Adsorption of Lead ions uding (Palms, coconut and Tamerind) fibers

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ABSTRACT

In this study, three different kinds of fibers (palms, Coconut, Tamarind) were tested at the room temperature. The sorbent dosage was studied in batch experiments. The experiments were carried out with (0.1-0.25)g of fibers in 25ml synthetic waste water containing about 4ppm Lead ions. Experiments showed that this topic all material have the ability to adsorption but differentiated palms fiber with (99.5%) removal efficiency , Coconut fiber with (97.5%) , and Tamarhind fiber with (97%).

INTRODUCTION

Industrial and municipal waste water frequently contain metal ions. These metal ions when present in sufficient quantity can be harmful to aquatic life and human health. Current methods for such wastewater treatment include precipitation, coagulation/flotation, sedimentation, flotation, filtration, membrane process, electrochemical techniques, ion exchange, biological process, and chemical reaction. Each method has its merits and limitation in application. The adsorption process with activated carbon is attracted by many scientists because of the effectiveness for the removal of heavy metal ion at trace quantities. But the process has not been used extensively for its high cost. For that reason, the use of low cost materials as sorbent for metal removal from wastewater has been highlighted. More recently, great effort has been contributed to develop new adsorbents and improve existing adsorbents like granular activated carbon, other adsorbents such as iron oxide coated sand [1], porous cellulose carrier modified with polyethyleneimine, iron coat granular activated carbon , modified chitosan ect. One of the exploitation is the use of natural waste. Materials investigated are Cotton [6]; walnut waste [5]; peanut skins; sugar cane waste and onion skin ; coffee grounds; tea leaves; apple waste; wool fiber; bark and other cellulosic material cottonseed hulls, Rice staw, soybean hulls [3] linseed flax straw .because of the low cost, high availability of these materials, and no need for complicated regeneration process. This method is attracting more and more scientists and engineers.

Materials and methods

1- Preparation of the biomass

The (palms, Coconut, and Tamarind) fibers were collected from Baghdad, sun dried and washed with tap water then rinsed with distilled water several times and thereafter dried at laboratory for 24 hours. Following cutting into small pieces then it was screened through a sieve 16 mesh No. this was done to remove any large particles and to obtain particles of size less than (1mm). This fine biomass was used in the batch experiments described below.

2- Preparation of synthetic polluted water (aqueous lead solution)

In this study the biosorption experiments were conducted by using synthetic polluted water (i.e., synthetic metal bearing solution), the solution containing dissolved Pb^{+2} added in the form of $Pb(NO_3)_2$.

The lead stock solutions of 1000 ppm were made either by dissolving the analytical grade of lead nitrate salt $Pb(NO_3)_2$ supplied by (Scharlau Chemie Certified) according to standard methods for examination of water and wastewater , or by using spectroscopic grade standards of Pb^{+2}. Working standard solutions (i.e., samples containing different levels of Pb(II) concentrations) were prepared as required by diluting stock solution (1000 ppm) with distilled water depending on dilution equation below (Langworthy,V.W., 1981):

$$C_1V_1 = C_2V_2$$

Where

C_1: concentration of solute (sorbate) in stock solution, mg/l (ppm)

V_1: volume of stock solution, l

C_2: concentration of solute in diluted solution, mg/l (ppm)

V_2: volume of diluted solution. l

3- Determination of metal ion concentration:

In all experiments after filtration, the synthetic polluted aqueous solution and the samples resulted from each treatment were analyzed for the concentration of Pb (Π) by atomic adsorption spectrometer (AAS).

4- A batch technique was used to perform biosorption experiments and to find the optimum fiber for biosorption of Pb (Π).

Generally, all experiments were carried out in 100 ml glass beaker. In each experiment a solution of (25 ml) with known initial lead concentration 4 ppm the initial pH of the synthetic wastewater was about (2-4) by adding caustic soda to solution it changed to adjusted to a desired pH value (8-9) lead ion found as soluble in this range. The solution was mixed with a definite amount of biosorbent (0.25 g). After that the sample was mixed (stirred) with certain speed 30 min by using magnetic stirrer. The suspension was then

filtered with whatman filter paper and the concentration of metal ion in the filtrate was measured by ASS.

