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Developing a Low Cost Activated Carbon from Agricultural Waste for the Removal of Heavy Metal from Contaminated Water

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Abstract

Rice husk ash is find out from the burning of agricultural waste material in paper industry due to it abundantly available in rice-producing countries. Activated carbon of rice husk (ACRH) was used to remove Cr(VI) from waste water. In this study we also use of the Batch process for study of the effect activated carbon of rice husk for Cr(VI) removal from aqueous solutions. In this paper we also studies of pH effect, contact time, adsorbent dose were examined. The removal decreased from 86.2 to 44.2% by increasing the Cr(VI) concentration from 1.5 to 5.0 mg/l. Removal, however, decreased from 80.0 to 42.2% by increasing the adsorbent particle size from 50 µm to 150 µm. The adsorbed dose of Cr(VI) tend to increase with the increase of pH. It has been found that low cost and high capabilities of the ACRH make it potentially attractive adsorbent for the removal of Cr (VI) from wastewater.

Keywords: Removal; Rice Husk ; Adsorption ; pH; water; Activated Carbon of rice husk etc.

INTRODUCTION

Chromium is an important heavy metal, and it is generally used in leather industry, electroplating, metal processing and paint and pigment. Removal of heavy metals by adsorption is an turn up field of research [5], Activated carbon is an effective adsorbent

for the treatment of wastewater rich in metals like Cr, Ni, Cu[9]. Chromium can be used for completely removal of heavy metal from the dilute solutions. Basically commercial activated carbons are very expensive. Recently our researchers are working on developing of a low cost new adsorbents, which are suitable for water pollution control[2,3]. Agricultural waste is quickly available and low in cost also. It has been found in previous study that an agricultural waste was used for removal of heavy metal with the help of adsorbent like sugarcane bagasse. [6], plant waste leaves[7], pomegranate peel[4], rice hull [10], saw dust,[1] cotton seed and tea leaves [9] etc. Coconut shell, rice husk ash and biomass also gave good results. In this work we reveals here with the adsorption studies on the activated carbon prepared from rice straw for the removal of chromium (VI) from aqueous solutions. In this study we have been taking of various parameters for the study the effect on adsorbent such as adsorbent dosage, initial metal concentration and pH.

MATERIAL AND METHOD

The rice husk is a plentiful agricultural waste in india. Rice husk was washed with water and subsequently dried at 105ºC for 24 h to remove moisture content. The dried Rice husk was ground and sieved to a particle size of 1-2 mm before loading it in a muffle furnance. The temperature and time was raise by observing the surface properties of the activated products obtained. After all take a 100g of dried samples were carbonized at 440 and 700 °C for 2 hr in a muffle furnace. After that charcoal was crushed and sieved to a size smaller than 250 µm to obtain the activated carbon of Rice husk. the sample was washed with hot deionized water and hydrochloric acid (0.1M) until the pH reached 6.5-7. After this process final products of carbon were sieved to the desired particle sizes such as 30 - 150, 150 - 200, and 200 - 250 mesh. The activated carbon of rice husk (ACRH) having the 30 - 150 mesh size was used in adsorption study. Lastly the product was stored in vacuum desiccators until required. The developed carbons are designated as ACRH (activated carbon of rice husk).

Batch Adsorption Experiments

In this work we take a Batch process experiments were carried out by agitating 2.0 g activated carbon of rice husk sample with 50 ml aqueous solution of Cr (VI) of desired concentration, temperature and pH. It has been take in separately cleaned polythene bottles on a shaking thermostat with a constant speed of 1000 rpm. At the end of predetermined time intervals, rice husk ash was removed from the aqueous solutions by centrifugation at 10,000 rpm for 20 min. The progress of adsorption was assessed by evaluating by the residual concentration of Cr(VI) by an atomic adsorption spectrophotometer [15].

