Removal of Hexavalent Chromium from Aqueous Solution by Rice Husk ash as Adsorbent

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Abstract: Chromium, essentially exists in two oxidation forms namely Cr(III) and Cr(VI). With comparison trivalent Cromium, Cr(VI) is reported to have toxic effect on humans and it is considered to be genotoxic and carcinogenic in nature. Present study deals with preparation of Rick husk ash, preparation of synthetic Cr(VI) Solutions like 10 mg/L, 20 mg/L,30 mg/L, 40mg/L and 50 mg/L and its adsorption. Different dosages of rice husk ash from 1 mg/L to 10 mg/L were used by varying the pH 2, pH4, pH6, pH8, pH10 for all concentrations of Chromium solutions. Finally dosage of Rice husk ash, pH, and Reaction time were optimized to get the maximum removal of Cr(VI) from aqueous solutions. Adsorption isotherms were analyzed to know the better performance of the Rice husk ash.

Keywords: Hexavalent chromium; Adsorption; Rice husk ash, Kinetic Studies

1. INTRODUCTION

The man made sources of the chromium are of many industries, like metallurgical, electroplating, production of paints and pigments, tanning, wood preservation, chromium chemicals production, pulp and paper production. Comparing all the industries the tanning is the main source of chromium pollution which is about 1000 times more present in our country. The hexavalent chromium is more toxic than Cr^{3+}[1,2]. It easily penetrates into biological membranes, food chain and it causes cancer to human beings, it is also known inhalation irritant.

Hence, Cr(VI) contamination of natural water is considered a important heavy metal for environmental concern. Several methods are adopted for the decontamination of waters polluted with Cr(VI); which includes: reduction followed by chemical precipitation, ion exchange, membrane separation,reverse osmosis, bioremediation[3]. Activated carbon (AC), is the oldest adsorbent which is having large porous surface area, controllable pore structure, thermo-stability and low acid/base reactivity proved to be effective for removal of inorganic and organic pollutants in the environment [4]. Among that rice husk ash is locally available and cheaper compared to the activated carbon. Therefore, the aim of this study was to explore the efficiency of reducing Cr(VI)

by use of rice husk ash and to investigate the effect of pH on rice husk ash capacity to reduce Cr(VI) in batch system.

2. MATERIALS AND METHODOLOGY

2.1 Preparation of activated rice husk carbon

The rice husk composite adsorbent was prepared using the washed, dried rice husk carbonized at 700 ^{0}C in the muffle furnace for about one hour[5]. Then it is sieved using 150 micron sieve and the used for the batch studies.

2.2 Preparation of Adsorbate Solution

The stock solution of Hexavalent chromium of 1000 ppm was prepared using the analytical grade of $K_2Cr_2O_7$ (2.828 grams in 1000ml) and it is diluted for different concentrations like 10, 20, 30, 40, 50 mg/L respectively by varying the different dosages of rice husk ash as adsorbent.

2.3 Experimental Procedure

Initially experiments were conducted to determine the exact of haxavalent Cromium concentrations using Vis spectrophotometer (ELICO Make) by drawing the calibration curve[6]. Then chromium concentrations were varied from 10- 50 mg/L by varing PH from 2-10. Then adsorbent dosage is varied from 1.0-30 mg/L with reaction time of 120 min in magnetic stirrer . Then the P^H, adsorbent dosage is optimized, finally reaction kinetics were studied to optimize the time .

3. RESULTS AND DISCUSSION

3.1 Effects of adsorbent dose and pH

Several experiment were carried out by varying the adsorbent dose and pH to find out the effect on the % removal of Cr(VI) as shown in following figures. During the experiments, Chromium concentration of 10 mg /L was kept constant and the rice husk carbon ash and pH were varied which is shown in the figure 1.

The dosage is varied from 2.0-10 mg/L with varying $_P$H from 2 to 10, % optimum adsorption with dosage of 6 mg/L and pH 4 was observed.The adsorption studies were carried out by varying the P^H from 2 to 10 and optimized the P^H for all concentrations.Similarly in the figure 2,3,4,5 the chromium concentration is varied as 20,30,40,50 mg/L respectively. In case of 20-50 mg/L chromium concentrations the optimum dosage was observed to be less than 6 mg/L from that we conclude that for higher concentrations lower the dosage and no change in the optimum P^H was observed for 20, 30, 40 50 mg/L respectively.

