

A Survey on Removal of Chromium from Aqueous Solutions using Activated Carbon of Almond-Shell

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Abstract. Chromium VI is one of the heavy metals and polluting water resources that are making in many industries wastewater such as electroplating, the tanning, dyeing and textile manufacturing, mining and fertilizer industries. Observing the toxic and hazardous properties of the metal, its removal by an effective and environmentally friendly method, is essential [1]. Activated carbon with nano pores is a green technology for separation of poisonous material in environment [2]. The aim of this research is to determine the level of cadmium absorption by activated carbon of almond-shell in concentration of “20”, “50” and “100” per part million (ppm) and different insolubility times from “15 to 120” min. Experiments for determining isotherms were assigned discontinuous in different concentrations and different amounts of biological activated carbon (from “0.1 gr to 0.3” gr) and the Chromium with desired PH. Measurement of cadmium performed by atomic absorption device and based on the standards. Observing the research results and the PH regulated on “6”, increase in primary concentration of Chromium resulted in increasing of absorption level and also by elapsing the time, absorption level was raised and the maximum absorption on “69/7 %” was happened in time range of “120” min. The results indicate that bio adsorbent containing sodium alginate containing activated carbon prepared from almond shell is new adsorbent for the removal of cadmium ions from aqueous environments.

Keywords: Almond shell, Activated carbon, Biological, Chromium

1. INTRODUCTION

Discharge of heavy metals into the environment is one of the threats and concerns of communities has been important in recent decades [3]. Toxic heavy metals in surface and ground waters is a risk to the health of living organisms [2]. of various heavy metals, Chromium VI is a very common and toxic pollutant [4] that into sources of water by various industries wastewater, such as electroplating, tanning, dyeing, textile manufacturing, mining and fertilizer industries [5,6]. The US Environmental Protection Agency has been determined limit for chromium VI (in standard) discharge capacity to the surface water 0/1 mg / l and for drinking water / 05 mg / l [5,6,7].

Chromium compounds usually are at capacity Chromium III and chromium VI. Chrome III capacity as a necessary element for the human body, especially for glucose metabolism and has much lower toxicity of Chrome (VI). Also its essential element for plants and animals [5,8]. Chromium VI compounds are toxic to humans and if inhaled, it can cause a hole in the lining of the nose, and respiratory tract inflammation of the liver, asthma, bronchitis, lung inflammation and increased risk of cancer. The skin contact with chromium cause allergies, dermatitis, skin necrosis and removal of the skin [9].

Because the valence of Chromium VI by the International Agency for Research on Cancer classified as carcinogens group by the EPA, the researchers took special attention [10]. If chromium is absorbed by the human body, have a cumulative effect and can serious damage in

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the human body in certain concentrations, so that if the concentration in the body 0/1 mg / g the weight of the human body can be fatal [11].

There are several ways to remove heavy metal ions from aqueous solutions that can be point to the chemical separation, membrane separation, electrochemical treatment, filtration, ion exchange, chemical precipitation, ion exchange, adsorption and reverse osmosis pointed. Adsorption by activated carbon with respect to efficiency and easy application of the most useful methods have been introduced [12,13,14].

Observing the increasing importance of water resources pollution to heavy metals and the necessity of removal of these materials from water resources and as a result of high performance of biological activated carbon system in eliminating heavy metals, this research was done. The aim of the research is to determine the efficiency of activated carbon produced by almond-shell in eliminating the cadmium in insolubility times of “15,” “30,” “45,” “60,” “90” and “120” min and concentration of “20,” “50” and “100” ppm.

2. MATERIALS AND METHODS

1- Materials

Potassium chromate ($K_2Cr_2O_7$) made by Merk Company and calcium compound used was calcium chloride ($CaCl_2$). Activated carbon with nano-pores in distribution of micro, meso, macro from “1 to 50” nanometer and sodium alginate was produced in the laboratory.

2- Activated carbon

In recent years using low-cost and varied absorbents instead of commercial activated carbon has been favored by researchers. As a result of flourishing the agriculture in several regions of the country and varieties of agricultural and garden products, removal of productive wastes from polluted waters was observed in this research. Hence the carbon produced from the shell is used to eliminating cadmium from water and also absorption level and removal level of cadmium was investigated.

