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Spectrophotometric Determination of Cd (II) Heavy Metal by Using Stone Apple Shell as a Low Cost Adsorbent

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ABSTRACTS: The toxic element Cadmium (II) was determined by using the widely and easily available shells of fruits of stone apple with a good result. The cadmium is a highly toxic element in a trace amount also, therefore its detection is most important. In the present work the effective and powerful adsorbent properties of shells of waste fruits of stone apple (Aegle marmelos) were thoroughly studied. In this work the determination of Cadmium (II) heavy metals from the solutions of its salt were efficiently carried out. The efficiency of removal of Cd (II) was found to be 85 % at the optimum pH 6.7 and the contact time was 118 min for the toxic metal Cadmium (II). The adsorbent used in the present work was ecofriendly cost effective and easily available and will become the better substitute adsorbent for the removal of heavy metal Cd (II). The different parameters such as contact time, effect of pH, initial concentration of metal ions and amount of adsorbent on the adsorption capacity were studied by using the double beam UV-Visible Spectrophotometer.

KEYWORDS: Cadmium(II), Ecofriendly, Heavy metals, Low cost adsorbent, Stone apple shell.

INTRODUCTION

Heavy metal or toxic metals can cause the fatal effect on the health concern of humans. The toxicity of Cadmium metal is severe even at the low concentration hence its study is most important. Due to the rapid industrialization and urbanization toxic metal pollution increasing day by day, it is the very dangerous kind of pollution from the health concerns of humans (Agbalian E. V 2012, Li *et al* 2013). Heavy metals are not the different kind of metals it is like of usual elements found in nature, it has properties of metal materials at room temperature. Unlike the usual metallic these are toxic not only to humans but also to the marine animals (B. Venugopal and T. D. Luckey 1979), different Microorganisms and plants. Increasing concentration of cadmium toxic element in nature leads to the environmental pollution (L. Friberg, M. Piscator, G. F. Nordberg and T. Kjellstrom (Eds.) (1974). Heavy metals are generally having the high densities, atomic weights, or atomic numbers. Some of the heavy metals are beneficial to living organisms[2] (P. B. Hammond and Robert P. Beliles (1986) in trace amounts some of them are cobalt, copper, manganese, molybdenum, vanadium, strontium, and zinc. If the concentration of such metals increases it becomes fatal to organisms (Williams *et al* 2000). The heavy metals such as mercury, lead, Chromium and cadmium in excess accumulation in the bodies of animals can leads to the carcinogenic can cause serious illness. The number of diseases are developed due to the accumulation of cadmium metals in the body of human being the common symptoms includes shortening of life-span, retardation of growth of organs of animals leads to, gross abnormalities of the vital organs and the risk of prostatic cancer, Kidney damage, instantaneous hypertension are also observed in cadmium poisoning (J. E. Fergusson (1989).

Considering the all above risks of Cadmium heavy metals from the health concern of human being its proper study, detection and isolation became the prime importance. The traditional methods for detection and isolation required the tedious and lengthy process. These processes are not economic and further leads to the environmental hazards due to use of chemicals.

To avoid the environmental adverse effect the use of low cost potential adsorbent is still in demand. In the literature it was observed that numbers of methods were developed to remove the cadmium heavy metals using the various low cost adsorbent. Some of the methods includes the use of agriculture waste fiber and coconut husk [W.T. Tan, S.T. Ooi, and C.K. Lee 1993], waste of yohimbe bark and cork (Villaescusa, M. Martinez and N. MIralles), one of the method include lignocellulosic substrate extracted from wheat bran (L. Dupont, J. Bouanda , J. Dumoneeau and M. Applincourt)

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In the present study the ecofriendly, economical and easily available low cost adsorbent was used to remove the Cadmium heavy metals by adsorption. Adsorption is a process employed in these days for the removal of heavy metals from water and wastewater due to cost effective and environmentally compatible this process may be universally accepted.

MATERIALS AND METHODS

All chemicals and reagents used in the process were of AR grade. The waste thrown parts of stone apple shells of fruits of Aegle marmelos were collected and washed thoroughly, first with running water and then with distilled water. After dried in the sunlight then powdered with the help of mortared and pistol. Powder is sieved into different fine particle and particle size nearly of 0.6 mm was used for characterization. In the present study double beam UV-VIS spectrophotometer was used for entire study.

In 125 ml Erlenmeyer flask 0.1 gm powdered stone apple shells adsorbent and 50 ml Cadmium solution were taken. Tightly Sealed the flask with rubber tubing sealed and were shaken for 4 to 5 hours at 160 rpm in a mechanical shaker. After the shaking the equilibrium established between the Cd(II) adsorbed and unabsorbed on the powdered stone apple shells.

