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REMOVAL OF LEAD (II) FROM WASTEWATER USING PEAS HUSK WASTE

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Abstract: This research is to study the possibility of using the peas husk, as biosorbent alternative low-cost to treat lead from wastewater because of its widespread and toxic application in the industrial products. Peas husk was obtained from waste plant peas on farms or food. Powdered peas husk was used to absorb lead ions from solutions simulation in batch experiments. The effects of contact time, initial metal concentration, dose and pH on the simultaneous adsorption of lead were studied. Experimental results concluded that better absorption efficiency was obtained within 30 minutes of connection time. Maximum removal of lead on the peas husk was achieved when pH is 4 which is about 96.9 %. Surface morphology was observed peas husk before and after application of adsorption process of solutions of lead under Field Emission Scanning Electron Microscopy (FESEM).

Keywords: *peas husk, biosorbent, lead, removal and batch.*

ازالة الرصاص من مياه الصرف الصحي باستخدام نفايات قشر الباقلاء

الخلاصة: هذا البحث اجري لدراسة إمكانية استخدام قشر الباقلاء كمادة مازة بديلة منخفضة التكلفة لمعالجة الرصاص من مياه الصرف الصحي بسبب انتشاره على نطاق واسع وتطبيقاته السمية في المنتجات الصناعية. تم الحصول على البازلاء النفايات النباتية في المزارع أو الغذاء. مسحوق قشر البازلاء استخدمت لامتزاز ايونات الرصاص من المحلول الصناعي عن طريق تجارب الدفعات. تمت دراسة تأثير كل من وقت الاتصال, التركيز الاولي للمعدن, الجرعة و الحامضية على الامتزاز المتزامن للرصاص. النتائج التجريبية استنتجت ان كفاءة الامتزاز الافضل تم الحصول عليه خلال 30 دقيقة من زمن الاتصال. اقصى ازالة للرصاص ب قشور الباقلاء تم انجازه عند الحامضية 4 كانت 96.6%. تم ملاحظة مورفولوجيا سطح قشر الباقلاء قبل وبعد تطبيق عملية الامتزاز لمحلول الرصاص تحت المجهر الإلكتروني الماسح للانبعاثات الميدانية.

1. Introduction

Heavy metals such as lead can frequently be found in manufacturing wastewater and their release to the environment carriages a serious threat due to their harmfulness to aquatic and global life which contains humans. So environmental engineers and scientist have examined the method by treat heavy metal-bearing wastewater effectively and economically. Enhanced industrialization by the several uses of lead which has produced the discharge of large amounts of the by-product of this material in air soils and surface waters.

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Lead is used as an industrial raw material in industrialized of storage batteries television tube printing paints fuels and explosives. The industrial procedure of these materials produces lead-bearing wastewaters which have to be treated and disposed of before have being relief into the surroundings. One of the chief users of lead is the storage battery industry followed by the petroleum industry in manufacturing gasoline additives.

Lead pollution in wastewater may regularly have many opposing effects on both aquatic and worldly life. Lead is an ubiquitous in the environment and its existence in variable concentrations can be found in opposing positions. The Royal Society of Canada (1986) reported that human exposure to lead has harmful effects on kidney and reproductive systems [1]. Air, food and water mostly do not usually enclose large quantities of lead. Nevertheless extreme pollution of the natural sources by industrial activities can result in endless contaminated stages of exposure and consequently clinical poisoning [2]. Additional health difficult of lead is bioaccumulation or magnification which may raise its concentration to poisonous level [3].

There are various methods for the removal of heavy metals from wastewater such as chemical precipitation ion exchange adsorption electrolytic recovery electro dialysis solvent extraction reverse osmosis membrane separation ultrafiltration ozonation foam floatation vapor recovery gamma irradiation and photochemical methods [3][4]. The application of chemical precipitation to dilute low concentration solution can be hard unless the adding of flocculating agents such lime caustic and sodium carbonate. Though a large sludge is formed and the disposal creates a problem [5]. Ion exchange and activated carbon adsorption are relatively expensive and need recharge of resin or spent activated carbon in addition to the disposal of important volume of used renewal solution. Additional procedures mentioned require elaborated and considerably great operation prices.

