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REMOVAL OF CADMIUM(II) ION FROM AQUEOUS SOLUTIONS BY ORANGE PEELS

Hania B. Alhaj[1], Sami H. Al-Mabrouk[2], Ranjan K.Mohapatra[3] and Marei M. El-ajaily[2*]

[1]Academy for higher studies, Benghazi, Libya

[2]Chemistry Department, Faculty of Science, Benghazi University, Benghazi, Libya

[3]Department of Chemistry, Government College of Engineering, Keonjhar-758002, Odisha, India

*E-mail: melajaily@gmail.com

Abstract

Cadmium is one of the heavy metals and that has adverse effects on human health and environment. The toxicity of cadmium is very severe, which appear after several years, and can cause cancer and disorder in the cycle of calcium within the human body to resemble cadmium with calcium. The present work deals with the biosorption of Cd (II) ions from aqueous solution using orange peels. Adsorption of these ions was found to be pH dependent and maximum removal of Cd (II) by orange peel is 98.9%.

Keywords: Cadmium, aqueous solution, adsorbent, adsorption, orange peels.

Introduction

Cadmium is a heavy metal with a high toxicity. Cadmium is toxic at very low exposure levels and has acute and chronic effects on health and environment.[1]. In humans, chronic Cd-exposure causes nephrotoxicity severe damage in nervous, endocrine and immune systems, linked to enhanced aging process as well as cancer. In animals, cadmium was shown to be toxic to all tissues. It has been reported that cadmium causes morphological and functional damage in hepatic[2]. Cadmium has been listed in "Blacklist" of European community [3]. Many natural materials have been studied with high efficiency and cost less economically for removal of heavy metals such as clay, leaves, peels, husks, stems and roots[4]. This process is known as bio-adsorption where, natural biological agents are used form the complexes with metal ions by functional groups on the surface of orange peel[5]. Biosorption can be defined as the use of biological materials that form complexes with metal ions using their functional groups[5]

In this study, orange peels were used to remove cadmium(II) from aqueous solution. Due to the functional groups which the orange peels contain such as hydroxyl and carboxyl, these functional groups make them a potential adsorbent for removing heavy metal ions.[6]

Experimental

Material and Methods

Chemicals: All chemicals used in this study were AR grade. Cadmium metal, HCl (98%), buffer solution, distilled water was used in all preparations.

Adsorbent: Orange was selected from the local market, and then washed with water several times to remove dust and other contaminants, finally washed with distilled water [7]. Then they were herded in small sizes, left to dry for 5 days and then were kept in a plastic box.

Adsorbate: Prepared stock solution of 1000 ppm for Cd(II) ion, dissolve 1g cadmium metal in minimum volume of conc. HCl and completed the volume to 1000 mL of distilled water in volumetric flask (ASTM), then diluted the stock solution several times to obtain concentration of 1 ppm.[8]

$$C \times V = C^{-} \times V^{-} \; ; \; * \; 1000_{PPM} \times V_1 = 100_{PPM} \times 1000_{ML} \; ; \; V_1 = 100_{ML}$$

$100_{PPM} \times V_2 = 10_{PPM} \times 1000_{ML}$; $V_2 = 100_{ML}$; * $10_{PPM} \times V_3 = 1_{PPM} \times 1000_{ML}$

$V_3 = 100_{ML}$

Adsorption studies:

Study of adsorption of cadmium(II) ion on orange peels, The general method used for this study is described as below:

Three different acidic, neutral, and alkaline solutions were taken for the water solution, where the solution was added to the buffer solution pH(4,7,9). For pH 4 add 35 ml from buffer solution 4, for pH 7 add 35 ml from buffer solution 7, for pH 9 add 85 ml from buffer solution 9. In 1ppm from Cd(II) ion, the weight of adsorbent 0.5 orange peel was taken and left at different temperatures 30, 60 and 90 C°. The sample is placed in 50 ml of solution in different contact times; 4, 8, 12 , 30 and 60 minutes. The suspension of the adsorbent was separated from solution by filtration using Whatman No.1 filter paper. The concentration of heavy metal ion remaining in solution was measured by FAAS (Flame Atomic Absorption Spectrometer). The effect of several parameters, such as pH, temperature, contact time and adsorbent dose on the adsorption were studied. The results of these studies were used to obtain the optimum conditions for maximum heavy metals removal from aqueous solution. The percentage of heavy metal removal was calculated as follows.

Metal ion removal (%) = [(Co – Ce) /Co] × 100

Where Co= initial metal ion concentration of test solution mg/l

Ce= final equilibrium concentration of test solution mg/l.