Filtered of the sample through the whatman filter paper no. 1 and filtrate was use to investigate the Cd (II) concentration as per the standard methods. The standard method employed for the determination of Cadmium is the methods proposed by J. M. Jamaluddin (2004) Cadmium reacts with 5, 7 dibromo-8-hydroxyquinoline(DBHQ) reagent at slightly acidic medium gives deep greenish-yellow colour shows maximum absorption at 396nm.

RESULTS AND DISCUSSION

To study the effect of various factors on the process of adsorption such as pH of the solution, contact time, quantity of the adsorbent and the initial concentration of Cd (II) batch study were performed for accurate results, by following the standard procedure.

EFFECT OF PH

The important factor for the process of adsorption is the pH of solution. pH of the solution played important role in the process of adsorption of metals on the adsorbent. To investigate the optimum pH we were perform the batch experiment by keeping all other factor same and change in pH from 1 to 10. It was observed that at pH 6.7 the adsorption is highest 85 %. As shown in the graph.

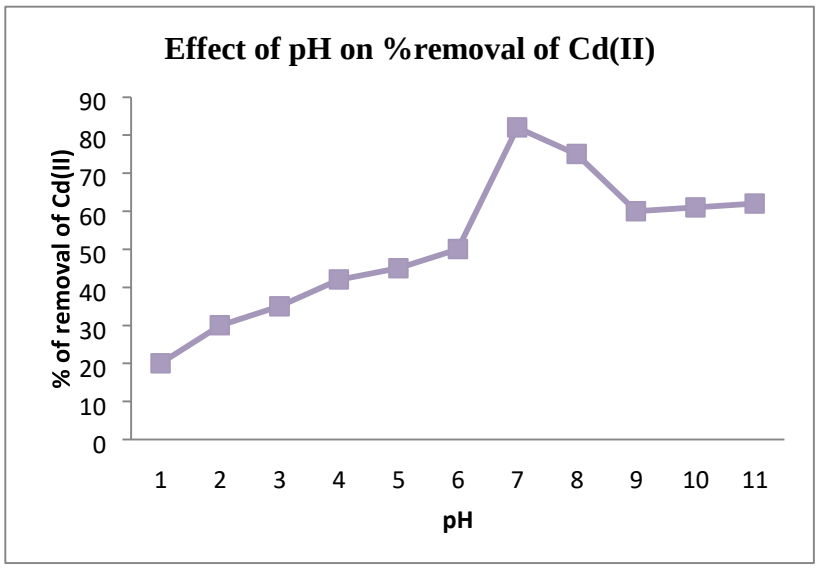

Figure: 1 Effect of pH on % of removal of Cd(II)

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EFFECT OF CONTACT TIME FOR REMOVAL OF Cd (VI)

Contact time is nothing but the time required for process of adsorption to attain the equilibrium between the adsorbed and unabsorbed material on the adsorbent. It is more important to check the efficiency of adsorbent to adsorb the material in less time. From the following graph it was observed that as the time goes on increasing the adsorption also increases at certain limit. At 118 min the adsorption is highest 84.5% then the process reach to equilibrium after maximum adsorption at 118min the adsorption decreases as the time increase.

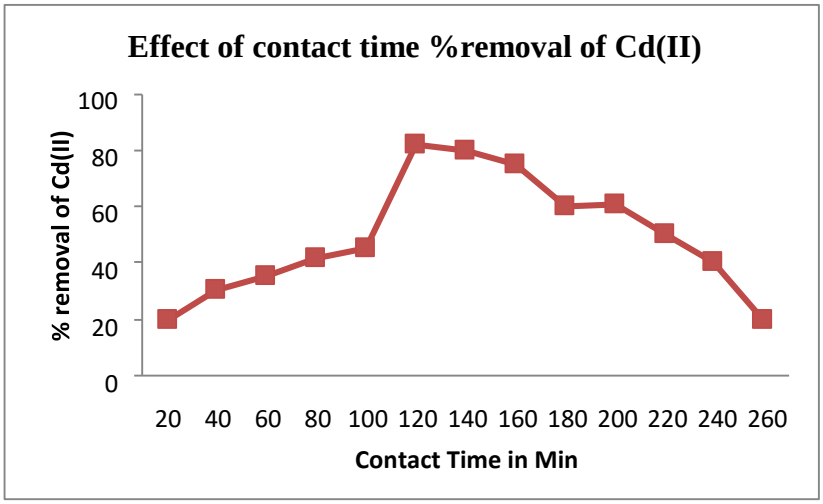

Figure: 2 Effect of Contact time on % of removal of Cd(II)