To produce active carbon from almond-shell, first, almond-shell was chopped in size of “1 to 1.5” cm and kept for “24” hours in activator element - edible phosphoric acid made by Union Co. with purity of “85%”. After “24” hours it was emitted from the activator and after entering it for one hour into an oven with temperature of “800” centigrade degree it was changed to carbon. After oven operation, active carbon was rinsed by deionized water to reach to PH “6”. This method is used in other researches nearly similar for making activated carbon from materials [2,15]. Produced active carbon was chopped and then milled and afterward it was passed through an 80-mesh riddle and finally the activated carbon with nano-pores was made.

Properties of activated carbon of almond shell are as Table 1.

Table 1. Properties of activated carbon of almond shell.

Parameter	Special surface (m ² /g)	Single point special surface (m ² /g)	Density (cm ³ /g)	Moisture (%)	Particles size (mm)	Volume of closed porosities (cm ³ /g)
activated carbon	13.5807	15.8605	1.8065	negligible	0.5-0.65	0.1751

3- Preparing sodium alginate spherical

“1%” solution (W/V) of alginate sodium was prepared by solving “1 gram of it into “100” ml of deionized water. Alginate sodium dissolves slowly in water by use of a mixer for “20” minutes

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and a jelly like solution will be made. Similarly we can dissolve alginate sodium in water through putting the solution on a heater with a moderate temperature nearly "50" centigrade degree. A "0.5" molar solution of calcium chloride was made with dissolving "13.873" g of calcium chloride in "250" cc of water [2].

The solution of calcium chloride was made by use of homogeny method in Joje balloon and then the jelly containing sodium alginate was inserted drop by drop using an insulin syringe.

In this manner, diameter of the resulted sphericals is about "2 to 3" mm. Because absorption level will be increased by reducing the bullets' diameter, syringe was used in this research that its needle was replaced by plastic sampler. After sieving the said spherical repeatedly, they were rinsed with calcium chloride "0.5 molar solution and deionized water and were kept and dried in room temperature. Then it was again dried by oven in order to fixing the weight. After drying, diameter of bullets was measured about "0.7" mm. This kind of absorbent bullet was named GM-92.

4- Stabilizing activated carbon in alginate sphericals

First, 0.1 g of nano carbon powder was mixed in 1" g of alginate sodium powder in aridly. Then "100" ml of deionized water was added to it and by use of a handy mixer for "20" min in a room temperature of "25" centigrade degree, the alginate sodium jell was produced in which activated carbon was stabilized. The sodium alginate with nano carbon powder were dissolved slowly in water for "20"min by use of handy mixer and in this operation, a black jelly solution was resulted. Also stabilization of activated carbon with "0.2" and "0.3" g of nano carbon powder was performed and absorbent bullet made by "0.1" g of carbon nano powder was named as GM-VK-92. Absorbent spherical produced by "0.2" g of carbon nano powder was named as GM-HR-92 and the one which was made with "0.3 " g nano carbon powder was named as GM-MN-92.

5- Preparing the water polluted to Chromium

The solution of "1000" ppm Chromium was prepared using Potassium chromate ($K_2Cr_2O_7$) made by Merk company of Germany. Concentrations of "20", " 50" and "100" ppm of Chromium solution were produced in "100" cc Erlenmeyer flask.

In order to investigating the effect of pollutants or metals, the Chromium's absorption level was surveyed by use of four types of absorption sphericals named "GM-92", "GM-VK-92", " GM-HR-92" and "GM-MN-92" of "20", "50" and "100" ppm.

6- Preparing samples and measurement

Kinetic response was surveyed on "15", "30", "45", "60", "90" min and "120" min. In such way that in the experiments for determining the isotherms, a specified weight of activated carbon (100 ml) in the produced solution containing Chromium was added to Erlenmeyer flasks in specific volume. For each specified concentration of Chromium ("20," "50" and "100" ppm), different concentrations of activated carbon ("0.1, " "0.2" and 0.3" gr) were added separately. Then the Erlenmeyer flasks were shaken on the shaker in "25" centigrade degree and "30" rpm speed. Erlenmeyer flasks were shaken for different times from "15" min to "2" hours with speed of "30" rpm and amount of the remaining Chromium was measured each time.

Absorption method used in these experiments was discontinuous system. Concentration of Chromium in the all solutions was measured by use of an atomic absorption spectrometer device – AA "240" model VARIAN.

Studying several resources about PH and because the most absorption was gained in range of PH “6”, optimal PH was determined as PH=6 for this research.

To calculate the absorption percentage, formula no.1 was used.

