Adsorption Studies of Pb(II) in Wastewater Using Some Eco-Friendly Technologies

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Abstract:

Pb(II) in wastewater is highly toxic and responsible for various diseases to living being. It is also well known responsible for extinction of Roman Empire. A simple, coast effective and eco-friendly method have been investigated for remediation of Pb(II) from wastewater using powdered and treated bark of Terminaliacatappa. The adsorption conditions are fixed in Batch studied as a function of pH (2-9), contact time (0-120min), initial concentration (20-55mg/L), doses of bark (0.5 - 3g) and temperature (32-90°C). It was observed that about 82% removal of Pb(II) takes place over the pH range of 7 – 8 and contact time of 1.5 hour at initial concentration of 20 mg/L. The adsorption of Pb(II) was inversely related to temperature. The results obtained in batch experiments were compared with that of GAC. The column having 2cm diameter with bed depth of 30cm was used in Column studies and 20mg/L Pb(II) solution passed at flow rate of 9.5ml/min. The column parameters like adsorption at different time intervals were studied. The bark was found to be efficient media for removal of Pb(II) as compared to GAC in continuous mode.

Keywords: Adsorption studies, Pb(II) removal, Wastewater, Column studies.

Introduction:

Now a day's metal contamination in environment has become global problem. Industries particularly in the trade of metal processing operations are significant sources of toxic metal emission in the environment increasing pollution considerably [1]. The main reason of the metal contamination is because most of the land is irrigated by waste water generated from industries [2]. The waste water commonly contains Cd, Pb, Cu, Ni and Co. These heavy metals are non-biodegradable and their presence in water resources leads to bio-accumulations in living organisms causes health problems in animals, plants and human beings [3].

The Pb(II) was selected in present studies because it is well known for its toxicity and responsible for various diseases to human being [4]. The present work is an attempt to remove the Pb(II) from wastewater using some eco-friendly technologies like the polymeric waste material i.e. tree bark of Terminaliacatappa after some treatment which is very cheap as compared to commercial Granular Activated Charcoal (GAC). The experiments were done on laboratory scale only. Therefore, there must be some degree of variation are possible in the result. But, such attempts are necessary for the benefit of society in concern with the metal poisoning.

Material and Methods:

The studies were performed in three phases: Sample collection, Batch study and Column study.

1) Samples collection: The waste water samples were collected from the Industrial Area of Pune. The collected samples were tested for Pb(II) ion content and diluted to required concentration of metal ion and pH was fixed.

2) Batch Study: The optimum conditions for adsorption of Pb(II) was fixed in batch study. In this study all experiments were performed by using synthetically prepared solution. The batch study carried out by conducting various experiments. The bark power was treated using formalin solution and 0.1N nitric acid for three days, washed several times with distilled water and then sun dried. 1 gm each of powdered bark of Terminaliacatappa and GAC were agitated separately with 100 ml Pb(II) solutions. The concentration of Pb(II) was analyzed before and after adsorption using standard methods [5]. The experimental parameters studied are -

i) Effect of pH

ii) Effect of contact time

iii) Effect of initial metal ion concentration.

iv) Effect of dosages

v) Effect of temperature

3) Column Study: In Column study a fixed column of treated Terminaliacatappa bark having 2 cm diameter and 30 cm bed depth with two ends plugged with glass wool was used. Similar column of GAC was prepared. The wastewater sample having optimum pH and 20 mg/L of Pb(II) was passed through the column using peristaltic pump in back flow mode. The flow rate was maintained at 9.3 ml per minute. The collected effluent was analyzed for Pb(II) content at different time intervals using standard methods. The results were compared with that of the results obtained by using packed column of GAC.

The experiments have been performed several times and the column was regenerated by using 0.01N nitric acid and reused.

Result and Discussion:

A] Batch Study:

Effect of pH: In this study, the concentrations of Pb(II) was selected to be 20 mg/L. It has been found that the adsorption of Pb(II) varies with pH of the solution from 2 to 9. The maximum adsorption of Pb(II) for bark was found to be 82.75% at pH 7. The final pH was found to be less than initial pH of solution for bark. The maximum removal of Pb(II) on GAC was 80.95%. Hence, the optimum pH of solution was fixed at 7.

Effect of Contact Time: It was seen that adsorption of Pb(II) is very fast and about 40% removal takes place within 15 minutes. The Pb(II) concentration remains fairly constant after a contact time of 1hr. Therefore, optimum contact time of 1.5 hr. was fixed.

Effect of Initial Concentration: The removal of Pb(II) decreases by changing the concentration from 20 to 40 mg/L because of unavailability of adsorption sites.

