industries use chromium compounds in attempt to improve human living standards, but the discharge of those chemicals into the environment without proper treatment reverse the intended living standard. Leather Tanning industries are ranked as the highest contributors of chromium pollution (Berihun, 2017) [7].

2. Materials and Method

2.1 Adsorbent

Neem bark collected from Neem tree in local area of Ujjain City (M.P). It is washed with distilled water to remove soluble impurities and kept for drying at room temperature for 24 hours. After drying, Neem bark is crushed in pieces with the help of ball mill and sieved to separate 600 micron size particle. The neem bark is activated by concentrated H_2SO_4 (98%) and washed with distilled water until it stops giving any color and keeping it in oven at 70^0C for 24 h.

2.2 Preparation of Cr (VI) solution

All the reagents used were of AR grade. Synthetic chromium solution is prepared by dissolving 2.8287 g of $K_2Cr_2O_7$ in 1 L of distilled water. Diluting 100 ml of this solution to 1 L of distilled water for obtaining stock solution. This stock solution was used to prepare other concentration of chromium solution.

2.3 Batch Mode Adsorption Studies

The low cost Neem bark was used to investigate the adsorption of chromium in synthetic solution by different known concentration 50, 100, 150 and 100 ppm solution. Adsorbent added in 100 ml of the chromium solution in each flask at different time interval from 60 to 240 min. Batch experiment was used to evaluate the percentage removal of Cr (IV) by using neem bark adsorbent. During experiments, various parameters such as pH, concentrations, contact time and adsorbent dose were investigated. UV spectrophotometer was used to measure adsorbate concentration by using neem bark adsorbent. After that, sample filtered by using Whatsman filter paper no. 42 and metal ion concentration was analyzed by spectrophotometrically at wavelength 540 nm using the complexing agent 1, 5-diphenyl-carbazide in acid medium. Removal percentage of Cr (IV) was determined using following Equation:

Percentage of heavy metal removal (%) = [(Co – Ce) /Co] × 100

Here, C_o- initial heavy metal ion concentration of test solution, mg/l; C_e was equilibrium final concentration of test solution mg/l.

3. Effect of Various Parameters on Percentage Removal of Chromium

3.1 Effect of time: Figure 1 represent the effect of contact time on adsorption of Cr (VI) ions by Neem bark adsorbent. In the figure it is seen that the adsorption increases by varying contact time from 60 min to 240 min. Maximum 70 % removal observed at 180 min optimum contact time at 50 ppm initial concentration of Cr. After optimum contact time there is no significant changes in percentage removal of Cr as shown in fig. below:

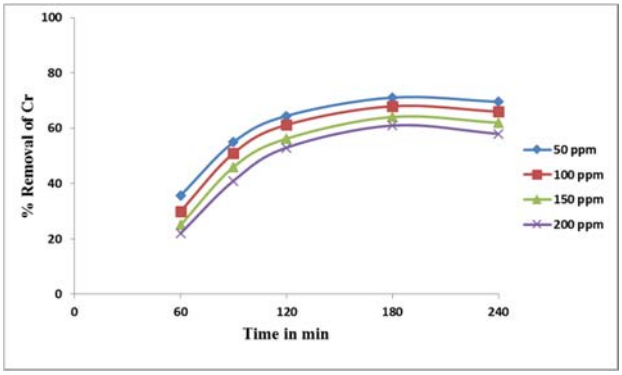

Fig 1: Effect of contact time on % removal of chromium (Cr) ion by Neem bark adsorbent. (Parameter- 8 g adsorbent dose, 3pH).

3.2 Effect of pH on adsorption of Cr (IV):

The influence of pH on the adsorption of Cr ions was examined by varying pH from 1 to 8 at different known concentration of Cr in solution. Figure 3.2 represent the effect of pH on percentage removal of Cr ion in aqueous solution. In the fig. pH was varying in between 1 to 8 at 50 ppm initial concentration of Cr. Maximum percentage removal obtained at 3 pH and 180 min of contact time.