Preparation of Synthetic Chromium Cr(VI) Waste Water

Aqueous solution 1000mg/l of chromium Cr(VI) was prepared by dissolving in K_2Cr_2O7 (s) in distilled water and diluted to get desired concentration 1.5 to 5 mg/l. the concentration of heavy metal was measured by (AAS) atomic adsorption spectrophotometer.

Effect of pH

Experiments were carried out at different pH (2, 3, 4, 5, 6, 7 8) and the initial Cr(VI) concentration of 1.5 mg/L at 30 ℃. The results of the effect of pH on adsorption of Cr(VI) are presented in Fig. 2 reveals the adsorption capacity of metal ions. At pH 8, and 1.5 g of ACRH was able to give chromium removal efficiency of 96.72%. It was studied that the total amount of adsorption of Cr(VI) onto ACRH 42% to 90 % with an increase of pH from 3.5 to 8.0.

it has been observed that pH value of the aqueous solution influences on the adsorption of Cr(VI) at the solid-liquid interfaces. The activated carbon has a negative surface charge in solution. Due to change of PH of solution charge changes, and the sorption of charged species is affected (attract ion between the positively charged metal ion and the negatively charged ACRH surface. it is expected that ACRH surface became more negatively charged. As well as pH value increase the electrostatic attraction forces enhanced cationic metal ions adsorption .it has been reported for Ni(II) and Cd(II) adsorption onto bagasse fly ash[14].

It is clear By experiment that Maximum 92 percent removal of Cr(VI) by the adsorption at pH 8.0.

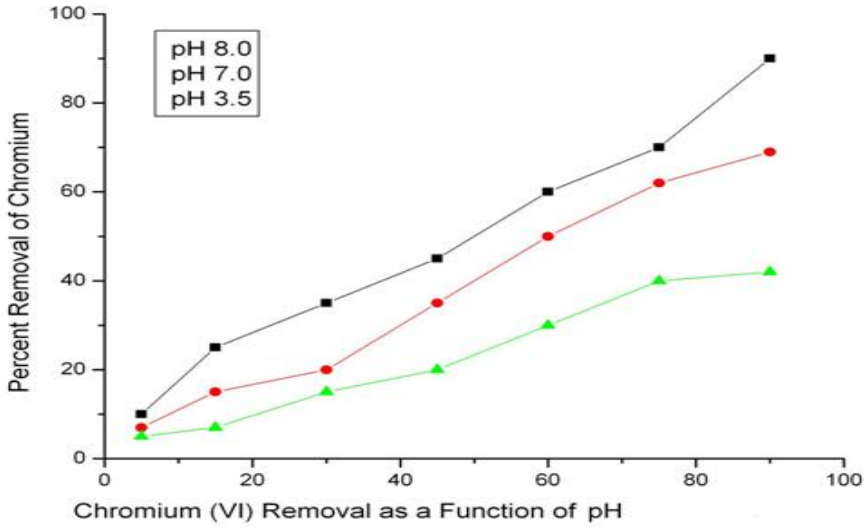

Fig 1.0 The Effect of Contact Time and pH value for the Removal of Cr (VI)

Effect of Contact Time and initial Concentration

In this research reveal that how affect contact time and concentration on removal of heavy metal. The Effect of contact time and concentration on the removal of Cr(VI) has been verified in Fig.1.It is reveal from this figure that by varying concentration of Cr(VI) in solution from 1.5 to 5.0 mg l^{-1}, the adsorption efficiency decreased from 86 to 44.2 % .. This figure reveals sharp rise in removal of Cr(VI) in initial stages. Then gradually it attains equilibrium in 100 min and becomes constant. It shows that the process of Cr(VI) removal on ACRH is highly concentration dependent. Higher percentage removal in lower concentration ranges has lot of industrial significance as in most cases the waste waters and industrial effluents have been recited to have lower concentrations of metallic species including that of Cr(VI [12]