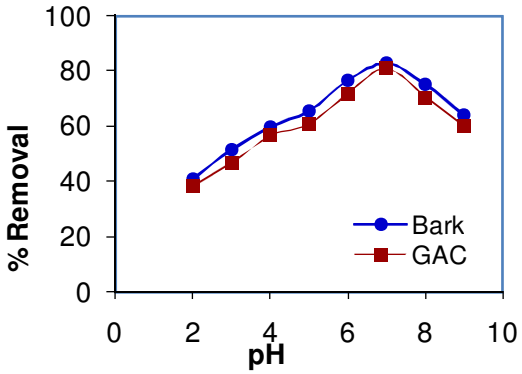
Effect of Doses: In this study, the doses each of the treated tree bark and GAC varies from 0.5 to 3g. It is observed that Pb(II) removal increases with the increase of doses of adsorbent.

Effect of Temperature: The maximum removal of Pb(II) was observed at room temperature (32°C) and percent removal decreases with increases in temperature up to 90°C. Hence, further studies were performed at 32°C.

B] Column Study:

The optimum pH for adsorption of Pb(II) fixed at 7, initial concentration 20 mg/L of Pb(II) and temperature was 32°C (i.e. room temperature).

The solution containing Pb(II) was passed through two different columns packed with treated tree bark and GAC respectively in back flow mode. The Pb(II) get preferentially adsorb on it. The adsorption of Pb(II) was more in the beginning but with increase of time the adsorption capacity of column decreased due to blockage of adsorption sites.



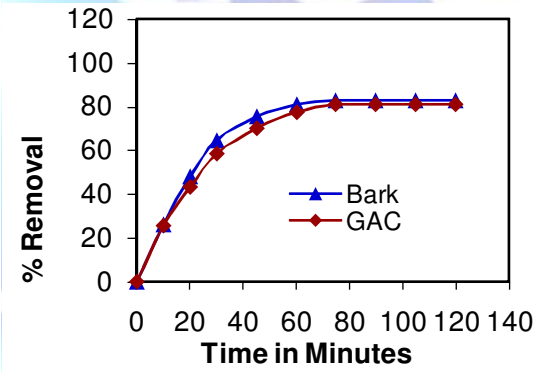
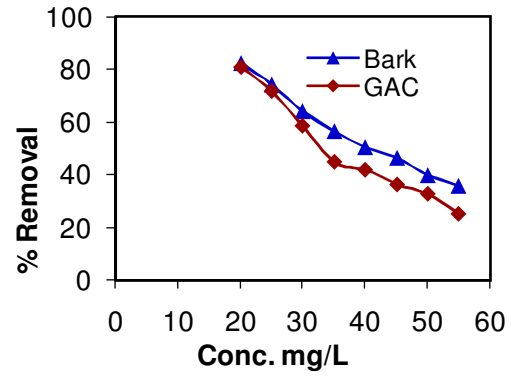


Figure. 1- Effect of pH on removal of Pb(II) **Figure. 2-** Effect of Contact time on removal of Pb(II)



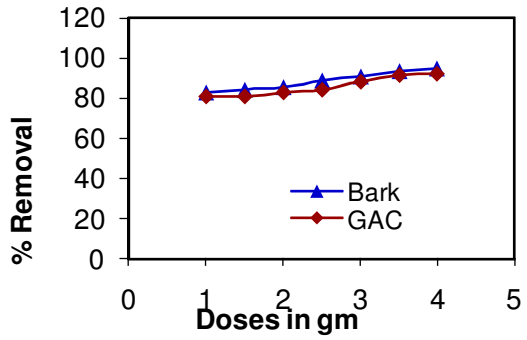
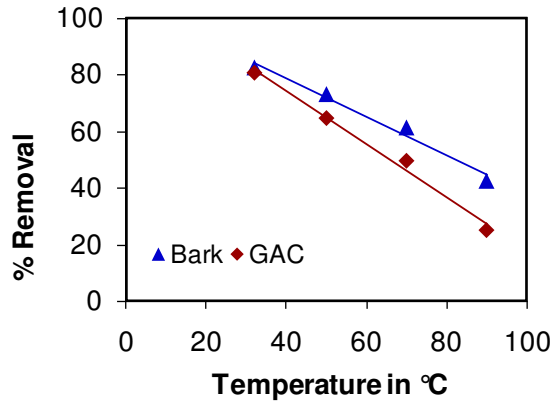


Figure. 3- Effect of Contact time on removal **Figure. 4-** Effect of Doses on removal of Pb(II) ofPb(II)