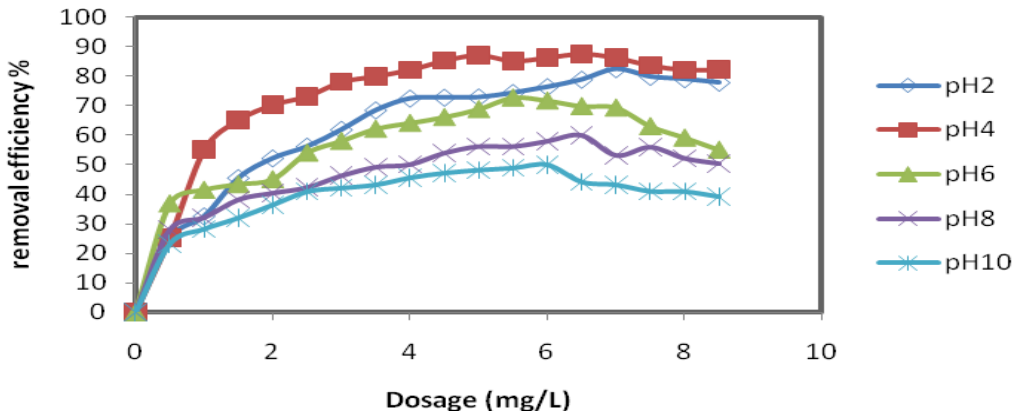

Figure 1 Cromium removal Effieciency Vs Dosage (mg/L) with 10 mg/L of Cr(VI)

3.2 Reaction kinetics

Kinetic study was conducted to optimize the reaction time of the experiments. The study was conducted at optimum dosage 6 mg/L with varying concentrations 10-50mg/L initial chromium concentration. The time is varied from 0-120 min and at every 10 minutes the sample is analyzed for final concentrations. The 80% of the removal was observed to be within 70 minutes, for 90% removal 100 min so the optimum reaction time was observed to be 80 minutes.

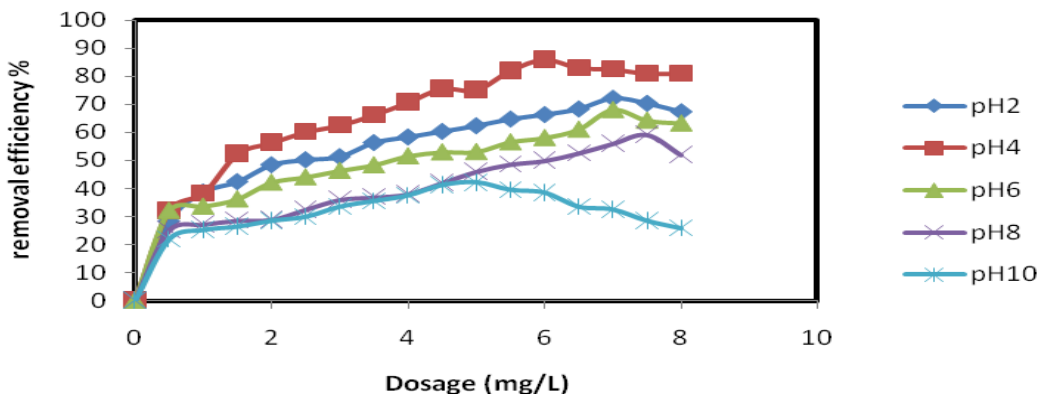

Figure 2 Cromium removal Effieciency Vs Dosage (mg/L) with 20 mg/L of Cr(VI)

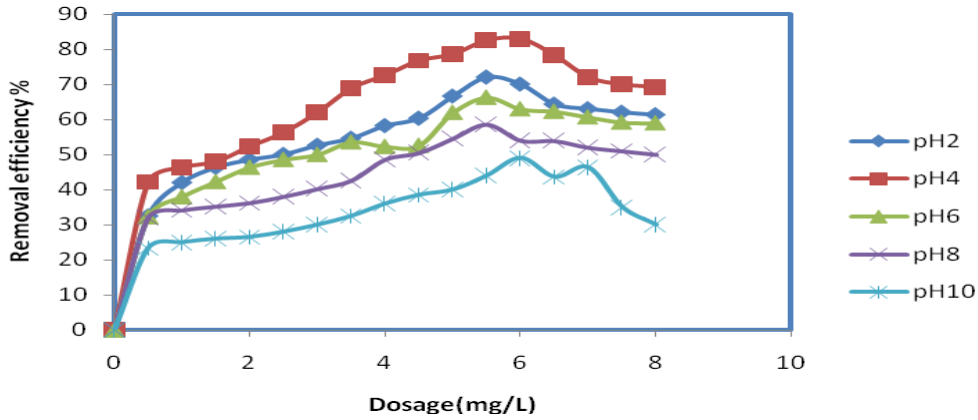

Figure 3 Cromium removal Effieciency Vs Dosage (mg/L) with 30 mg/L Cr(VI)