Adsorption method is a important process in the physicochemical treatment of municipal wastewater' a treatment which can be economically meet today’s higher effluent typical and water reuse necessities. Activated carbon is the most active adsorbent for this application. The adsorption process is improved by in- situ limited renewal affected by biological growth on the surface of the carbon. Benefits over biological treatment systems which contain the inferior and area requirements lower sensitivity to daily flow and concentration differences and contaminated resources potential for important heavy metal removal larger flexibility in design and operation and greater removal of organic wastes [6].

Activated peas husk used as adsorbent is a porous carbonaceous material equipped by carbonizing and activating the organic substances of chiefly biological source. Also it is a potential alternative to be used as low cost adsorbent for the adsorption of heavy metal from aqueous solution since its abundant in nature inexpensive require little processing and is effective material. This waste material has little or no economic value and frequently present a disposal problem. The aim of this study are to determine the percentage adsorption of lead ions from an aqueous solution using low-cost adsorbents namely peas husk based on the limitation of contact time, pH, initial metal concentration, and dose.

2. Materials and Methods

2.1. Chemical and Adsorbent

The chemicals used in experiments such as hydrochloric acid, sodium hydroxide, nitric acid, sulfuric acid and lead nitrate were analytical grade and deionizer water was used to prepare the solution. In this search, an agricultural by-product waste pea's husk has been used as low cost sorbents to remove lead from aqueous solutions. This waste was collected in spring from plant peas on farms or food, in the form of large flakes, cut and dried Sun/air at room temperature. The absorbent result was used after series treatment by mixing of 10 grams of sorbents with 2 liters of distilled water in a beaker strongly agitated at a speed of 400 rpm by magnetic stirrer at room temperature of 25 ± 1 ° C within 4 hours, and then filtered, washed down with distilled water until the ongoing pH to remove surface particles adhere and water soluble substances, then oven-dried at 80 ° c for 24 hours after the nomination. Finally, it was crushed and sifted for particles of size 0, 80 - 1, 60 mm with predominant size 0.50-0.80 mm for further testing batch adsorption.

2.2 Preparation of Synthetic Wastewater

For the preparation of synthetic wastewater, 1.6 g of $Pb(NO3)2$ was dissolved in 1000 ml distilled water to prepare 1000 mg/L lead stock solution. The Preferred lead concentration was prepared from the stock solution by making fresh dilution for the sorption experiment.

2.3 Experimental Procedure

2.3.1 Effect of Initial Metal Concentration

For adsorption experiment, the effect of initial metal concentration was obtained by resolving various $Pb(NO3)2$ metal ion concentration ranging from (10, 20, 40, 60, 80, to 100) ppm in different containers. Then, add 1 g of peas husk in each container leaving them for 1 hour with mechanical stirring running at 400 rpm. The solution is filtered using a suction pump and analysis by atomic adsorption spectrum (AAS) to measure the ability of lead to adsorption.

2.3.2 Effect of pH

For the effect of pH, 25 ppm from 1000 mg/l lead stock solution was taken in 100 ml volumetric flask to mark with distilled water and prepare the lead concentration of 25 mg/l. The varying pH of the aqueous solution from 2-8 was adjusted by using 0.01 M hydrochloric acid (HCl) and 0.01 M sodium hydroxide (NaOH). Then, peas husk samples were added into the solution of lead. Using the electrical grinder the mixture was stirred at 300 rpm for 1 hour and by the suction filtration adsorbent solution was separated then analyzed by using AAS.

