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Removal of Cr (VI) Using Low Cost Activated Carbon Developed By Agricultural Waste

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Abstract: *Rice straw is find out as agricultural waste material labundantly in india. It is also used in paper industry due to it abundantly available in rice-producing countries. Activated carbon of rice straw (ACRS) was used to remove Cr(VI) from waste water. The Batch process were used to evaluate the effect activated carbon of rice straw for Cr(VI) removal from aqueous solutions. The adsorption studies on pH effect, contact time, adsorbent dose were examined. The removal decreased from 74.2 to 47.2% by increasing the Cr(VI) concentration from 1.5 to 5.0 mg/l. Removal, however, decreased from 80.3 to 7.2% by increasing the adsorbent particle size from 100 µm to 200 µm. The adsorbed dose of Cr (VI) tend to increase with the increase of pH. It has been found that a low cost and high capabilities of the ACRS make it potentially attractive adsorbent for the removal of Cr (VI) from wastewater.*

Keywords*: Removal; rice straw ; adsorption ; pH; water; Activated carbon etc.*

I. Introduction

Chromium is an significant heavy metal widely used in leather industry, electroplating, metal processing and paint and pigment. Removal of heavy metals by adsorption is an crop up field of research [5], Activated carbon is an effective adsorbent for the treatment of wastewater rich in metals like Cr, Ni, Cu[9]. It can completely removes the heavy metal from the dilute solutions. It has been found that Commercial activated carbons are very expensive. So our researchers are working on low cost new adsorbents, and studied by researchers which are suitable for water pollution control[2,3]. Agricultural waste are readily available and low in cost also. It has been studied by previous research on removal of heavy metal with the help of agricultural waste 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. it has been studied that Peat moss effective in adsorbing heavy metals. Coconut shell, husk ash and biomass also gave good results. This work reported here deals with the adsorption studies on the activated carbon prepared from rice straw for the removal of chromium (VI) from aqueous solutions. The effect of various parameters such as adsorbent dosage, initial metal concentration and pH has been studied.

II. Material And Method

The rice straw is an agricultural waste in india. Rice straw was washed with water and subsequently dried at 105^{o}C for 24 h to remove moisture content. The dried RS was ground and sieved to a particle size of 1-2 mm before loading it in a muffle furnance. The temperature and time were optimized by observing the surface properties of the activated products obtained. The 100g of dried samples were carbonized at 450 and 700 °C for 2 hr in a muffle furnace. After that charcoal was crushed and sieved to a size smaller than 850 µm to obtain the activated carbon of rice straw (ACRS) The sample was washed with hot deionized water and hydrochloric acid (0.1M) until the pH reached 6.5-7. After this products were sieved to the desired particle sizes such as 30 - 200, 200 - 250, and 250 - 300 mesh. The activated carbon of rice straw (ACRS) having the 30 - 200 mesh size was used in adsorption study. Lastly the product was stored in a vacuum desiccators until required. The developed carbons are designated as ACRS (activated carbon of rice straw).

Batch Adsorption Experiments

Batch adsorption experiments were carried out by agitating 1.0 g of rice straw activated carbon 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, activated carbon of rice straw (ACRS) 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 chromium concentration 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 25 ℃. 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 1g of ACRS was able to give chromium removal efficiency of 96.72%. It was studied that the total amount of adsorption of Cr (VI) onto ACRS 42% to 90 % with an increase of pH from 3.1 to 8.0. it has been found 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 ACRS surface. it is expected that ACRS 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 that Maximum 90 percent removal of Cr(VI) by the adsorption at pH 8.0.

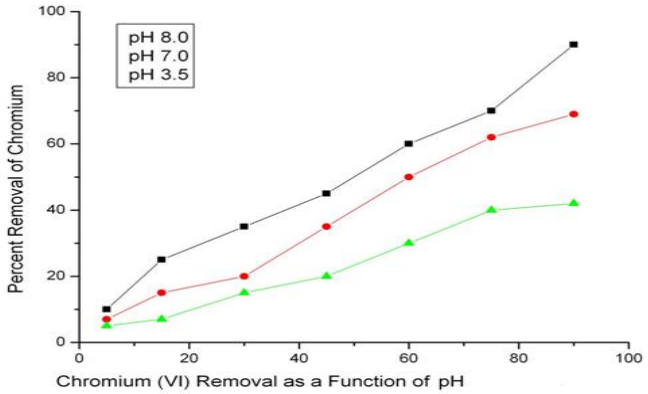

FIG 1.0 The Effect of Contact Time and pH value for the Removal of Cr (VI)

Effect of Contact Time and initial Concentration

Researcher has been studied 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 76 to 46 % .. 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 ACRS 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]