Formula no.(1): $Y = (C_i - C_e) / C_i * 100$

In which, Y, absorption percentage, C_i is the primary concentration of the solution and C_e is the final concentration of the solution.

To calculate the absorptive capacity, formula no. 2 was used.

Formula no. 2: $Y = (C_i - C_e) * V / M$

In which C_i is the primary concentration of the solution and C_e is the final concentration of the solution, M, dry absorbent mass and V, mass of the solution.

3. DISCUSSION

1- Results of surveying the relation between Chromium's absorption level and increase of activated carbon

Results of absorptive capacity (Q) of simple alginate sphericals and sphericals prepared by activated carbon were showed in Figur “2” in which by increase of activated carbon, absorptive capacity of Chromium has increased to “6.1” mg/gr and the most absorption was occurred by “GM-MN-92” (absorbent contains “0.3” gr of activated carbon) which its picture captured by SEM device (electronic microscope) and has been showed in Figur 1.

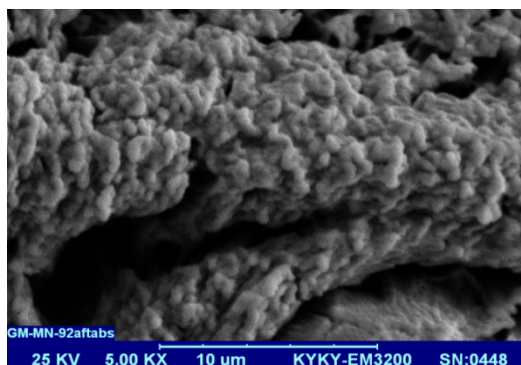


Figure 1. Absorbent sphericals GM-MN-92 after absorption magnified by 5000 times by SEM after drying the samples.

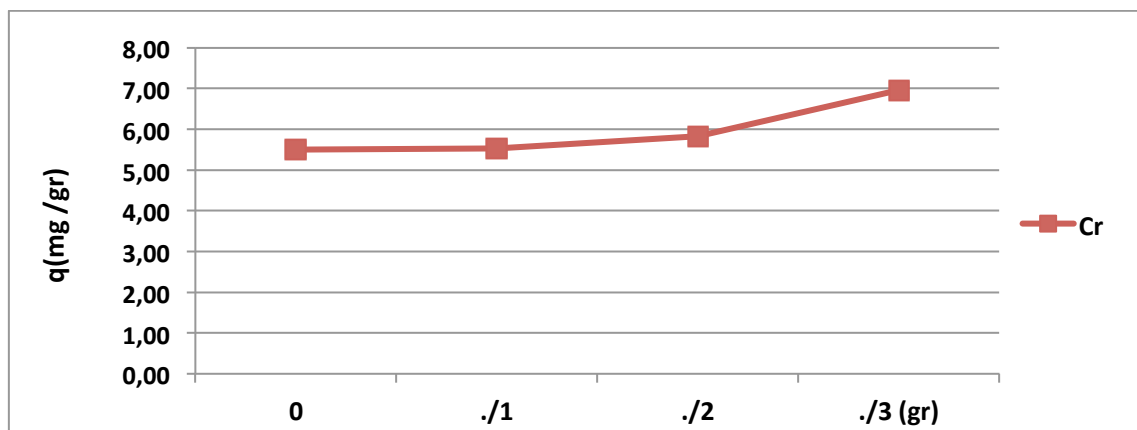


Figure 2. Relation between Chromium absorption level and increase in activated carbon

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2- Results of surveying relation between chromium absorption and increase of volume

Results of atomic absorption spectrometer in Figur “3,” show that increase in concentration of chromium solutions, would raise the absorption level and also by surveying the amount of active carbon in different concentrations it shows that increasing of the active carbon in absorptive bullets, would increase the absorption level (absorption percent and absorption capacity) and the most elimination level of chromium occurs in “100” ppm.

