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Study of the Efficiency of Extracted Silica from Rice Husk Ash in Reducing the Concentration of Some Heavy Metal in Industrerial Wastewater

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Abstract

The aim of current study is estimate the ability of low cost adsorbents, which consist of extracted silica from rice husk ash in treatment of Industrial waste water that contains heavy metals (Cd, Co and Pb) with other pollutants by fixed filters technique with determine the best method for that, and study the effect of a number of variables and parameters. This study involved one waste water samples were collected from. State battery manufacturing company (SBMC) (before treatment unit) at 5th and 22th, of the January 2015. Adsorption tests showed that all tested adsorbent materials had a significant heavy metal removal efficiency. pH values showed a significant impact on adsorption process, but best removal efficiency occurred at pH 4.5 and 6 with removal efficiency for Cd 91% at pH 6, 90.8% at pH 4.5 respectively .Furthermore, the best pH for pb removal was ranged from 4 to 6, 77.75% to 71% and finally the pH of Co ranged from 4.5 to 6, 64.4% according to adsorbent materials and type of heavy metals in this study. Regarding contact time, adsorbent silica gel showed high adsorption efficiency at a variable time from 6 min to 93 min. for Cd, Co and pb. chemical and physical measurement were done for samples of industrial waste water before treatment and also after treating by adsorbents such as Cd, Co, Pb, pH, TDS, S, COD and EC. Moreover, the current work has examined the impact of various environmental variables such as pH values and contact time.

Keywords: extracted silica, heavy metal, waste water.

دراسة كفاءة مادة السيليكا المستخلصة من فحم قشور الرز في خفض عدد من العناصر الثقيلة من مياه الفضلة الصناعية

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الخلاصة

هدف الدراسة ألحالية هو تقدير كفاءة ألممتزات منخفضة ألتكلفة وألمكونة من السيليكا المستخلصة من قشور الرز في معالجة مياه الفضلة الصناعية الحاوية على ألمعادن ألثقيلة (ألكادميوم والكوبلت والرصاص) مع ملوثات أخرى بواسطة تقنية ألمرشحات ألثابتة مع تحديد ألطريقة ألافضل لذلك، وكذلك دراسة تأثير عدد من ألعوامل ألمتغيرة. شملت هذه ألدراسة ثلاث عينات من مياه الفضلة الصناعية جمعت من معمل البطاريات (قبل وحدة المعالجة) في الشركة العامة لصناعة البطاريات في الوزيرية في شهر كانون الثاني من عام 2015. أظهرت أختبارات ألامتزاز لكل المواد الممتزة كفاءة ازالة معنوية للمعادن الثقيلة. وأظهرت قيم الرقم الهيدروجيني تأثير واضح على عملية الامتزاز، ولكن حصلت أفضل كفاءة ازالة عند الرقم الهيدروجيني 4.5-

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6 بلنسبة للكادميوم وبكفاءة ازالة تتراوح بين 91% الى 90.8 % وللرصاص كانت نسبة الازالة عند رقم هيدروجيني 4−6 تتراوح بين 77.75 الى 77.7 واخيرا عند الكوبلت نسبة الازالة عند رقم هيدروجيني 4.5−6 كانت بمعدل 64.4. وفيما يتعلق بزمن التلامس فقد اظهرت السيليكا جل كفاءة بوقت يتراوح من 6− 93 دقيقة للكادميوم والكوبلت والرصاص وقد أجريت كل القياسات الكيميائية والفيزيائية لعينات مياه الفضلة الصناعية قبل المعالجة في وحدة المعالجة الموقعية في الشركة، وأيضا بعد ألمعالجة بواسطة الممتزات (السيليكا جل) مثل ألكادميوم والكوبلت والرصاص والمواد ألصلبة الذائبة الكلية والمواد الصلبة ألعالقة الكلية وألعسرة ألكلية وألمتطلب ألكيميائي للاوكسجين و التوصيلية الكهربائية. علاوة على ذلك ، بينت الدراسة الحالية أثر المتغيرات البيئية المختلفة مثل قيم الأس الهيدروجيني وزمن التلامس، ومتغيرات.