2.3.3 Effect of Dosage of Adsorbent

The effect of dosage of adsorbent was obtained by taking 25 ppm of lead concentration and placed in 5 containers. Peas husk ranging from 1.0, 2.0, 3.0, 4.0 and 5.0 grams were added to each container of lead solution. Expose the mixture to hot plate stirred at 300 rpm for 1 hour. Then the filtrate was analyzed by using AAS.

2.3.4 Effect of Contact Time

Finally, for the effect of contact time, 25 ppm concentration of lead was taken, added with 1 g of peas husk. The solution was stirred at 300 rpm in different period ranging between 30, 60, 90, 120, 150, 180, 210, 240, 270 and 300 minutes. The filtered mixture by suction filtration was analyzed by using AAS.

3. Result and Discussion

3.1. Effect of Initial Metal Concentration

From fig. 1 it noticed that the adsorption of lead ions by the adsorbent peas husk augmented with increasing of lead ions concentrations from (20 to 100) ppm. It shows the removal efficiency of lead ions about (90.8 to 98.3) % from (20 to 100) ppm correspondingly. The hasty increase in the uptake of lead ions can be attributed to the connections between the metals ions and the energetic situates of the adsorbent. This is because the higher the concentration of lead ions means the higher the quantity of lead ions existing in the solution. Therefore, the more adsorption of the metal ions happens on the adsorption situate of the adsorbent. Then, at higher metal ions concentration / adsorbent ratio, metal ions adsorption includes higher energy situates. By way of the metal ions / ad bnsorbent ratio increase resulting in the decreasing adsorption efficiency [7].

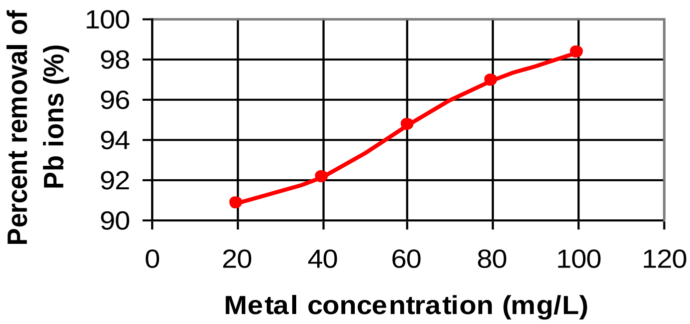

Figure 1: Effect of metal concentrations on the removal of lead by pea's husk.

3.2. Effect of pH

Peas husk can produce a good aggregate of negative charge ion. One of the most important factors in the study of the adsorption of metal ion on solids is the pH of the solution. The condition of metal ions in solution effectively depends on the pH. The acidity and alkanity of the numerous solutions can affect the conformation and the properties of the adsorbent surface. Hence, in order to decide the optimum pH for metal adsorption, the adsorption was studied at numerous pH. The adsorption was done by using an adsorbent of peas husk in order to see the performance of adsorption of lead ions. As shown in fig. 2, graph had maximum adsorption at pH 4 in which shows the removal efficiency of Pb(II) ions about 97.7%. This may be due to the holes on adsorbent of peas husk so more Pb(II) ions have been confined into the pore of the adsorbent thus increase the adsorption ability of the Pb(II) ions. At pH 2, the adsorption of Pb(II) ions is low and increase at pH 3 until achieved maximum adsorption at pH 4 and then decreasing until pH 8. This is because at pH < 3; higher concentration of H + ions contest with Pb(II) ions for the surface of adsorbent which would delay Pb(II) ions from getting the bonding situates of the sorbet caused by the repulsive forces. At pH > 6; the Pb(II) ions get precipitated due to hydroxide anions creating lead hydroxide precipitate. The hydroxylated formula of metal can also participate with the metals ions at the actives situates of the adsorbent so decreasing the adsorption [7].