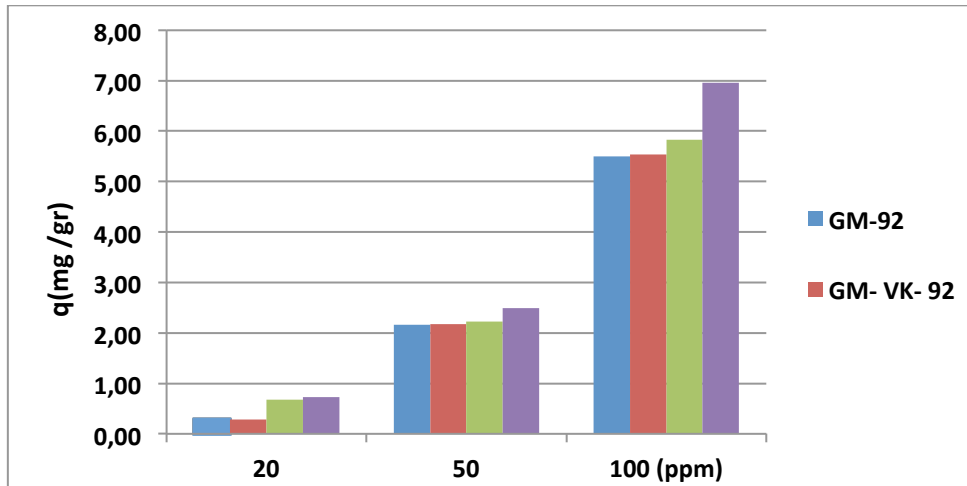


Figure 3. Relation between absorption level of chromium and increase of concentration

3- Results of surveying the relation between increase of time and absorption level of chromium in the field of the absorbent and in different concentration

Results of the atomic absorption spectrometer in Figur “4”, “5”, “6” and “7” show that by increasing the time factor, absorption level of chromium in different concentrations in absorbent sphericals containing activated carbon is also increased and also the most level of chromium absorption in “69/7 %” was in “120” min and in “100” ppm and absorbent sphericals in type of “GM-MN-92” which contains “0.3” gr of almond-shell activated carbon has appeared.

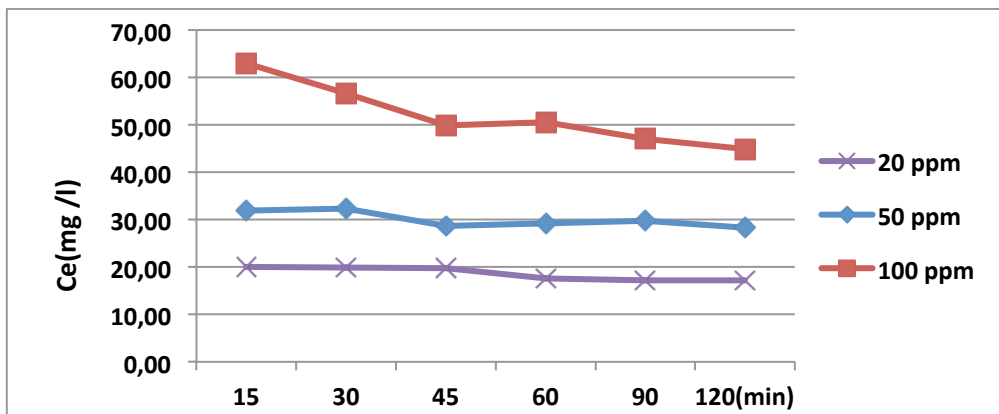


Figure 4. Kinetic of chromium absorption versus time in the field of absorbent GM-92

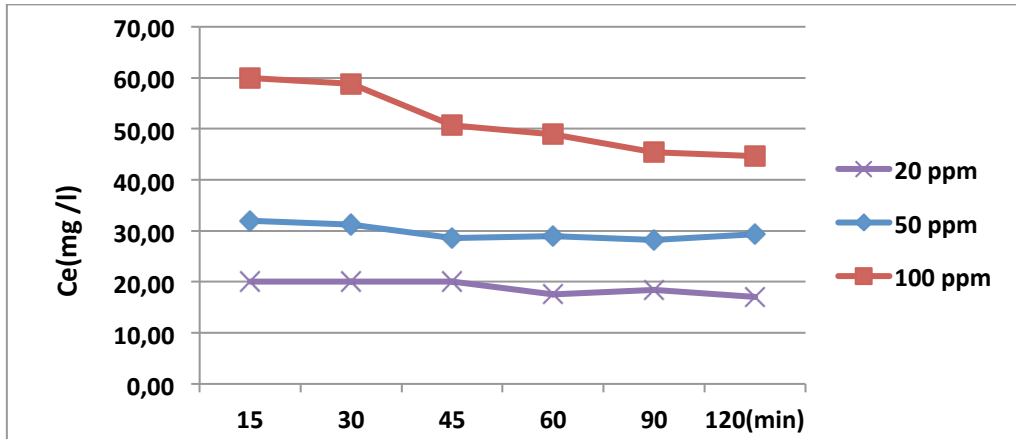


Figure 5. Kinetic of chromium absorption versus time in the field of absorbent GM-VK-92.