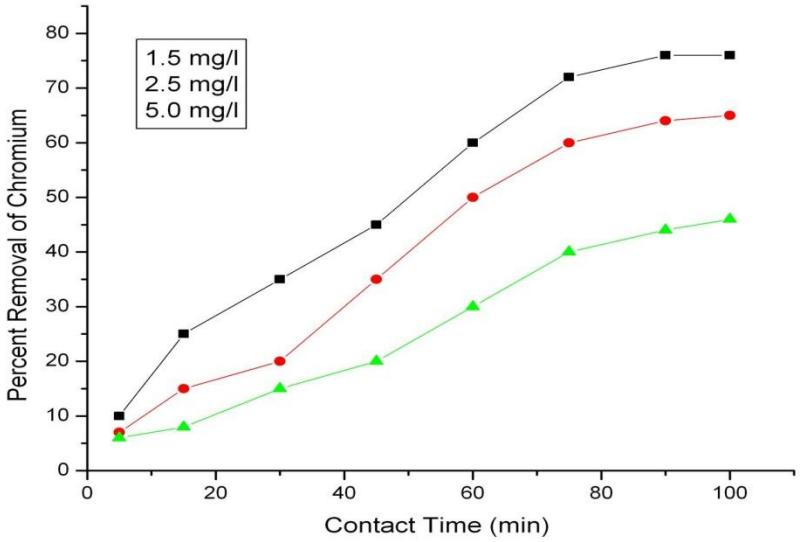

Fig 2.0 The Effect of contact time and concentration on the removal of Cr(VI)

Effect of Particle Size

In this research we take variation in particle size and study the effect of adsorbent particle size on removal of Cr(VI), experiments were conducted at 50,100 and 150 µm diameter of Activated carbon of rice husk (ACRH) particles. It has been found that the removal of heavy metal decrease from 80.2 to 42.3% by increasing the diameter of the adsorbent particles from 50µm to 150 µm at 1.5 mg l^{-1} Cr(VI) concentration, pH **8**.0 and 298 K in (Fig.3). It is revealed that at Higher external surface area in smaller particle sizes at a constant amount of the adsorbent is the reason for higher removal of chromium at low particle sizes [12,13]. Result shows that the lower concentration of

Cr(VI) for smaller Activated carbon of rice husk (ACRH) particles is significantly less than that for the larger adsorbent particles.

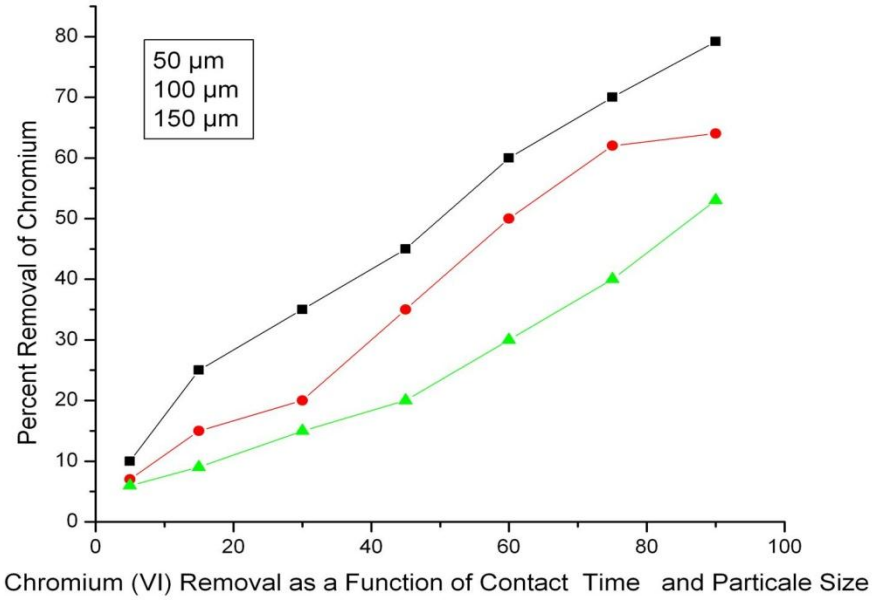

Fig 3.0 The Effect of contact time and particle size on the removal of Cr(VI)