EFFECT OF ADORBENT DOSAGE

To study the concentration of the adsorbent dose the batch study is the perfect. For this we performed the doses of adsorbent from 1 mg/ml to 10mg/ml. keeping the concentration of Cd(II) is constant. From graph a it was observed that the at 3mg/ml concentration of adsorbent can attain the 85% of Cd (II). As we go on increasing the concentration of adsorbent the adsorption or removal of Cd(II) goes on decreasing. It may be due to the number of ions are adsorbed are decreases with respect to the space available for the ions to adsorbed.

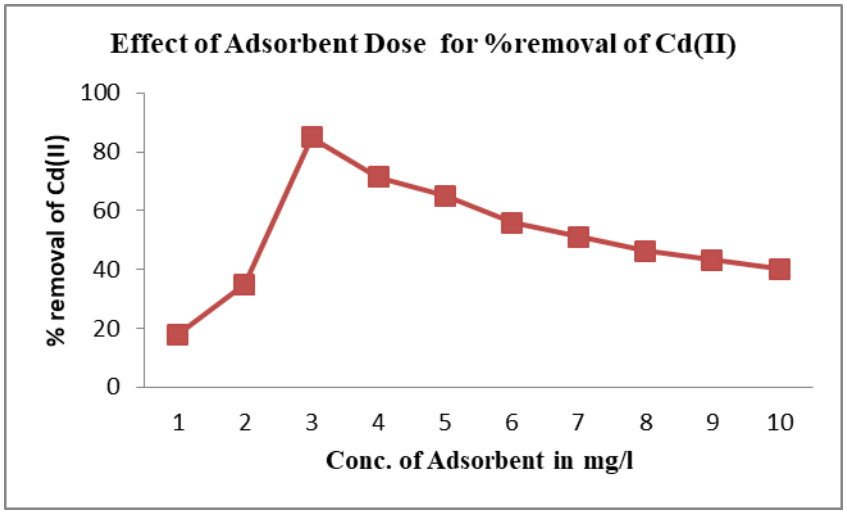

Figure: 3 Effect of Adsorbent dose on % of removal of Cd(II)

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EFFECT OF INITIAL CADMIUM (II) CONCENTRATION

To study the effect of concentration of metal the batch study were performed by taking the amount of initial concentration from 5mg/ml to 300mg/ml at 6.7 pH of solution and 3gm/ml of adsorbent and the contact time is 120 min. it was observed that the at initial concentration of metal in mg/ml the adsorption is more and after gradual increase in concentration the curve down steadily. The % removal of Cd(II) decreases as we go on increase in
the concentration of metal in mg/ml. it was due to the total area for occupying the metal is fixed but the number of ions goes on increasing this why the % removal decreases.

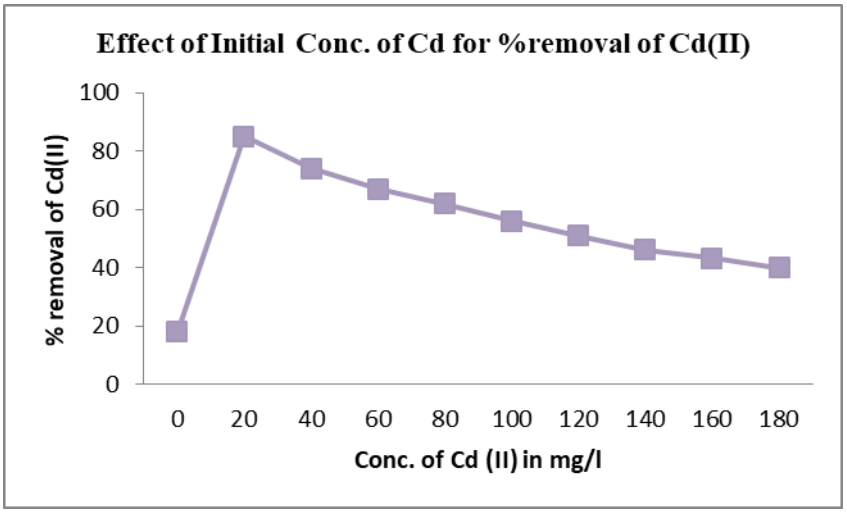

Figure: 4 Effect of initial conc. of Cd(II) on % of removal of Cd(II)

ADSORPTION ISOTHERM

To study the process of adsorption the mechanism of equilibrium adsorption isotherm is most important tool. In the present study the two popular adsorption isotherms Langmuir and Freundlich adsorption isotherm were consider. The Langmuir adsoption isotherm equation can be represented as $Q_e = Q^o b C_e/1+ b C_e$

It was observed from the following graph the Langmuir adsorption valid for monolayer adsorption of Cd(II) on the powder of Stone Apple Shells waste.