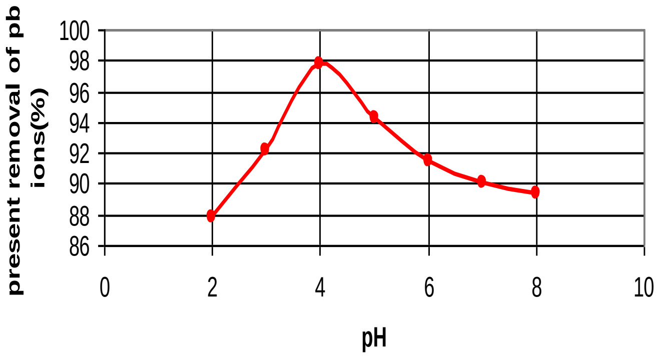

Figure 2: Effect of pH on the removal of lead by pea's husk

3.3. Effect of Adsorbent Dosage

As shown in fig. 3, the adsorption of Pb(II) ions is detected increase as the quantity of adsorbent is increased steadily from 1g to 4g and constant from 4g to 5g. The maximum adsorption is achieved at the adsorbent dose 4g with 96.9% removal efficiency of Pb(II) ions where an additional increase in the amount of the adsorbent had no more influence to the adsorption ratio. So, the study specified that 4g of the adsorbent is enough to adsorb the maximum Pb(II) ions.

For the 1g to 4g of adsorbent, the adsorption is intensification due to the obtainability of more adsorbing situates at high dosages. It has been proposed that electrostatic connections between the adsorbent can be an important factor in a correlation between adsorbent and metal sorption. It noticed that at a known metal concentration; the higher adsorbent dosage in suspension means the higher will be the metal ration ant the metal reserved by sorbent element unless the adsorbent touches unsaturation [8].

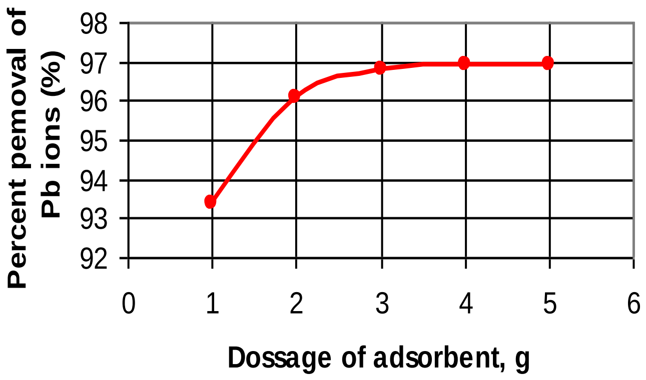

Figure 3: Effect of dosage of adsorbent on the removal of lead by pea's husk.

3.4. Effect of Contact Time

Finlly, fig. 4. shows the effect of contact time on the uptake of Pb(II) ions by the peas husk as the adsorbent. This was done by changing the contact time from (30 to 300) minutes. The adsorption of lead ions becomes constant when it reaches equilibrium. At specific time the adsorption was increase and becomes constant when reach equilibrium.

The adsorption of Pb(II) into peas husk as the adsorbent happened in two steps: an initial rapid uptake due to surface adsorption onto peas husk and almost constant uptake due to transmission of Pb(II) ions onto the surface of adsorbent have reach equilibrium.

The rapid uptake from (30 to 60) minutes is about (90.1 to 93.7) % removal of Pb(II) ions. It was shows some specifications of the interface between metal ion and the situate of organic matter answerable of ions uptake.

The fast initial uptake was due to the buildup of metal ions on surface of adsorbent which is a rapid step, this is also may be attributed to the highly permeable structure of adsorbent and the particles size which offer large surface area for the sorption of metals on the binding situates. More time was expended on transmission of ion to binding situates [9].

The adsorption process also can be considered quicker because of the largest quantity of Pb(II) ions attached to the adsorbent within 30 minutes.