Effect of Adsorbent Dose

The effect of adsorbent doses of ACRH Rice husk activated carbon 2-9 g/L and chromium removal are shown in Fig.4. The results indicate that the percentage removal of chromium metal ions increases as the adsorbent dose increases by giving removal efficiency from 40.0 % to 96.12% for rice husk activated carbon. The removal efficiency and specific uptake of heavy metals depend on type and quantity of the biosorbent. It has been studied that percentage removal of chromium increasing with increase in adsorbent dose due to the availability of more and more adsorbent surfaces for the solutes to adsorb.

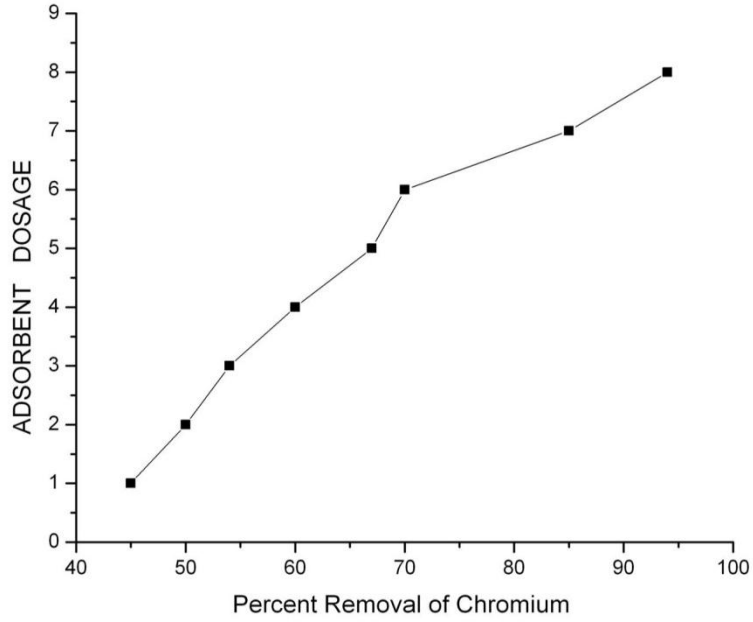

Fig 4.0 The Effect of adsorbent dose on the removal of Cr(VI)

CONCLUSIONS

It has been found that the Activated carbon of rice husk (ACRH) to be a very effective adsorbent for the efficient removal of Cr(VI) from water. The adsorption capacity of the Activated carbon of rice husk(ACRH) was maximum 70.5 mg Cr(VI) absorb at temperature of 30 ℃ and at the initial Cr(VI) concentration of 400 mg/L and pH 8.0. The adsorbed amounts of Cr(VI) tend to increase with the increase of pH value . The relatively low cost and high capabilities of the Activated carbon of rice husk make it potentially attractive adsorbent for the removal of Cr(VI) from waste water. it has been studied that Activated carbon of rice husk used as a good adsorbent for Cr(VI) removal. It examine that removal of metal is highly dependent on initial concentration of Cr(VI) in solution and higher removal 96(%) has been observed in lower concentration ranges. This study reveals that rice husk activated carbon can be used as a low cost adsorbent for removal of heavy metal from waste waters. In this study a Researcher conclude that rice husk activated carbon (ACRH) has great capacity for adsorption and is highly efficient. it has been studied that percentage removal of chromium was high with increasing of contact time and the equilibrium time is nearly 3 hours. It has been found that the removal of heavy metal decrease from 80.0 to 42.2% by increasing the diameter of the adsorbent particles from 50µm to 150 µm at 1.5 mg l^{-1} Cr(VI)concentration. The percent removal

of heavy metal increases with increased adsorbent dose as reveal from the experiments that an adsorbent dose of 9g/L completely 96.12% removes the chromium. As the rice husk is easily available and is also cost effective so it can be used in little greater amounts to obtain complete removal of Cr(VI)

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