ISSN NO. 2320-5407

Journal homepage:http://www.journalijar.com
Journal DOI:10.21474/IJAR01

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Adsorption of Cadmium (II) from solution onto activated carbon prepared from *Madhucalongifolia*Fruit Shell

***Vilayatkar N.D[1],Rahangdale P.K[2], Donadkar D.K[3].**

1. S.S.Jaiswal College, Arjuni/Morgoan-441701, India.
2. Bhawabhuti College, Amgoan-441902, India.
3. Priyadarshini College of Engineering, Nagpur-440019, India.

Manuscript Info

Manuscript History:

Received: 18 March 2016
Final Accepted: 22 April 2016
Published Online: May 2016

Key words:
Madhucalongifolia,cadmium toxicity, wastewater treatment, isotherm.

****Corresponding Author***

Vilayatkar N.D.

Abstract

Activated carbon derived from *Madhucalongifolia* Fruit shell has been used for theadsorption of Cd(II) from solution. Cadmium is toxic to living systems and therefore it is essential toremoveit from wastewater. Activated carbon was characterized using techniques like FTIR and SEM. Adsorption capacity of *Madhucalongifolia* fruit shell activated carbon (MLFSAC) for Cd(II) abetment wasinvestigated employing batch equilibration method. The effects of variousparameters like contact time, initial adsorbate concentration, pH and MLFSAC doses have also been studied and reported. The adsorption data were found to fitwell with the Freundlich and Langmuir isotherm models.The percent removal of Cd (II) was found to beincrease with adsorbent doses from 1 to 8 gm.Andmaximum efficacy was found at 8 gm. At optimum condition nearly 92% abatement of Cd(II) has been noted using MLFSAC. Thus the self-prepared activatedcarbon underinvestigation has been proved to be an excellent economical adsorbent materialfor Cd(II) removal from contaminated water/wastewater.

Copy Right, IJAR, 2016,. All rights reserved.

Introduction:-

Different industrial discharge effluents which containing toxic metals can cause severe contamination of ground water and surface water. However environment become polluted not only by rapid industrialization, deforestation and unplanned urbanization, but also some natural phenomenon of anthropogenic activities such weathering of rock and volcanic activities also play a crucial role for enriching the water reservoirs with heavy metals(Jonathan, 2009 andKamruzzaman,2010).Cadmium is rare and uniformly distributed element in the earth crust with an average concentration of 0.15 to 0.20 mg/kg. It occurs in the form of inorganic compounds and complexes with chelating agent (Hiatt et al.,1975). Cadmium is one of the most toxic environmental and industrial pollutant because it can damage allmost all important organs (ATSDR,2008). Cadmium and its compounds are also used in paints, pigments, plastics, electroplating, equipments, machineries, baking channels and photography(Csuros et al.,2002)**.**Even small quantity of Cd assimilation by the body can cause severe high blood pressure, heart disease and can lead to death(Pan etal., 2010)**.**The acute over exposure to Cd fumes can cause pulmonary diseases while chronic exposure causes renal tube damage and prostate cancer(Jarup et al. 2009)**.**The commonly used methods for removing metal ions from waste water includechemical reduction(Chen et al.,2007), nano filtration(Ahmed et al.,2006), bioaccumulation(Preetha et al.,2007), ion exchange (Cvaco et al.,2007) and adsorption on silica composites(Kumar et al., 2007 and Arenas et al., 2007)/ activated carbon materials (Mohan et al.,2005).Bio-sorption a technically feasible and economical process, hasgained increased creditability during recent years(Loukidouet al., 2004). A number of biosorbent have been used such as tree barks, saw dusts, activated rice husk, coconut shell, almond shell etc. for theadsorption of heavy metals.Use of surface modified/chitosan coated bio-sorbent as low costmaterial for abatement of Cr(VI) has been reported in the literature(Hunge et. al.,2014) The low costactivated carbon derived from Cassia fistula has also been reported as an excellent adsorbent for removal of Cr(VI)(Vilayatkar et al., 2015).

The objective of the present study is to investigate the possible use ofactivated carbon derived from *Madhucalongifolia*FruitShell as an alternative adsorbent material for removal of Cd(II)employing batch experiments.

Materials and Methods:-

All the chemicals used were of analytical or chemically pure grade. Distilled water was used throughout the investigation.