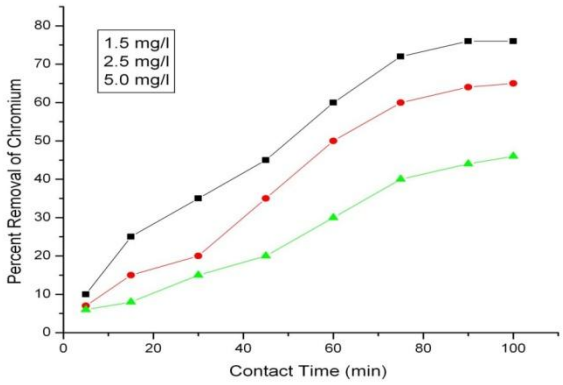

FIG 2.0 The Effect of contact time and concentration on the removal of Cr(VI)

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 100,150 and 200 µm diameter of Activated carbon of rice straw(ACRS) particles. It has been found that the removal of heavy metal decrease from 79.2 to 53.3% by increasing the diameter of the adsorbent particles from 100µm to 200 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]. It is clear that the increase in metal removal with particle size does not have a 'directly proportional' relationship. It has been found that the lower free concentration of Cr(VI) for smaller Activated carbon of rice straw (ACRS) particles is significantly less than that for the larger adsorbent particles. This leads to comparatively lower value of adsorbed species.

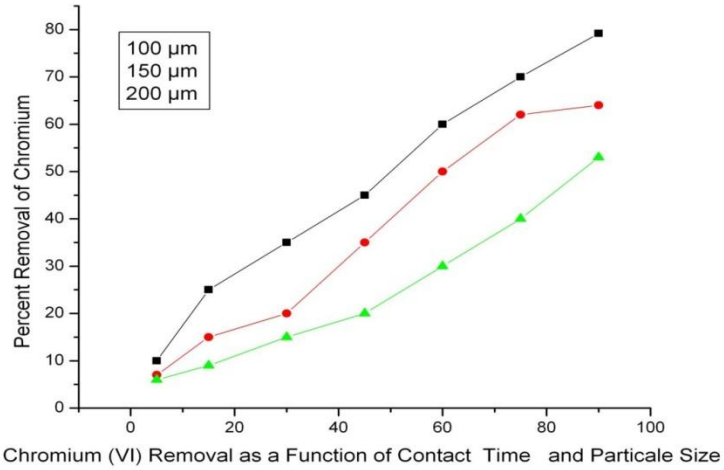

FIG 3.0 The Effect of contact time and particle size on the removal of Cr(VI)

Effect of Adsorbent Dose

The effect of adsorbent doses of Rice straw activated carbon ranging 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 45.0 % to 97.12% for rice straw activated carbon. The removal efficiency and specific uptake of metals depend on type and quantity of the biosorbent. The increase in percentage removal of chromium with increase in adsorbent dose was due to the availability of more and more adsorbent surfaces for the solutes to adsorb.

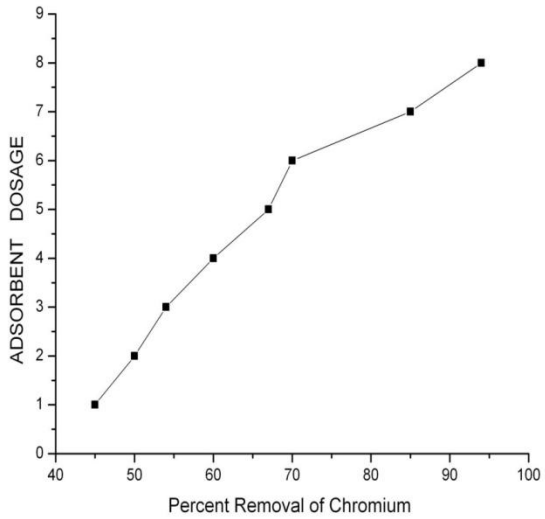

FIG 4.0 The Effect of adsorbent dose on the removal of Cr(VI)

III. Conclusions

It has been found that the Activated carbon of rice straw(ACRS) to be a very effective adsorbent for the efficient removal of Cr(VI) from water. The adsorption capacity of the Activated carbon of rice straw(ACRS) was maximum 63.5 mg Cr(VI) absorb at temperature of 30 ^{0}C and at the initial Cr(VI) concentration of 400 mg/L and pH 7.0. 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 straw (ACRS) make it potentially attractive adsorbent for the removal of Cr (VI) from waste water. it has been studied that Activated carbon of rice Straw(ACRS) used as a good adsorbent for Cr(VI) removal. The removal is highly dependent on initial concentration of Cr (VI) in solution and higher removal 76(%) has been observed in lower concentration ranges. This study highlights that the rice straw carbon can be used as a low cost adsorbent for removal of heavy metal from waste waters. Researcher found that rice straw activated carbon has great capacity for adsorption and is highly efficient. The 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 79.2 to 53.3% by increasing the diameter of the adsorbent particles from 100µm to 200 µm at 1.5 mg l^{-1} Cr(VI)concentration. The percent removal of heavy metal also increases with increased adsorbent dose as evident from the experiments that an adsorbent dose of 9g/L completely 97.12% removes the chromium. As the rice straw is easily available and is also cost effective so it can be used as an good adsorbent for complete removal of Cr (VI)

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