Result and Discussion

The present study is carried out for % Cd(II) ions removal by the effect of temperature, pH and contact time with the change in acidity and the ability of orange peels to remove cadmium(II) ions

by adsorption process. [9]

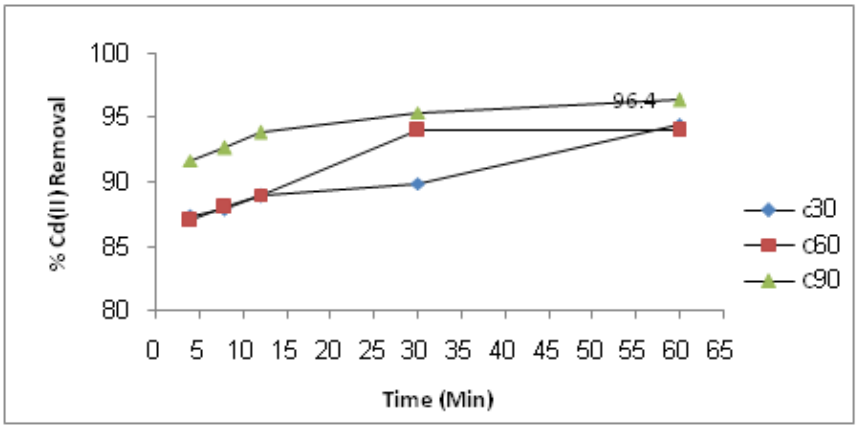

Figure-1: Effects of temperature and contact time on the % removal of Cd(II) ions from aqueous solution.(initial concentration 1ppm), pH(4).

Fig-1 shows the effects of temperature and contact time on the % removal of Cd(II) ions, the effect of contact time on the removal of Cd(II) ions at 60 min and equilibrium was attained after 30 min. Best removal occurred when 90 C° of 96.4% in pH(4).

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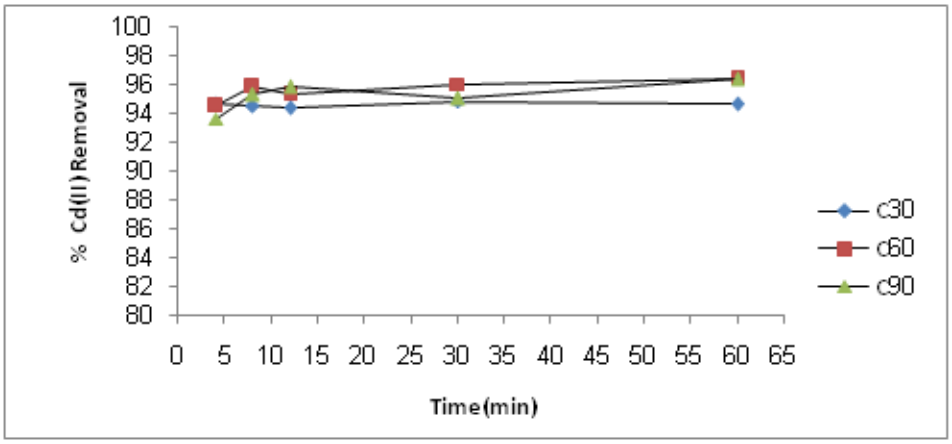

Figure-2: Effects of temperature and contact time on the % removal of Cd(II) ions from aqueous solution.(initial concentration 1ppm), pH (7).

In Fig-2, the result was convergent at pH (7) and the effect of contact time on the removal of Cd(II) ions at 60 min and equilibrium is attained after 12 min, Best removal occurred when 60 C° of 96.3% .

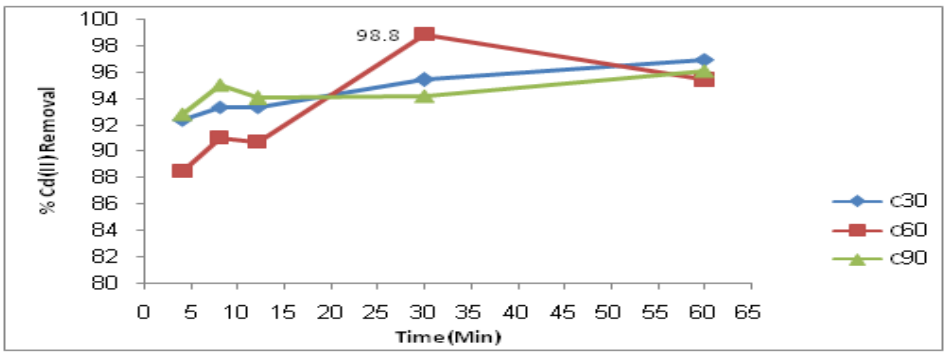

Figure-3: Effects of temperature and contact time on the % removal of Cd(II) ions from aqueous solution.(initial concentration 1 ppm), pH (9).

From Fig-3, it is found that the pH 9 is the best condition for the adsorption process, where, the change was apparent at different temperatures. The best removal of Cd(II) ions at 60C° is of 98.8%.

Conclusion:

Orange peels are cheap and effective adsorbent for the removal of Cd(II) ions from aqueous solution. The obtained results revealed that maximum removal of Cd(II) ions by orange peels at optimum condition parameter pH 9, 30 min contact time, concentration 1ppm is 98.8%. These experimental studies on adsorbents would be quite useful in developing a proper technology for the removal of Cd(II) ions from contaminated industrial effluents. When using this technique in waste water or industrial water, it is necessary to take into account the increase in Chemical Oxygen Demand (COD).

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