The adsorption almost constant from (60 to 90) minutes with 93.7% and 93.9% removal efficiency of lead ions. Then the adsorption increase back from (90 to 210) minutes with 97.4% to 97.4% removal efficiency of Pb(II) ions and it was almost constant from (210 to 300) minutes with highest 97.4% removal efficiency of lead ions. In this last time, it was indicated the adequate to reached equilibrium and the adsorption did not variation with additional increase in contact time.

The constant phase perhaps due to the less plentiful availability of active situates therefore, the sorption becomes fewer efficient in the constant stage [10].

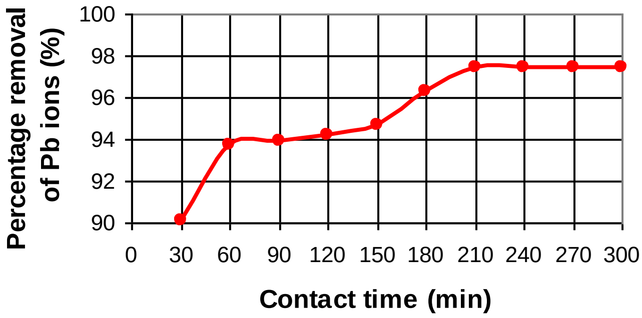

Figure 4: Effect of contact time on the removal of lead by pea's husk.

3.5. Morphology of Peas Husk

A comparison of the morphology of peas husk powder before and after adsorption is shown in Fig. 5, The peas husk reveal that the surface was extremely porous in nature and this will increased the surface area for metal adsorption. The peas husk structure expose irregular netlike configuration which implies the materialization of complete three dimensional porous inner structures consisting rough surface area.

Most of the holes show a round or elliptic form and opening diameters about 10 µm. The micrograph of peas husk surface before adsorb lead ions is different from the surface of peas husk after adsorb lead ions. Also it can noticed that, there are small particles was adhering on the surface was seen on the structure of peas husk after adsorption of lead ions.

Based on the surface morphology result of peas husk it is suggested that the peas husk can be used as low cost adsorbent for liquid/ solid adsorption process due to the important of mesopores to numerous liquid adsorption process [11].

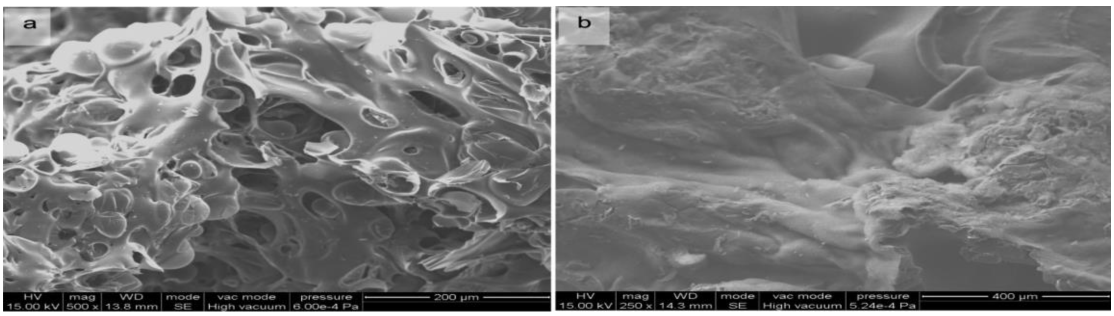

Figure (5): FESEM micrographs of peas husk (a) before adsorption (b) after adsorption process.

4. Conclusions

Peas husk can be used as a biological resource with the possibility to immerse to absorb lead in aqueous solution. Efficiently peas husk to remove metal ions depend on absorption batch of connection time, and concentration of minerals, heavy dose and Ph. Quicker adsorption in 30 minutes and almost constant after (150-300) minutes.

At a certain time, adsorption becomes constant due to the limited availability of intensive heavy metal trap because no more sites available.

Lead removal efficiency obtained at pH 4 with efficiency removal of lead ions of 96.9%. Moreover, the peas husk can cause environmental problem but could turn out to be good and cheap sources of readily available for adsorbent.

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