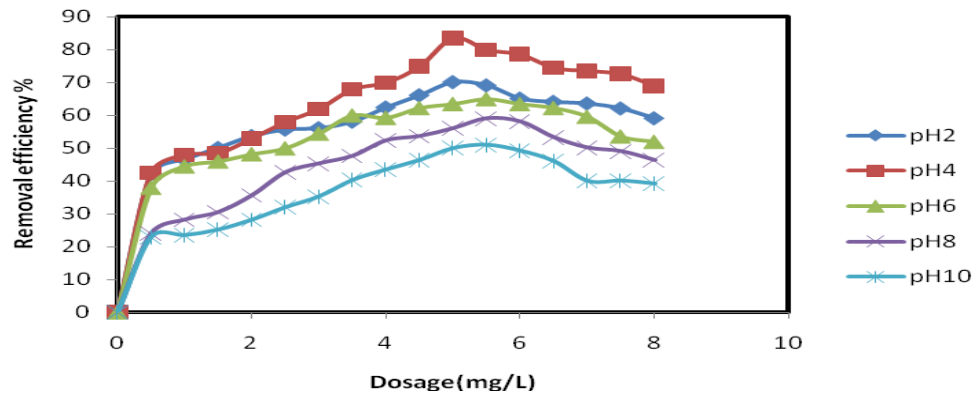

Figure 4 Cromium removal Effieciency Vs Dosage (mg/L) with 40 mg/L Cr(VI)

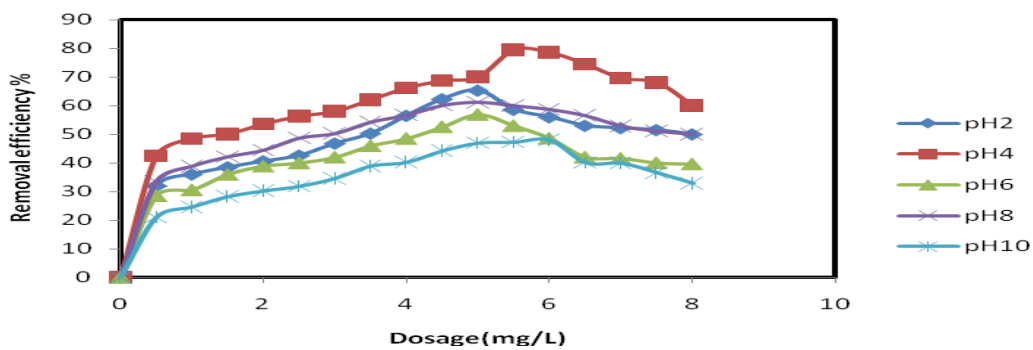

Figure 5 Cromium removal Effieciency Vs Dosage (mg/L) with 50 mg/L Cr(VI)

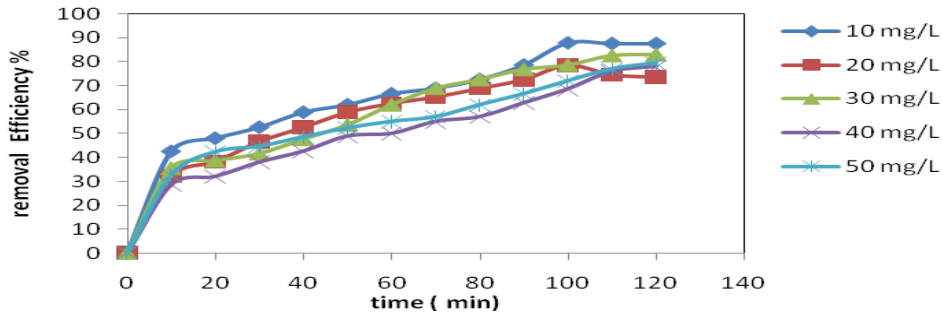

Figure 6 Reaction kinetics

4. CONCLUSIONS

Based on the above discussion it can be concluded that optimum dosage was observed to be 6 mg/L for 10 mg/L of chromium concentrations and 4 mg/L for 20, 30, 40,50 mg/L of chromium concentrations. The optimum P^H was observed to be 4 for all the chromium concentrations with optimum reaction time of 80 minutes.

REFERENCES

[1] Lay, P.A.; Levina, A. Activation of Molecular Oxygen during the Reactions of Chromium with Biological Reductants: Implications for Chromium-Induced Genotoxities. *J. Am. Chem. Soc*., 1998. 120: 6704.

[14] Levina, A.; Codd, R.; Dillon, C.T.; Lay, P.A .Chromium in Biology: Toxicology and Nutritional Aspects. *Prog. Inorg. Chem*., . 2003, 51: 145.

[15] Gheju .M., *Chromium and the environment*. Politehnica Publishing House, 2005, 99-234.

[16] U.S. Environmental protection agency Washington, dc "Toxicological review of hexavalent chromium" (CAS no. 18540-29-9) August 1998.

[17] Ismaeel. A,.Attar S.J .Parande M.G.Removal of hexavalent chromium from industrial wastewater by using biomass adsorbent (rice husk carbon) *IJAERS.* 2012 1(2), 92-94 E-ISSN 2249–8974.

[18] APHA,2005. Standard methods for examination of water and waste water.

[19]