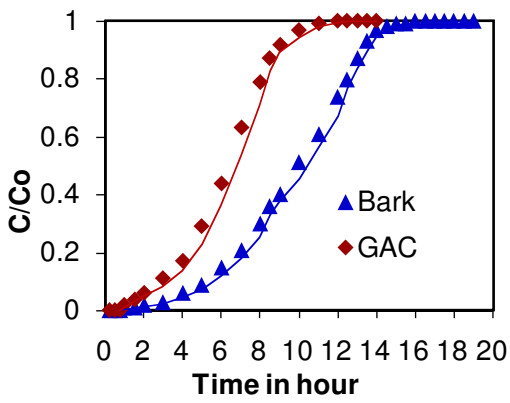


Figure. 5- Effect of Temperature on removal of Pb(II)

Figure. 6- Breakthrough curve for Pb(II)

Desorbing agent = 0.01 M HNO_3 Flow Rate
= 9.3 ml/min. Bed Height
= 10 cm
ID of column = 2 cm

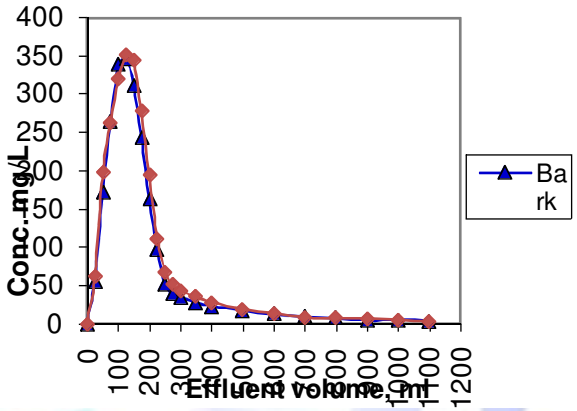


Figure. 7- First cycle desorption of Pb(II)

Conclusion:

The adsorption of Pb(II) in wastewater was studied using bioremediation technology. Based on the result obtained it is concluded that, GAC is an efficient biomaterial for removal of lead from industrial wastewater, but the treated bark of Terminaliacatappa seems to offer a less expensive, eco-friendly and effective alternatives as compared to the expensive commercial GAC. This adsorbent material can be used for removal of toxic metals from industrial wastewater.

References:

MalairajanSingananet. Al., 2005. Removal of Lead ions from industrial wastewater by using biomaterial - A novel method. Bull. Chem. Soc. Ethiop. 19(2), 289-294.

Aydin, H., Y. Bulut and C. Yerlikaya, 2008. Removal of Cu(II) from aqueous solution by adsorption onto low-cost adsorbents. J. Environ. Manage., 87: 37-45.

Bhatti, H.N., B. Mumtaz, M.A. Hanif and R. Nadeem, 2007. Removal of zinc ions from aqueous solution using Moringaoleifera Lam. (horseradish tree) biomass. Process Biochem., 42: 547-553.

Qiu, Y., H. Cheng, C. Xu and S.D. Sheng, 2008. Surface characteristics of crop-residue-derived black carbon and lead(II) adsorption. Water Res., 42: 567-574.

Iqbal, M. and A. Saeed, 2007. Production of an immobilized hybrid biosorbent for the sorption of Ni(II) from aqueous solution. Process Biochem., 42: 148-157.

Kenneth L. Dorris and Shyam S. Shukla, 2005. Removal of Cadmium from Aqueous Solution by Crab Shells. Res. J. of Chem. and Environ. 9(4): 42-45.

Malik, R., D.S. Ramteke and S.R. Wate, 2007. Adsorption of malachite green on groundnut shell waste based powdered activated carbon. Waste Manage., 27: 1129-1138.

Rao, M.M., D.H.K.K. Reddy, P. Venkateswarlu and K. Seshaiah, 2009. Removal of mercury from aqueous solutions using activated carbon prepared from agricultural by-product/waste. J. Environ. Manage., 90(1): 634-643 [3]

Pechyen, C., D. Atong, D. Aht-Ong and S. Viboon, 2007. Investigation of pyrolyzed chars from physic nut waste for the preparation of activated carbon. J. Solid Mechanics Material Eng., 1(4): 498-507.

Ramadevi A. and Srinivasan K. 2005. Agricultural Solid Waste for the Removal of Inorganics: Adsorption of Mercury (II) from Aqueous Solution by Tamarind Nut Carbon. Res. J. of Chem. and Environ. 9(1): 54-59.

Wan Nik, W.B., M.M. Rahman, A.M. Yusof, F.N. Ani and C.N. Che Adnan, 2006. Production of activated carbon from palm oil shell waste and its adsorption characteristics. In Proceedings of the 1st International Conference on Natural Resources Engineering and Technology 2006, pp: 646-654.

Upendra Kumar and ManasBandyopadhyay, 2005. Fixed Bed Column Study for the Removal of Ni(II) from Aqueous Waste by NCRH. Res. J. of Chem. and Environ. 9(4): 81-86.