Preparation of Activated Carbon from the*Madhucalongifolia*:-

*Madhucalongifolia*fruit shell was collected from local area and cut into small pieces and washed several times with tap water followed by distilled water. The clean biomass so obtained was sun dried for 5 days. The biomass was subjected to pyrolysis process using Muffle Furness. During slow carbonization of raw material in absence of air at temperature range 600-700^{0}C, volatileproducts were removed and residue was converted into char. The char was then subjected tochemical activation process using 25% zinc chloride solution. This activated carbon was thenwashed with distilled water and dried at 105^{0}C for 2hrs.and stored in air tight bottle. The material has been characterized by FTIR and SEM studies.

Preparation of stock solution:-

Synthetic stock solution of Cd(II) was prepared by dissolving required quantity of cadmiumsulphatesalt in the distilled water. This solution was diluted to proper proportions to obtainvarious standard solutions ranging their concentrations 10-100mgl^{-1}. pH adjustment was doneusing 0.5N HCl and 0.5N NaOH solution.

Batch Experiment:-

Batch equilibrium studies were conducted with different parameters such as pH, agitation time,initial concentration of Cd(II) solution and effect of adsorbent doses. The systems were agitatedon rotary shaker at 200 rpm, filtered through Whatmman no.42 filter paper and filtrate wasanalyzed for Cd(II) concentration using UV-Visible Spectrophotometer. From experimental data, the applicability of Freundlich and Langmuir model were judged. Linear regression coefficient (R^2) and isotherm constant values were determined from the model.

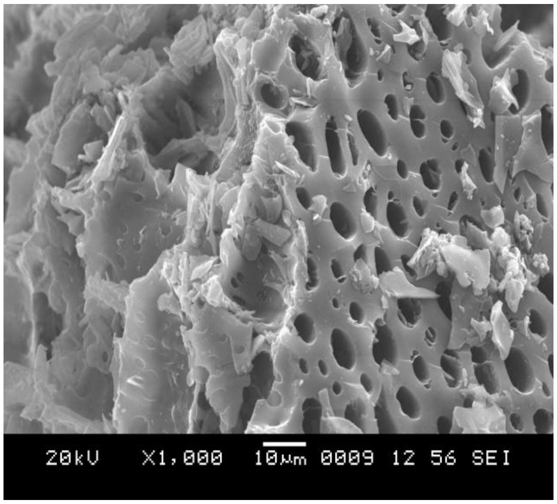
Characterization of MLFSAC:-

SEM Studies of MLFSAC:-

Fig.1shows the SEM image of MLFSAC which is obtained using an accelerating voltage of 20 KV at x 1000 magnification. SEM micrographs clearly revealed that wide variety of pores are presents on the surface of activated carbon(MLFSAC) accompanied with fibrous structure. It can also be noticed that there are holes and caves type opening on the surface of the adsorbent, which would have create greater surface area available for adsorption.

FTIR Studies of MLFSAC

FTIR spectrum of MLFSAC has shown in **Fig.2**The peak at 3838cm^{-1} indicates N-H stretching. The band at 3628cm^{-1} indicates the presence of dissociated or associated –OH on the adsorbent surface. The band at 2343cm^{-1} shows more strongly hydrogen bonded –OH group. The weak peaks appeared in range 1450cm^{-1} to 1580cm^{-1} indicate the presence of C=C bond stretching and N-O stretching. The weak peaks appear in range 540cm^{-1} to 700cm^{-1} shows presence of carbon- bromine stretching in alkyl halide.