Introduction

A major environmental concern due to the dispersal of industrial, commercial, agricultural and municipal wastes generated by human activities causing water contamination. Controlled and uncontrolled disposal of waste, accidental and process spilling, mining, manufacturing and smelting of metallic-ferrous ores, sewage sludge application to agricultural soils or water surface are responsible for the mobilization of contaminants into non-contaminated sites in the form of dust, leachate or outpouring and contribute towards contamination of our ecosystem. However the source of water pollution was classified into two main categories which are natural and artificial sources. The artificial sources may be the most effective and common sources which includes various industrial activities, such as; mining, sewage treatment plants, transporting, agricultural applications and others relating to the civilization and development [1]. Natural organic Matter found in all the surface water, such as aromatic and large aliphatic compounds. These materials differ due to weather changes, water system and a number of other environmental factors [2] and mining activities have been accompanied by various problems of industrial wastes which may be toxic, ignitable, corrosive or reactive. If improperly managed, this waste may pose dangerous health and environmental consequences. The industrial wastes are divided into hazardous and non-hazardous wastes. Hazardous wastes may result from certain manufacturing or other industrial processes. Certain as commercial products such cleaning liquids, paints or pesticides discarded by commercial establishments [3]. Industries that constitute a threat, particularly on health and environment, are those that use heavy metals such as; electrical batteries, manufacturing electrical, electronic appliances and where these industries emit large quantities of various pollutants, such as toxic pollutants, Recently it seems clearly that biotechnology may be an effective alternative technique for the removal and recovery of metals from contaminated water[4]. Plant waste materials which are available in large quantities from many operations and almost costless, may be successful alternative biosorbent material to be used as effective adsorbents, such as fruit peels, tree bark, peanut skin. have been used to reduce different heavy metals ions from contaminated water [5]. Rice husk ash may have significant biosorption capacity for bioremoval heavy metal ions from industrial wastewater. Effect of some heavy metals**.** Exposure to lead at levels more than 0.015 mg/L in drinking water can lead to serious health problems such as growth delays and attention deficits in children, and kidney problems and high blood pressure in adults. Additionally, prolonged exposure can cause brain, nervous system, and hearing damage along with headaches in children, as well as memory problems, pregnancy complications, reproductive problems, and muscle and joint pain in adults [6].However Cobalt is essential trace metals in the human diet. They are also major components of the alloys employed in the plate and screw used for connecting bones in orthopedic surgery and in the manufacture of artificial organs [7]. The effects of acute cobalt poisoning in humans are very serious; among them are asthma-like allergy, damage to the heart, causing heart failure, allergy, damage to the heart, causing heart failure, damage to the thyroid and liver. Cobalt may also cause mutations (genetic changes) in living cells [8].Finally Cadmium is a metal, It is an environmental contaminant that has been recognized as a risk factor in humans and animals mentioned human beings are exposed to cadmium and cadmium compounds through occupational and environmental settings primarily via diet, drinking water and air, by slowly accumulating in the body [9] Cadmium toxicity may be due to changes in enzyme activity, changes in proteins with sulfhydryl groups (thioneins), induction of oxidative stress and apoptosis, changes in the structure and/or function of cell membranes, changes in DNA structure and altered gene expression [10] So, this study was designed to examine the use of silica that product from rice husk

ash in the bioremoval of cadmium, lead and Cobalt ions from industrial wastewater and to answer the following objectives:

1. Examining biosorption capacities of Cd, Co and Pb ions from industrial wastewater by silica.
2. Design a laboratory treatment unit using silica to work as successful bioremoval of heavy metal ions in industrial wastewater.
3. Assessing the impacts of several environmental factors such as; pH, contact time, initial metal concentration by silica.

Materials and Methods

Silica extraction by alkaline method:

1500(g) of rice husk ash were added to the basify water (5 liter) concentrations of sodium hydroxide solution .most solutions were 2.0 M The mixture was then heated by heater stirrer at 100 C for 1 hrs . The solution was filtered through filter paper (41 µm) and the carbon residue was washed with 100 ml of de-ionized water. The filtrate and washing were allowed to cool to room temperature. Concentrated sulfuric acid was added to the obtained solution until pH 7.0 and incubated for 48 hours to promote silica gel formation. The silica gel produced was separated from soluble salt solution by vacuum filtration and washed with de-ionized water. Then silica gel was dried at 150oC for 48 hours and ground into powder. The obtained silica gel was white rough powder [11].

Silica extraction by acidic method:

1500(g) of RHA sample was added to5L of basified distilled water and the pH was then adjusted to 3 using 6 and 1 N HCl. These dispersions were stirred for 2 hours and filtered through Whitman No. 41 ash less filter paper and then the RHA residues were washed with 500 ml of distilled water. The residues were used for silica extraction. The filtrate and washings at each pH were collected and dried in an evaporating dish [12].

Results and Discussion

Basic extraction (alkaline method)

Silica production by basic extraction method higher amount than acidic method that was 87% Table- 1. This comparison of ratio depended on silica yields from rice husk. There for, adopted basic extraction method for the production of silica in order to conduct the rest of other experiments. Other studies consistently reported that rice husk contains high silica content (87-97%), (87.7%), respectively [12, 13].

