Investigation of the effect of PH value on the removal of cobalt from aqueous solutions by low cost activated carbon material

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Abstract: It is well recognized that the Cobalt is among the prominent contaminants in aqueous solutions. This hazardous metal can result in a high risk contamination and causes illness. It should be mentioned that the Cobalt metal also appears in wastewaters of a lot of manufacture and it can produce variety of undesirable effects. For removal of this contaminant from water many methods are used in this way. In this paper the bark of oak is intended as an alternative, low-cost, filter material for contaminated waters. In this research we investigate the removal of Cobalt metal on activated carbon. This was prepared from Iranian oak bark, from solutions. Adsorption of Cobalt was studied in batch tests. In this research, the effect of pH as the operation condition was investigated. The obtained results are discussed in the following sections.
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1. Introduction

Previous researchers have addressed that Cobalt is an element that occurs naturally in many different chemical forms throughout our environment. Small amounts of cobalt are essential for good health [1]. It is a natural earth element and is present in trace amounts in soil, plants and in our diets. In pure form it is a steel-grey to black shiny hard metal [1]. It also exists as Cobalt II and Cobalt III, which form a number of organic and inorganic salts Cobalt is among the prominent contaminants in aqueous solutions [1].

It is well recognized that with recent development in industrial activities, contaminants are become one of the major problems especially in developed countries as well as third world countries. Therefore, the removal of contaminants is one of the most important problems for health and medical science as well as engineering.

It is well recognized that the Cobalt is among the prominent contaminants in aqueous solutions. This hazardous metal can result in a high risk contamination and causes illness. It should be mentioned that the Cobalt metal also appears in wastewaters of a lot of manufacture and it can produce variety of undesirable effects like nausea, vomiting, asthma, damage to heart, causing heart failure, damage to thyroid and liver on human beings[1-3].

For removal of this contaminant from water many methods are used in this way. Some nanoparticles such as ZnO can be used for contaminant degradation [4-6]. Among these methods the important are membrane filteration, liquid extraction, reverse osmosis, electrochemical operation, flotation, electrodialysis and adsorption [7-13]. Adsorption is a very useful technique in the removal of organic and inorganic contaminants from waters.

Activated carbon is one of the most widely used adsorbents for the adsorption of contaminants. It exists mainly in powder, granular or cloth (fiber) forms. Recently, activated carbon cloth (ACC) has received considerable attention as a potential adsorbent materials for wastewater treatment applications.

It has several unique characteristics compared to conventionally used powder or granular activated carbons. One of the most important traits of this adsorbent is cheapness. So far, many studies have been done on producing and designing the activated carbon material.

Activated carbon is produced by two methods [14-16]. In chemical method, Activated carbon after carbonization is activated by chemical agents such as KOH, NaOH, and H3PO4. But in physical method, after carbonization, carbon is activated by CO2 and H2O vapor. Its raw materials are available and low cost. Agricultural materials and sold waste can be suitable for producing activated carbon that is a highly good performance absorbent material or industrial applications.

Only a few studies have been published for the removal of Co (II) from aqueous solution using

various adsorbents. Recent studies revealed that adsorbents with sulphur groups are very effective for the removal of heavy metal ions from aqueous solutions. In this track, Gomez-Serrano et al. studied the ability of commercial activated carbon loaded with sulphur groups for the removal of Hg (II), Pb(II) and Cd(II) from aqueous solutions.

In this paper, activated carbon has been produced by low cost agricultural solid waste. Activated carbon has been designed and produced by bark of Iranian oak. After carbonization, black product has been activated by H2SO4. The operational conditions i.e effect of pH has been investigated.

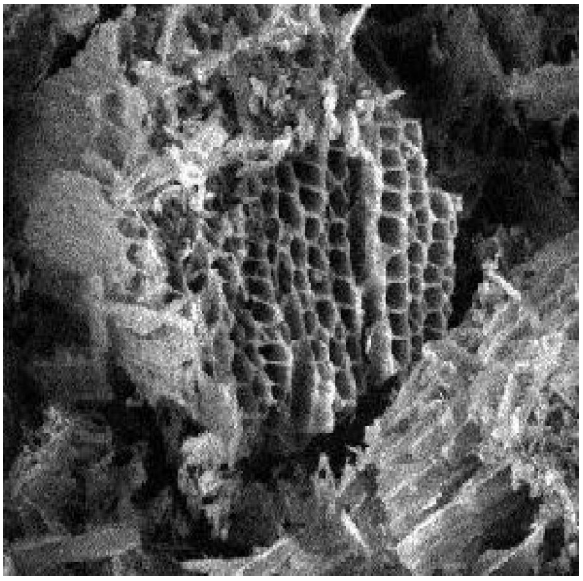

Figure 1: SEM image of activated carbon. A pours structure is observed [17].

2. Material and Methods

Oak bark, collected from a local source, was dried and ground. The powdered samples (below mesh No. 150) were impregnated with H2SO4 concentrated solution (98%), in a (shell: H2SO4) weight ratio of 1:1 (OC).

