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Removal of Heavy Metal (Chromium) From Aqueous Solution using Acacia Arabica Wood (Black Babul)

B.V.Dhananjaneyulu

Abstract: ***Heavy metals become a serious problem to society in the view of water pollution. Polluted water causes many disorders in human beings, animals and plants also. The concentration of heavy metals increases mainly due to the activities like mining, agricultural activities and disposal of industrial waste products. Most of the activities releases heavy metals like Mercury (Hg), chromium(Cr), arsenic(Ar), thallium (Tl), nickel (Ni), lead (Pb), and cadmium (Cd). Separation of these heavy metals from water many treatment methods are available like chemical precipitation, ion exchange, membrane separation, electro-dialysis, ultra-filtration, nano filtration, coagulation, flocculation, floatation and adsorption. Adsorption is the best method out of all these methods. Activate carbon is normally used as adsorbent but it is expensive. Black babul wood is the cheapest and abundant available in nature. So treatment of heavy metals black babul wood used as adsorbent. In this article, effect of parameters like process time, initial concentration, adsorbent dosage, adsorbent particle and temperature on separation of Chromium from aqueous solution is studied.***

Keywords: Black babul wood , adsorption

I. INTRODUCTION

Pollution becomes one major problem facing by the world. It is increasing day to day and the quality of environment becomes degrading[1]. Pollution is occurring in the ways like water pollution, air pollution and land pollution etc. This pollution mainly occurs due to human activities like industrialization, burning of fossil fuels, mining, agricultural activities etc[2]. Industries wastages releases into water bodies like river, lakes and ocean without any proper treatment. Many of the industry wastatges contains heavy metals like Mercury (Hg), chromium(Cr), arsenic(Ar), thallium (Tl), nickel (Ni), lead (Pb), and cadmium (Cd)[3,7].It causes serious water pollution and effects on aquatic plants and animals. By the mechanism of food chain process higher level of tropical levels also affected. It causes skin problems, immunity problems, damage nervous system, lung cancer, diabetes, cancer, anemia and respiratory problems etc[4].Primary drinking water has certain limitations for heavy metal concentration and it decided by WHO(World Health Organization).

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* Correspondence Author
B.V.Dhananjaneyulu,* Department of Chemical Engineering, Vignan's Foundation for Science, Technology and Research, Vadlamudi, Guntur (Dist.), Andhra Pradesh, India.

According to WHO, concentration limitation for Chromium 0.1mg/l, Lead 0.015 mg/l, Cadmium 0.005 mg/l and thallium 0.002mg/l. etc. Separation of heavy metal(Chromium) from aqueous solution can be done by many treatment methods like chemical precipitation, ion exchange , electrodialysis, and adsorption etc[1,5]. Adsorption method is ecofriendly and economic of all these treatment methods. Basically
adsorption is a mass transfer operation, in which liquid or gas material deposits on the surface solid material[6]. The material which is adsorbing (liquid or gas) is known as adsorbate and solid material is known as adsorbate. Adsorption is occurs mainly in two types, physical and chemical adsorption[3,6]. Physical adsorption happens due to molecular intermolecular forces (Vander waal's forces) of attraction between adsorbate and adsorbent. This process is reversible and not requires any activation energy[2]. The adsorbate molecules form as multimolecular layer on adsorbent in physical adsorption. It usually occurs at low temperature and decreases with temperature [3,5]. Chemical adsorption happens due to strong chemical bonds between adsorbate and adsorbent molecules. It is irreversible and requires activation energy. It occurs as monomolecular layer and at high temperature[9].Activated carbon is mostly used as adsorbent for adsorption technology. It also called activated characol, it is form of carbon only. Activated carbon has high porosity and large surface area to adsorb the adsorbate molecules on within limited volume of adsorbent[5]. It has around three thousand square meter surface area per gram of activated carbon. But activated carbon is expensive, so there is a need to find the effective adsorbents to treat the aqueous solutions. In the nature, so many adsorbents (wastes & bio waste materials) are available with cheap and abundantly[7]. For example coconut peel, rice husk, egg shell, banana peel, plant leaves(neem,tamarind) and cassava peel etc[6].All these type of materials are just dumping in to environment, it causes damage to the surroundings. Biomass also can be used as adsorbent to separate heavy metals from aqueous solution. In the present studies black babul wood is used to remove chromium from aqueous solutions.