The percent adsorption (%) was calculated using the equation

$$\% \, adsorption = \frac{C_i - C_f}{C_i} \times 100 \quad \text{……..(1)}$$

Where C_i and C_f are the concentrations of the metal ion in initial and final solutions, respectively.

The Pb (Π) uptake (qe) at equilibrium was calculated by using Eq.2

$$qe = \frac{v[l](C_i - C_f)\left[\frac{mg}{l}\right]}{S[g]} \quad \text{……..(2)}$$

V: volume of solution l

S:sorbent weight g

5- Effect of fibers biomass dose

Effect of fibers dosage on biosorption process was studied through doing test with a dose of (0.1,0.15,0.2,and0.25 g) of (palms, Coconut and Tamarind) fibers /25 ml lead solution of (4) ppm with pH (8-9) and contact time of 30 min.

RESULTES AND DESCUSSION

Figure (1) was showed the percent removal values were obtained at pH 8-9 for [C_i=4ppm, S=0.25 g/25ml and time for mixing=30 min] by the three agro-biomasses used with the order, where palms fiber has the higher ability followed by Coconut fiber and Tamarhind fiber consequently. The removal efficiency with palms fiber was (99.5%) which gave the lower remaining concentration for Pb (II) in solution sample. The removal efficiency with Coconut fiber and Tamarhind fiber were (97.5% , 97%) consequently lower than the removal efficiency with palms fiber. The heavy metals are taken up from water predominantly by ion exchange. Plant biomass is composed of cellulose, hemicelluloses and lignin. These materials (lignocellulosic moieties) usually contain more than one type of chemical functional groups such as carboxyl (-COOH) and hydroxyl (-OH).

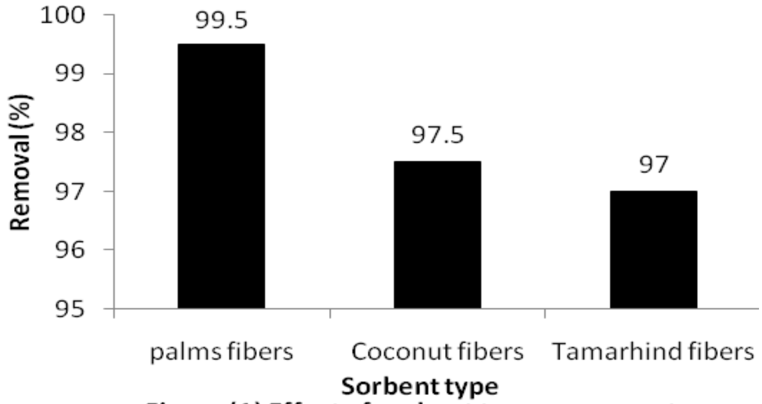

Figure (1) Effect of sorbent type on persent removal of lead ion for [C_i=4ppm , S=0.25g/25ml and pH (8-9)

The optimum values of Pb(II) uptake by the palms fiber, Coconut fiber and tamarhind fiber at pH(8-9) and for [C_i=4ppm, S=0.25 g/25ml and time for mixing=30 min] are (0.398,0.39,and 0.388 mg/g) respectively, as show in Figure (2).

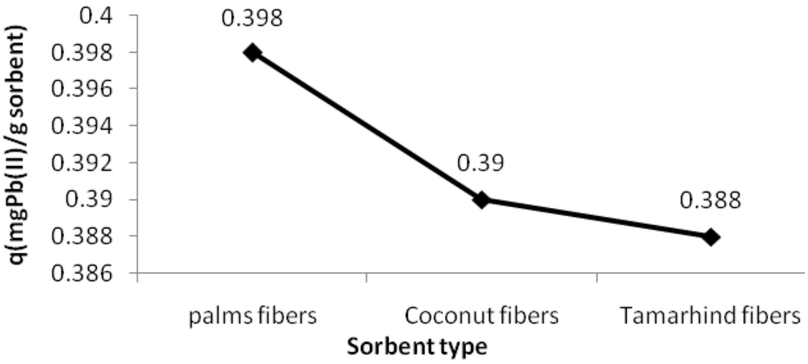

Figure (2) Effect of sorbent type on Pb(II) uptake

Figure 3 demonstrates that an increase in the concentration of fibers biomass in the solution increases the Pb(II) biosorption efficiency. For solutions with 4 ppm of Pb(II) when the quantity of fibers has increased from 0.1 to 0.25 g/25 ml of lead solution, percent removal for Pb(II) increases for palms fiber from 96.25% to 99.5%, for Coconut fiber from 95.25% to 97.5%, and for Tamarhind fiber from 94.25% to 97% respectively. With a further increase in the quantity of fibers dosage, the corresponding increase in the observed uptake of Pb(II) drops off, leveling off at 99.5% maximum percent removal for palms fiber for Pb(II)with (0.25 0f palms fiber/25 ml).