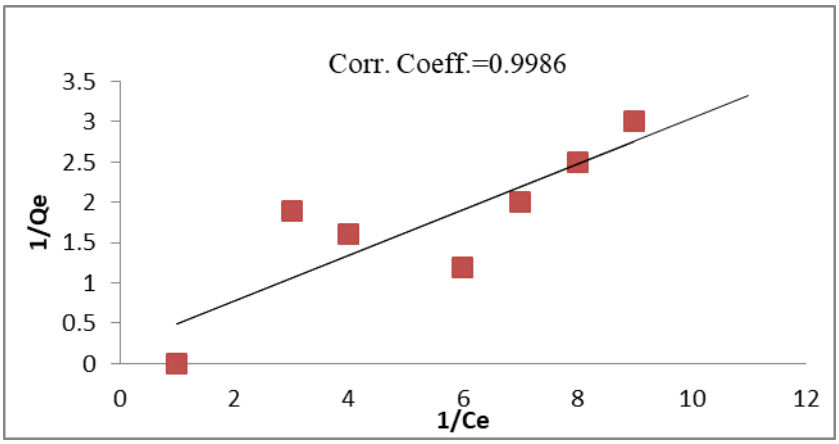

Figure: 5 Langmuir adsorption isotherm curve

Freundlich adsorption isotherm can be represented as

Qe = Kf Cel/n

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From the following graph it was observed that the Freundlich adsorption isotherm is well followed by the adsorbent and the slope 1/n indicates that the adsorbent is well for entire concentration range of adsorbent.

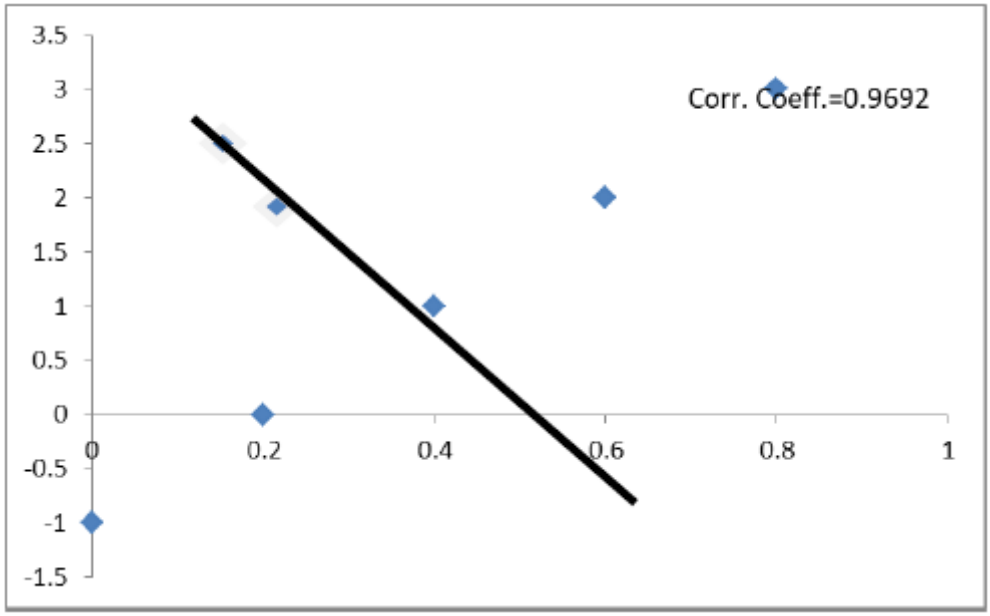

Figure: 6 Freundlich adsorption isotherm curve

CONCLUSION

The adsorbent used in the present investigation, waste stone apple shell was found to be the Potential and excellent adsorbent for the removal of Cd (II) heavy metals from all types of samples solutions. The factors affecting of adsorption i.e. pH, Contact time, initial concentration of metal ion were thoroughly studied and observed that the process depends on the above mentioned factors. The efficiency of removal of Cd (II) was found to be 85 % at the optimum pH 6.7 and the contact time was 118 min for the toxic metal Cadmium (II). This adsorbent is the ecofriendly cost effective, easily available and will become the better substitute adsorbent for the removal of heavy metal Cd (II).

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