II. PREPARATION OF ADSORBENT BLACK BABUL WOOD

Black babul wood is collected from nearest sawmill shops. It is cleaned thoroughly with air with compressors and rinsed with pure water to remove the dust particles.

2.1 Preparation Of Black Babul Powder

Black babul trunk contains three sections. First section is the outermost layer called as bark and it is present as top layer on wood. It is normally present in dark brown or black color. Bark is reduced to small size pieces which are then kept in hot air oven at more than 100°C for removal of moisture for 5-6 hours. Hammer mill is washed with water and cleaned properly without any dust or any foreign particles. The dried wood pieces are then sent to hammer mill separately for reduce the size.

The product is then processed to mixer for further grinding. Using Taylor sieve shaker final product is separated and product is passes through the mesh number 150 and retained on mesh no 200.

2.2 Aqueous Solution Preparation

Aqueous solution of Chromium is prepared by 11.31 g of Potassium dichromate(K2Cr2O7) in 1 liter of distilled water. This is main stock solution, different required concentrated solutions can be prepared by adding particular amount of water to main stock solution.

III. RESULTS & DISCUSSION

3.1 Effect of Process Time on Batch Adsorption:

To study the effect of batch process time adsorbent size greater than 150 mesh size is taken into aqueous solution of initial concentration 0.1 gm/l at acidic medium of pH 5.5, temperature of 25°C with rotational speed 140rpm for the time of 120 minutes. The experiment was conducted with same parameters by changing the process time like 10,20,30,40…..120 minutes.

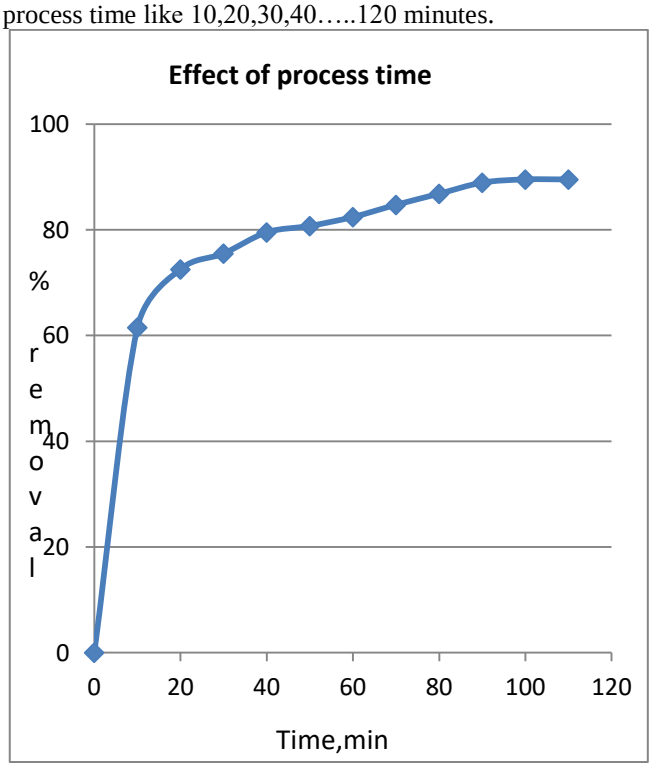

Fig.1 Effect of process time on batch adsorption process

It is shown from the graph, the percentage removal of chromium is increases with increasing the process time upto 110min.After that but percentage removal of chromium becomes constant. It means adsorption process reaches to the equilibrium condition. Adsorption rate is more at initial time and decreases with process time. This happens because of occupation of active sites on adsorbate. Active sites are vacant initial time and with respect to time occupied by the adsorbate molecules. Finally adsorption rate decreases with respect to time.

3.2 Effect of Initial Aqueous Solution Concentration

To observe the effect of initial aqueous solution concentration, solution is prepared with different initial concentrations 0.05,0.1, 0.15, 0.2, 0.25, 0.3 gm/l by adding the sufficient water. The experiment was conducted by keeping the same agitation speed (140 rpm), contact time, dosage, mesh size, pH and at 25^{0}C temperature with different initial concentration.