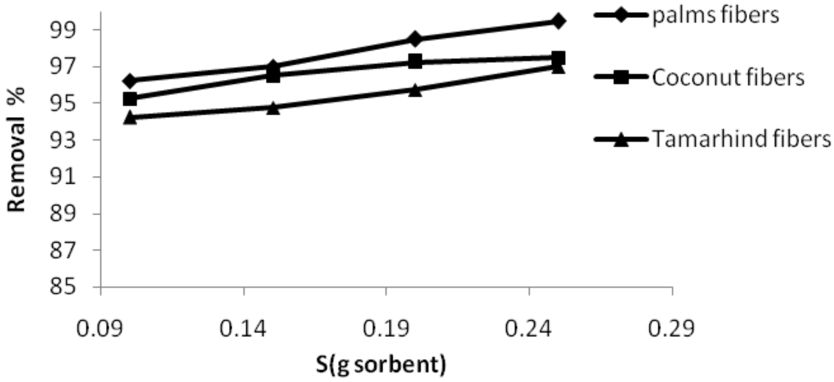

Fig. 3 Effect of sorbent dosage on Pb(II) removal %

While Figures 4,5,and 6 show the data for dose effect. From these figures can be seen that the increase in the biomass concentration leads to decrease the metal ion uptake, this attributed to the responsibility of metal ion concentration shortage in solution [4]. On the contrary, when the values of Pb(II) uptake for fibers increased with a decrease in fibers mass, though this cannot be attributed to greater biosorption capacity. By other meaning, when the biomass or the metal ion concentrations are varied, this can be explained in terms of the ratio of biosorbent sites to metal ion concentration [2]