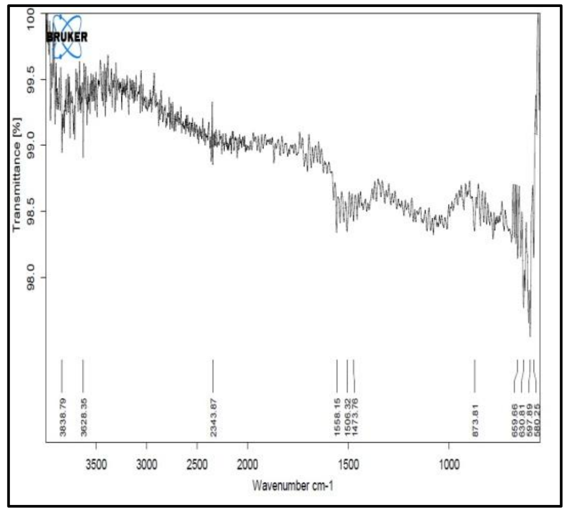
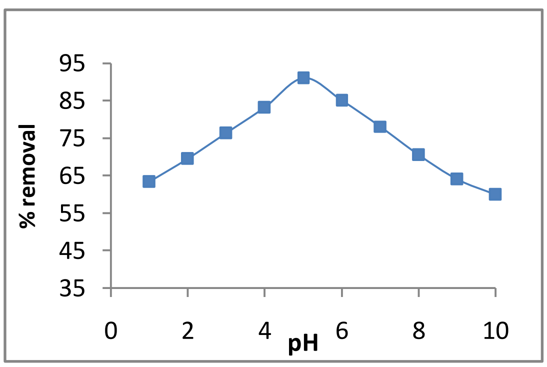


Fig. 1:- SEMof MLFSACFig. 2:- FTIR Spectrum of MLFSAC

Results and Discussion:-

Effect of pH on adsorption

Effect of pH on Cd(II) adsorption using MLFSAC as an adsorbent has been studied in the pH range 1to10 and presented in Fig.3. It is seen that solution pH plays a very important role in theadsorption of Cd(II). The percentage removal increases steadily from 64 to 91% when pH is increased from 1 to 5 in Cd(II) adsorption and slowly decreases on further increases in pH.



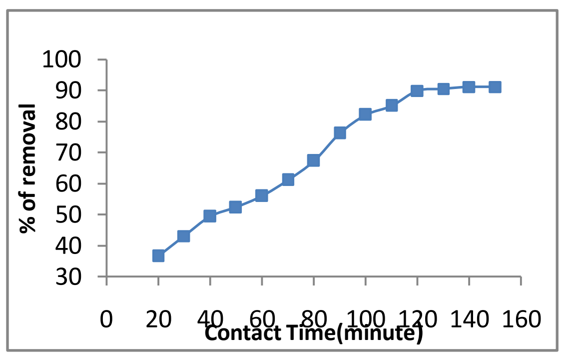


Fig.3:-Effect of pH on Cd(II) removal by MLFSAC Fig.4:- Effect of Contact time on Cd(II) removal byMLFSAC

Effect of contact time on adsorption:-

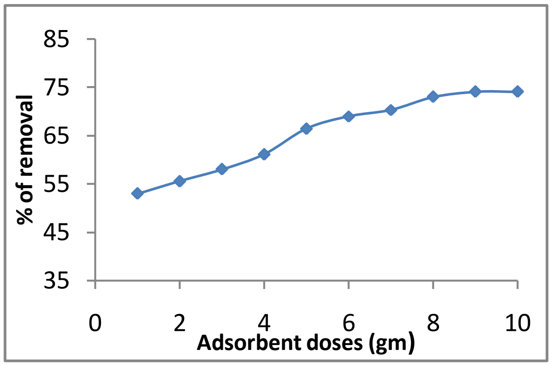
Adsorption experiments were conducted as a function of contact time and results have shown in Fig.4. Therate of Cd(II) binding with adsorbent was greater in the initial stages then gradually increases andremains almost constant, after optimum period of 140 min.

Effect of adsorbent doses:-

The effect of adsorbent (MLFSAC) doses on percent removal of Cd(II) in the range 1 to 10gm isrepresented in Fig.5. The initial Cd(II) concentration was taken to be 30ppm. However after certainadsorbent dose it becomes constant and it is treated as an optimum adsorbent dose, which is found to be8 gm/lit. for the MLFSAC adsorbent.

Effect of the Initial concentration of Cd(II) solution:-

The Experimental studies were carried with varying initial concentration of Cd(II) ranging from10 to 100 ppm using 8 gm/lit.of adsorbent dose.The results have shown in Fig. 6. The resultsdemonstrate that at a fixed adsorbent dose the percentage of Cd(II) removal decreases withincreasing concentration of adsorbate.