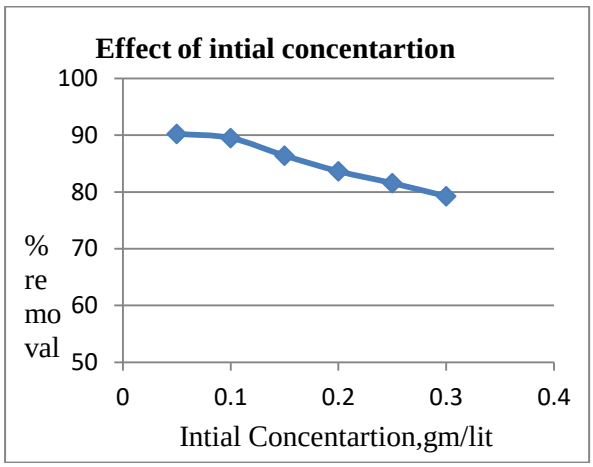

Fig.2 Effect Of Initial Concentration On Batch Adsorption Process

From the graph, it is observed that with increasing the initial stock solution concentration the percentage separation of chromium from aqueous solution is decreases. The actual amount of chromium adsorbed for unit mass of black babul increases but in terms of percentage decreases. So that batch adsorption process is more dependent on stock initial concentration.

3.3 Effect of Adsorbent Quantity:

The quantity of adsorbent is also effects on adsorption process. Experiments are conducted to study the effect of adsorbent quantity on adsorption with different amounts of adsorbent. The amount of adsorbent with 0.5, 1, 1.5, 2, 2.5 grams with the parameter conditions (temperature 25^{0}C, rotational speed 140RPM, particle size 150 mesh and P^H of 5.5).

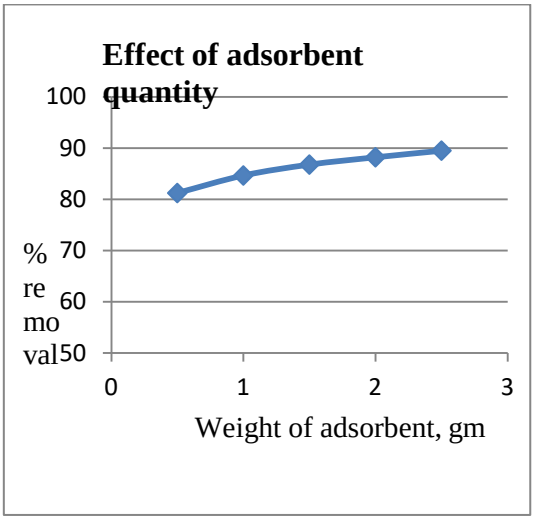

Fig.3. Effect of adsorbent quantity on batch adsorption process

From fig 3, it is observed that percent separation of chromium metal aqueous solution increases with increases in quantity of black babul wood. It occurs because of number of active sites for adsorption on the adsorbent surface is increases with increasing the quantity of adsorbent.

3.4 Effect of Adsorbent Particle Diameter

To observe the effect of adsorbent average particle diameter on adsorption process, different adsorbent feeds are prepared from size of 50mesh to 150 mesh diameter in Talyor series screen analysis. Stock solution is prepared with the standard concentration. Experiments are conducted by keeping parameters (temperature 25^0C, rotational speed 140RPM, and P^H of 5.5) as constant by varying the adsorbent particle diameter.