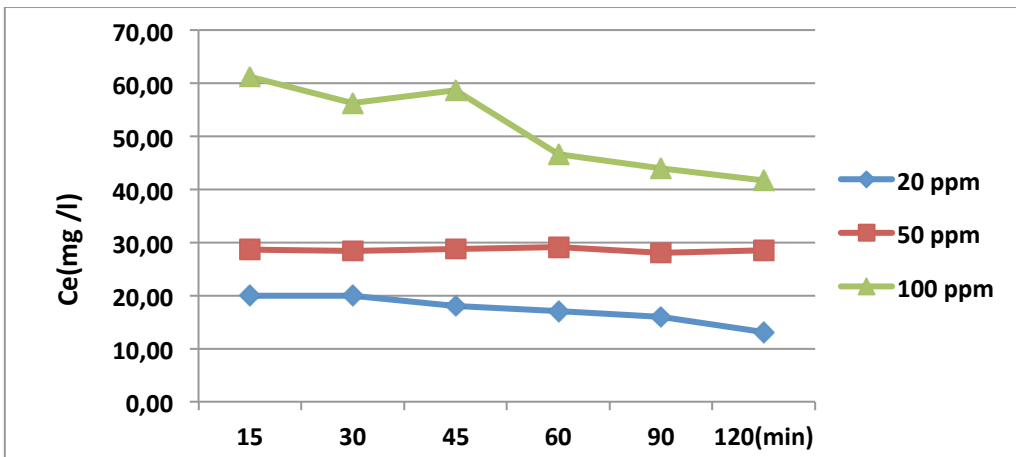


Figure 6. Kinetic of chromium absorption versus time in the field of absorbent GM-HR-92

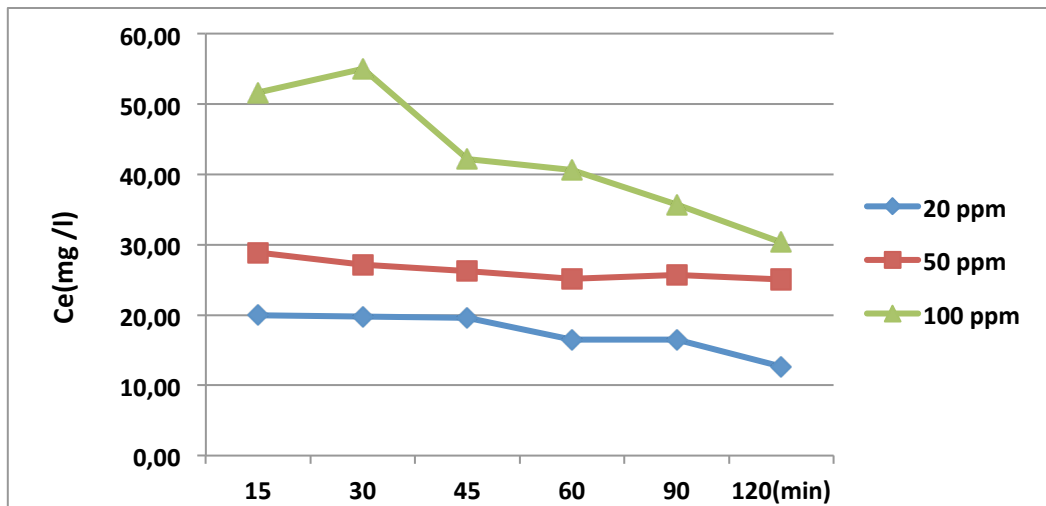


Figure 7. Kinetic of chromium absorption versus time in the field of absorbent GM-MN-92.

4. CONCLUSION AND RECOMMENDATION

Results of this research and the past studies about absorption power of alginate absorbent sphericals and active carbon in absorbing metal cations such as chromium show that the absorptive capacity of the said absorbents is *high* for metal positive cations. In this research, an increase in absorption capacity of alginate was studied and the results showed that by increasing the activated carbon, absorptive capacity of absorbent would increase significantly and it is necessary to say that in this method, the amount of active carbon is severely low and this method is economical compared to direct use of activated carbon. Because the most absorption is occurs in 120 min and on 100 ppm, and as a result of the possibility of an increase in absorption power by elapsing the times and at higher concentrations, it is proposed to study the activated carbon in higher concentrations and with more contact times and also for absorption of other metal cations.

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