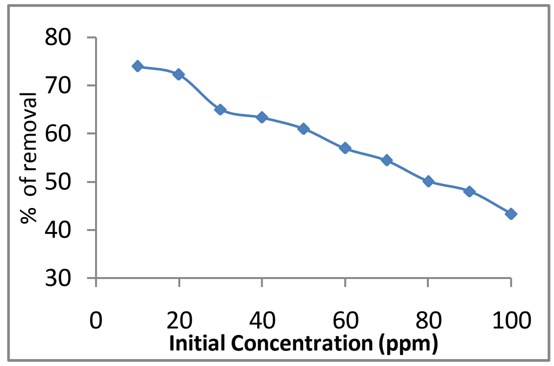
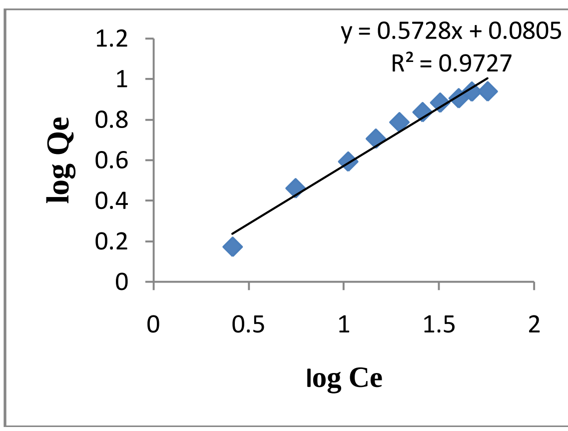


Fig.5:- Effect of adsorbent doses on Cd(II) adsorption.**Fig 6:-** Effect of initial concentration on Cd(II) adsorption.

Adsorption Isotherm:-

Freundlich adsorption isotherm-The plot of logCe versus log Qefor Cd(II) is presented in Fig.7 which show linear curve and hence the adsorption process obeys Freundlich adsorption isotherms. Freundlich constants 'n' and $k_f$for Cd(II)) were found to be 1.20 and 1.74 mg/g respectively. The square of the correlation coefficient (R^2) values was found to be 0.9727 for Cd(II) which shows well-fitting of the Freundlich isotherm. The 'n' values are in between 1 to 10 which indicate the favorable adsorption of Cd(II) on MLFSAC.

Langmuir adsorption Isotherm- The results obtained from Langmuir model for the removal of Cd(II) by MLFSAC has been represented in Fig.8. The values of square of the correlation coefficient (R^2) is found to be 0.9943 for Cd(II), which show the best fitting of equilibrium data. The adsorption efficiency'Q_m'valuefor Cd(II) was found to be 11.73 mg/g while values of 'b' was 0.054. The lower values of b(less than one) implies an excellent the affinity between solute and sorbent sites. To confirm the adsorbility of the adsorption process, the equilibrium parameter also called separation factor 'R_L' for Cd(II) was calculated which were found to be 0.3808.



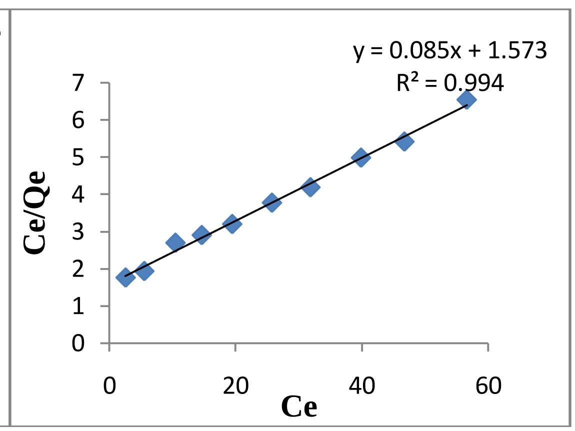


Fig.7:-Freundlich isotherm for the adsorption of Cd(II) Fig.8:-Langmuir isotherm for the adsorption of Cd(II)

Conclusion:-

- Activated carbon (MLFSAC) has been obtained and activate successfully.
- The activated carbon derived from the Fruit Shell of*Madhucalongifolia* has been characterized by FTIR andSEM studies.
- MLFSAC was most effective forCd(II) removal. At pH 5, 92 % of Cd(II) was removed from aqueoussolution and adsorption was found to be pH dependent.
- The increase in percent removal capacity wasobserved with increased adsorbent doses andcontact time. Maximum Cd(II)removal is 75 % for8.0 gm/lit.dose and 91% at 140min. of contact timerespectively.
- The newly obtained activated carbonunder present investigation can be successfully employedforCd(II)abatement from contaminated water and thuscan be used for water/ wastewatertreatment and pollution control.