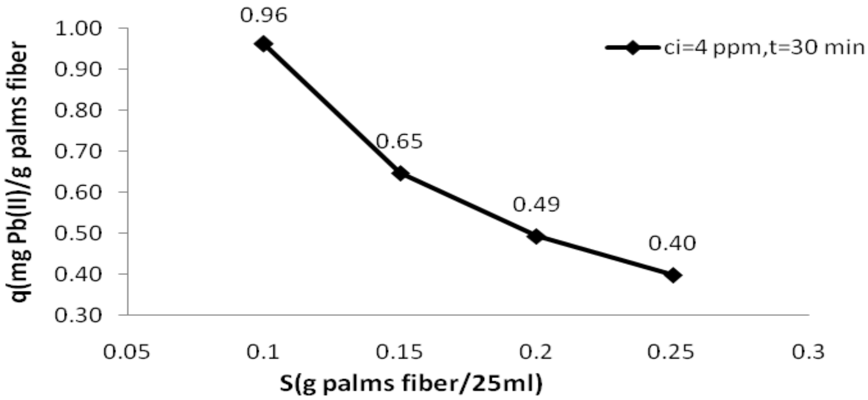

Fig. 4 Effect of palms fiber dosage on Pb(II) uptake

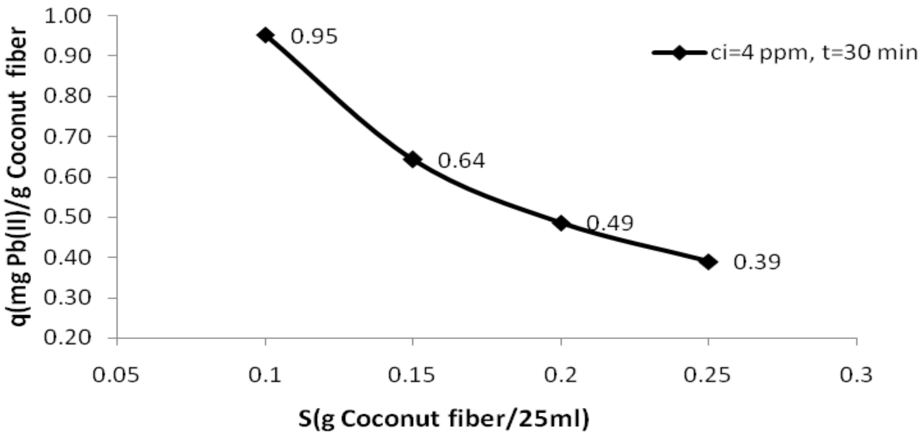

Fig. 5 Effect of Coconut fiber dosage on Pb(II) uptake

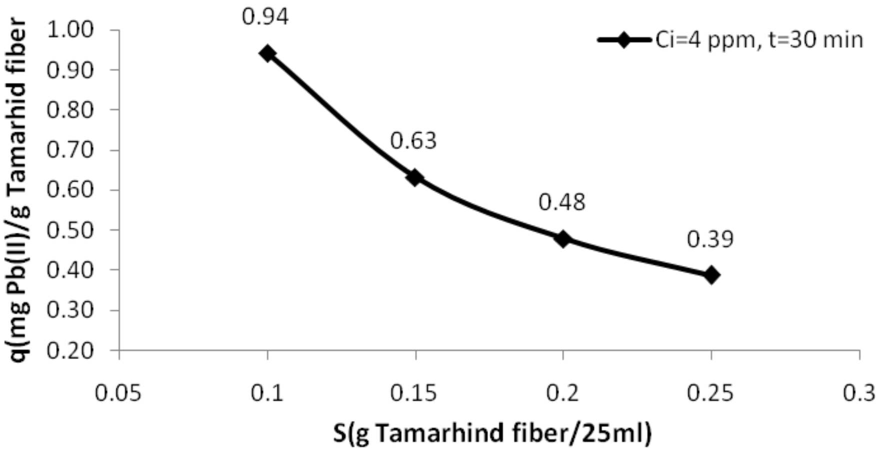

Fig. 6 Effect of Tamarhind fiber dosage on Pb(II) uptake

REFERENCE

1- Benjamin, m.m.; Sletten, R.S.; Bailey, R.P.; Bennett, T. "sorption and filtration of metals using iron –oxide- coated sand", water research, v30 n11 Nov 1996, p2609-2620.
2- Cordero, B., Lodeiro, P., Herrero, R. and de Vicente, M.E.S., "Biosorption of Cadmium by Fucus Spirals", Environ. Chem., Vol. 1, (2004) , pp.180-187.
3- Marshall, Wayne E; Champagne, Elaine T., "Agricultural By Products as Adsorbents for Metal Ions in Laboratory Prepared Solutions and in manufacturing wastewater", Journal of Environmental Science and Health, Part A:Environmental Science and Engineering V30, N2, Feb 1995, P241-261.
4- Quek, S.Y., Wase, D.A.J. and Forster, C.F., "The Use of Sago Waste for the Sorption of Lead and Copper", Journal Water SA, Vol. 24, No.3, (1998), pp. 251-256.
5- Randall, J.M.; Hautala, E.& Waiss, A.C.; "Removal and recycling of heavy metal ion from agricultural by products" ,proc. 4th mineral waste utilization symp., Chicago, IL, USA., 1974.
6- Roberts, E.J.& Rowland, S.P. "Removal of mercury from aqueous solutions by nitrogen containing chemically modified cotton" Environ. Sci. Technol., 7, 1973, 552-5.

امتزاز ايونات الرصاص باستخدام ألياف
(النخيل، جوز الهند، تمر هند)

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الخلاصة

أجريت في هذه الدراسة استخدم ثلاثة أنواع مختلفة من الألياف وهي (ليف النخل، ليف جوز الهند، وليف تمر هند) حيث حصل الاختبار في درجة حرارة الغرفة، وتم إجراء التجارب بطريقة الدفعات وتم دراسة تأثير كمية المادة الممتزة وجميع التجارب أجريت باستخدام (0.1–0.25) غرام من المادة الممتزة (الألياف) في 25 مل من المياه الملوثة بعنصر الرصاص بتركيز (4) جزء بالمليون.
وبينت التجارب ان جميع هذه المواد لها القابلية على الامتزاز ولكن بنسب متفاوتة الياف النخيل كانت نسبة الازالة لها هي (99.5%)، الياف جوز الهند (97.5%)، والياف تمر هند (97%).