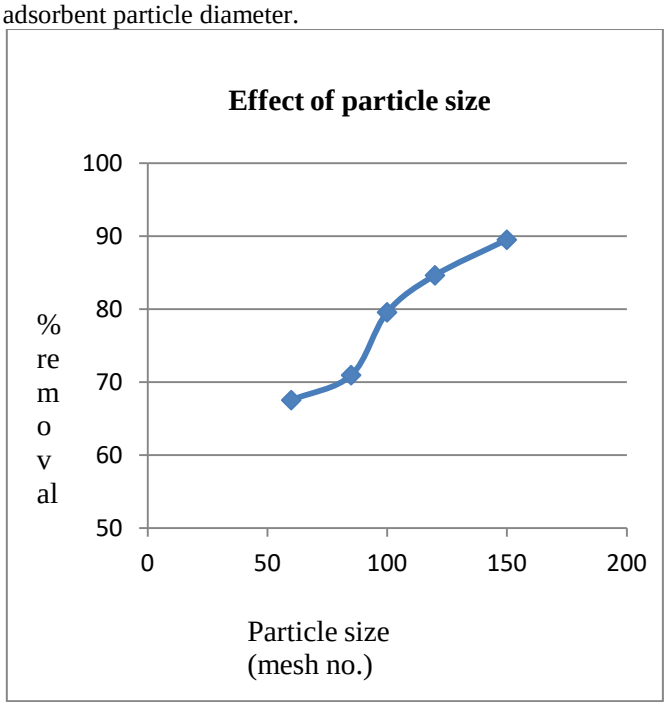

Fig .4. Effect of adsorbent particle diameter on Adsorption

The experimental results show that with decreasing the adsorbent particle diameter the separation of chromium from aqueous solution increases. It occurs due to the small particle diameter have large surface area for adsorption process. If surface area is more means more number of active sites available for process and consequently enhance the adsorption.

3.5 Effect of Temperature

Adsorption is depends on process temperature also. To observe the dependency of adsorption on temperature, stock solution was added to 150 mesh average particle size of adsorbent i.e., experiments have been done at rotational speed (140 RPM), concentration, dosage, pH and particle size with different temperatures of adsorbent from 25-50^0C.

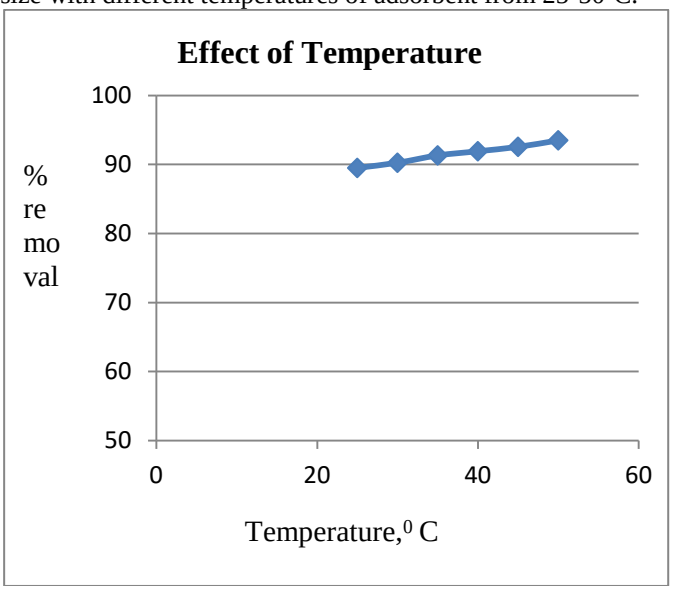

Fig.5. Effect of temperature

From fig 5,it is noted that with increasing operating temperature percentage removal chromium from aqueous solution increases. It shows that adsorption is a function of temperature and it enhances the adsorption.

IV. CONCLUSION

From present studies, it can be concluded as the separation of Chromium metal from the aqueous solution by using cheap black babul adsorbent.

1. Effect of contact time: Separation of Chromium from solution by black babul needed 110 minutes to reach equilibrium condition in adsorption process.
2. Effect of initial aqueous solution concentration: With increasing initial aqueous solution concentration the percentage separation of Chromium metal decreases. .
3. Effect of adsorbent particle diameter: Adsorption of Chromium(Cr) decreases with increasing black babul particle diameter.
4. Effect of quantity of adsorbent: With increasing amount of black babul wood the separation of heavy metal (Cr) also increases.
5. Effect of temperature: With increasing temperature the separation of Chromium metal removal increases.

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AUTHOR PROFILE

Mr.B.V.Dhananjaneyulu, is an Assistant Professor at Vignan's Foundation for Science, Technology & Research, India. He completed Master of Technology in Chemical Enginering.He has published 10 publications in reputed journals. His area of interstes are adsorbtion, water treatment and pyrolosis,