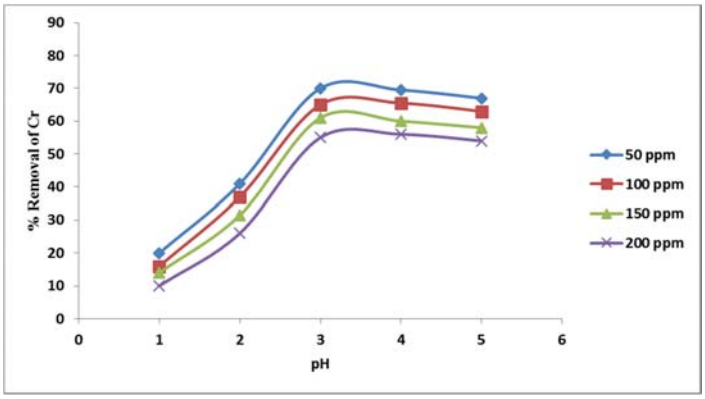

Fig 2: Effect of pH on percentage removal of Cr ion by Neem bark adsorbent (Parameter – 8 g adsorbent dose, 180 min contact time)

3.3 Effect of adsorbent dosage: Figure 3 shows effect of adsorbent dosage on percentage removal of Cr by using Neem bark adsorbent. It is seen that in figure adsorbent dose varying between 2 gm to 12 gm at 50 ppm initial concentration of Cr. It indicate that percentage removal increases slowly with increase in adsorbent dose of Neem bark after 8gm of adsorbent dose it reaches to optimum condition. Maximum removal was observed in 50 ppm initial concentration of Cr and 8 gm of adsorbent dose.

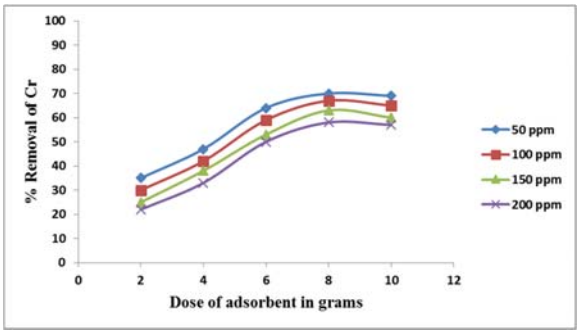

Fig 3: Effect of adsorbent dose on % removal of Chromium ion by Neem bark (Parameter – 3 pH, 180 min contact time, 50 ppm initial conc., 8 gm adsorbent dose)

3.4 Effect of initial concentration

Figure 3.4 shows effect of concentration on percentage removal of Cr (VI). Percentage removal was determined by varying known concentration of Cr (VI) from 50 to 200 ppm by using Neem bark adsorbent. The result shows that maximum adsorption occurs at 50 ppm initial concentration of Cr (VI). 70 % adsorption was found at 180 min of contact time.

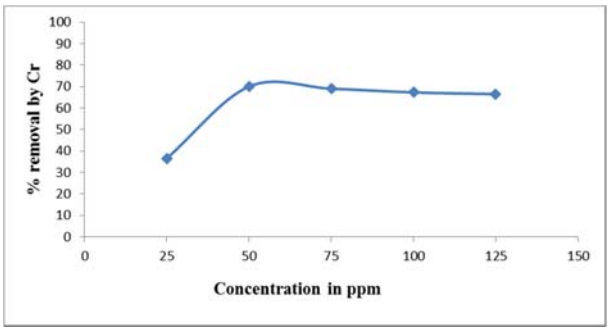

Fig 4: shows Effect of concentration on percentage removal of Cr ion by using Neem bark adsorbent (Parameter- 180 min contact time, 8 gm adsorbent dose at 3 pH)

Conclusion

Neem bark is natural adsorbent which is easily available in our environment and it is very effective and low cost adsorbent for removal of Chromium in water. During experiment, adsorption method is used to remove Cr (IV) ion in solution. It is simple technique as compare to other removal techniques. In the study it is found that maximum 70 % removal of chromium occurs at 8 gm of adsorbent dose.

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