Acknowledgment:-

Acknowledgment Authors are highly thankful to Dr. R.B. Kharat, Ex- Director, Institute of Science, Nagpur for his valuable guidance, moral support, timely help and constant encouragement during the course of this investigation. Thanks are also due to the Principal, S.S.Jaiswalcollege,arjuni/mor.for providing necessary laboratory facilities. Authors are also thankful to Director, SAIF Cochin University, Kerala for characterization of activated carbon.

Reference:-

1. **Ahmed M.T., Taha S., Chaabane T., Akretche D., maachiR.andDorange G., (2006),** Nanofiltration process applied to the tannery solution. Desalination, 200: 419-420.
2. **Arenas L.T., lima E.C., Santos A.A., vaghetti J.C.P., Costa T.M.H. and Benvenutti E.V., (2007),**Use of statistical design of experiments to evaluate the sorption capacity of 1 4-Diazoniabicycle(2.2.2) octane/silica chloride for Cr(VI) adsorption. Colloids and Surface A:Physicochemical and Engineering Aspects,297: 240-248.
3. ATSDR – (2008a) Draft toxicological profile for cadmium, Agency for toxic substances and Diseases Registry, U. S. Department of Health and Human Service, Atlanta USA.
4. **Chen S.S, Cheng C.Y., Li C.W., Chai P.H and Chang Y.M., (2007),** Reduction of chromateFromelectroplating wastewater from pH 1to 2 using fluidized zero valent iron process. J.Hazardous Materials, 142: 362-367.
5. **Csuros M. and Csuros C.(2002)** Environmental Sampling and Analysis for metals, London: Lewis Publisher.
6. **Cvaco, S.A. Fernandes S., Quina M.M. and Ferreira L.,(2007),**Removal of chromium fromElectroplating industry effluents by ion exchange resin. J Hazardous Materials, 144: 634-638.
7. **Hiatt V. and Hutt I. E.,(1975)** The environmental impact of cadmium: An overview, Int. J. Environment Stud. 7, 277 – 285
8. **Hunge S.S.,Rahangdale P.K., Lanjewar M.R.(2014)** Adsorption of Chromium (VI) From Aqueous Solution Using Bio-Sorbent, International Journal of Current Research Vol. 6, Issue, 05, Pp.6787-6791.
9. **Jarup L. and Akesson A.(2009)** Current status of cadmium as an environmental health problem, Toxicology and Applied Pharmacology, 238, 3, 201–208.
10. **Jonathan Y., (2010)** Am. J. Appl. Sci. 7(2),153.
11. **Kamruzzaman B.Y. and M.C., (2009),** Am. J, App Sci.6(7), 1418.
12. **Kumar P.A., Ray M. and Chakraborty S.,(2007)** Hexavalent chromium removal from wastewaterusing aniline formaldehyde condensate coated silica gel. J HazardousMaterials, 143:24-32.
13. **Loukidou, M.X., Zouboulis A. I., Karapantsios T.D. and Matis K.A.,(2004)** Equilibrium and Kinetic modeling of chromium (VI) biosorption by Aeromonascaviae. Colloids and surface A: Physiochemical and Engineering Aspect, 242: 93-104.
14. **Mohan D., Singh K.P. and singh V.K., (2005),** Removal of hexavalent chromium fromaqueous solution using low cost activated carbons derived from agricultural waste materialsand activated carbon fabric cloth.J.Chemical Technol. Biotechnol., 44: 1027-1042.
15. **Pan J., Plant J. A., Voulvouliis N. Oater C. J., Ihlenfeld C.(2010),** Cadmium Levels, In Europe: Implication for human health, Environ. Geochem.Health 32, 1 – 12.
16. **Preetha, B. and T. Viruthagiri, (2007)** Bioaccumulation of Cr(VI), copper(II) and nickel (II)ions by growing Rhizopusarrhizus. Biochem.Engineering J.34: 131-135.
17. **Vilayatkar N.D., Gadegone S.M., Rahangdale P.K.(2015)**Application of CFFSAC as a New Adsorbent Material for Cd(II) Removal, International Journal of Chemical and physics Science, ISSN:2319-6602 Vol. 4.