The resulting product was then dried in an oven at 120◦C for at least 8 h. Impregnated sample was placed on a ceramic boat, inserted in a tubular furnace. The sample was heated to the carbonization temperature under N2 flow at the rate of 10◦C/min. The activated carbon product was then dried in an oven at 110◦C.

The adsorbent particle size distribution was obtained and the mean diameter was about 0.104 mm. All the chemical and reagents used were of analytical reagent grade obtained from Merck Company.

Batch Study

The adsorption of Co(II) from aqueous solutions by bark of oak activated carbon was studied as follow. Each adsorbate containing solution was prepared by dissolving necessary amount of CoCl2 in the distilled water.

Each solution was then diluted to obtain standard solutions containing 50–200 ppm of Co prior to adsorption experiments.

Batch adsorption studies were carried out with 0.08 g sorbent and 50 ml of Hg solution with a desired concentration at pH 5.5 in three conical flasks, simultaneously.

The flasks containing adsorbent and adsorbate were agitated for predetermined time intervals at 22◦C on a mechanical shaker with 600 rpm. At the end of agitation, the suspensions were filtered by the aid of filter paper.

The amount of Co (II) ion in the final 20 ml volume was determined by atomic absorption spectrophotometer equipped with a Zeeman atomizer. The obtained results for two similar solutions were averaged and then reported.

Iodine number

The surface activity of activated carbons towards iodine was determined by using the DIN 53582 standard method. The iodine No. of the sample is obtained as 850 mg/g.

3. Results and discussion

Cobalt is a natural earth element present in trace amounts in soil, plants and in our diets. It usually occurs in association with other metals such as copper, nickel, mangane [1]

The effect of pH on the ad removal of Co(II) by OC over a pH range 2.0–11 is shown in Fig. 1. From the figure it is clear that OC is effective for the adsorption of Co(II) over the pH range 4.5. With increasing the pH of solution the removal efficiency of Co (II) has been increased. As the pH increases from 2.0 to 6.0, there is a sharp increase in the amount of adsorption and at pH 6.0, carbon shows maximum adsorption of Co(II).

This hazardous metal can result in a high risk contamination and causes illness. It should be mentioned that the Cobalt metal also appears in wastewaters of a lot of manufacture and it can produce variety of undesirable effects like nausea, vomiting, asthma, damage to heart, causing heart failure, damage to thyroid and also to the liver on human beings.

The obtained experimental data in previous research show that solution concentration of Co (II)

ions reduces with increase in the temperature indicating an endothermic nature of the sorption processes, while the time required reaching equilibrium remains practically unaffected. Increase in the adsorption capacity with temperature suggests that active centers on the surface available for adsorption increase with temperature.

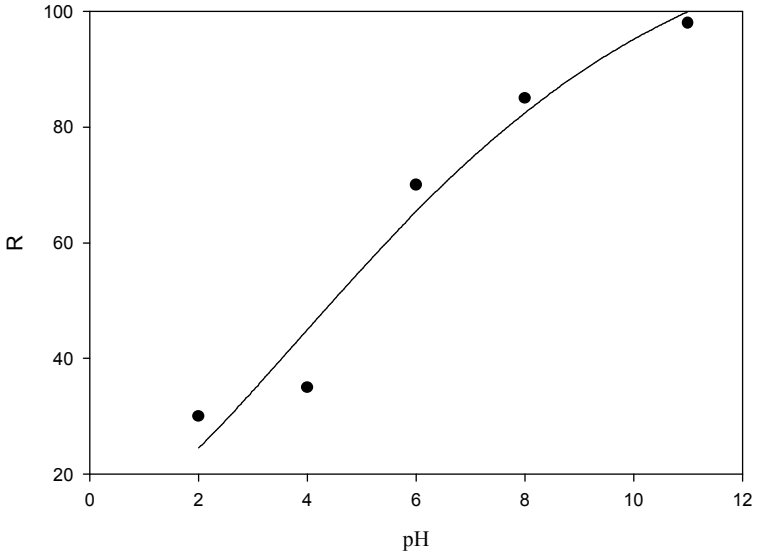

Fig. 2. Effect of pH (Dose=0.08, Time= 15 min, Temperature= 22^{o}C).

4. Conclusion

It is well recognized that the Cobalt metal is among the prominent contaminants in aqueous solutions. This hazardous metal can result in a high risk contamination and causes illness. It should be mentioned that the Cobalt metal also appears in wastewaters of a lot of manufacture and it can produce variety of undesirable effects. For removal of this contaminant from water many methods are used in this way. In this work it has been indicated that designed activated carbon from oak bark can be effectively used for the removal of Co (II) from aqueous solutions. The investigated adsorbent was cost effective as well as eco-friendly. The adsorption process was highly pH dependent and was more effective within the pH over 4.5. It is clear bark of oak is known as trifling matter, but in this research we have shown that this solid waste can be used as the best adsorbent to remove Co(II) from water as dangerous contaminant.

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