Table 1-Production ratio of silica gel from rice husk according to the extraction method

Type of method	Weight of rice husk (gm)	Weight of ash (gm)	Ash husk Ratio (%)	Weight of silica (gm)	Product ratio (silica %) of husk	Product ratio (silica %) of ash
Acidic extraction	2000	1500	75%	350	17.5	50%
Alkaline extraction (Basic)	2000	1500	75%	610	30.5	87%

Data analysis of Box- Wilson design and removal efficiency according factor affecting adsorption process

Silica showed higher efficiency for the removal of Pb ,Cd and Co ions from industrial waste water at different conditions(pH value and contact time) The highest removal efficiency (RE) was 77.75% of Pb observed at 40ppm after (6 min) of treatment while (RE) of Cd was 91%observed at 10 ppm also after (6 min) and the (RE) of Co was 64.4% observed at 5 ppm after (6 min) .the lowest RE was 54.25% of Pb at (30 min) of treatment while Cd was 87.5% at (93 min) and Co was 47.4% at (93min) observed at 40ppm, 10 ppm and 5 ppm after treatment respectivly. Heavy metal residuals (after treatment) ranged from 0.9 to 18.3 ppm Table-2. Also shown a different removal efficiency (E.R) of heavy metal (Cd, Pb, and Co), removal efficiency ranged from 77.75 to 91% Table -3.

Table 2- Ability of adsorption for Heavy metals (Cd, Pb and Co) at different pH value and contact time

Parameters			Heavy Metal Concentration after Treatment (Residual)		
No.	pH Values	Contact Time(min)	Cd (10ppm)	Pb (40ppm)	Co (5ppm)
1	4.5	30	0.92	18.3	1.78
2	4.5	155	1.1	9.5	1.42
3	7.5	155	1.1	8.9	2.14
4	7.5	30	1	8.9	2.14
5	4	93	1.25	11.62	2.63
6	8	93	0.9	8.9	2.1
7	6	6	0.9	6.97	1.78
8	6	180	1.06	15.11	2.1
9	6	93	1	15.11	1.57
10	6	93	1	15.11	1.57
11	6	93	1	15.11	1.57
12	6	93	1	15.11	1.57
13	6	93	1	15.11	1.57

Table 3-Removal efficiency (E.R) of Heavy metals (Co, Pb, and Cd) at different pH value and contact time

Parameters			Removal Efficiency of Heavy Metal (%)			
No.	pH Values	Contact Time(min)	Cd (10ppm)	Pb (40ppm)	Co (5ppm)	Mean
1	4.5	30	90.8	54.25	64.4	**69.81**
2	4.5	155	89	76.25	71.6	**78.95**
3	7.5	155	89	77.75	57.2	**74.65**
4	7.5	30	90	77.75	57.2	**74.98**
5	4	93	87.5	71	47.4	**68.63**
6	8	93	91	77.75	58	**75.58**
7	6	6	91	82.57	64.4	**79.32**
8	6	180	89.4	62.22	58	**69.87**
9	6	93	90	62.22	68.6	**73.60**
*	**Means of Metal Concentrations**		**89.74**	**71.30**	**60.75**	

Chemical and physical measurements of samples after treatment by adsorbents

According to the data resulted from applying Box – Wilson design in adsorption experimental studies, the best empirical conditions were selected to conduct optimal conditions, for industrial waste water samples treatment at pH 6 and contact time 6 min. The results of chemical and physical analyses were found to vary among the adsorbents, Table-4.

Table 4- Chemical and physical measurements of industrial waste water after treatment by silica adsorbents at pH: 6, contact time: 6 min.

Parameter	Physical and chemical properties	
	Before treatment	After treatment
PH	9.3	**6**
Turbidity	250	**200**
E.C.	81000	**73000**
T.D.S	41000	**37000**
C.O.D	20	**18**
Temp.	12	**25**

These data showed that the silica adsorbent showed they have ability to reduce efficiency for chemical and physical parameters tested. It is obviously that the silica in present study showed high efficiency for waste water treatment. Also, the results obtained from current study are in agreement with a study carried out by [14].For the purpose of removing COD,TSS,TDS and conductivity of the industrial waste water and increasing efficiency of its adsorption reported the rice husk ash modified have high efficiency for COD, , TDS and conductivity removal with values 87, 58 and 89% respectively. When silica are used as an adsorbent, they have ability efficiency for COD, ,E C, , TDS, and conductivity reduced, while the results of COD, , TDS, and conductivity can increase of the same time in waste water when soluble organic compounds are released from plants to water,[15].

Conclusions

From the results of present study it is possible to conclude all Chemical and physical measurements of industrial waste water showed higher values of pH, TDS, TSS, E.C and COD and satisfactory decreases in heavy metals concentration after treatment by the silica gel, examined adsorbent materials (silica gel) have an ability in removal of Cadmium, Lead and Cobalt from industrial waste water. Removal efficiency of these examined adsorbent materials was affected by various environmental factors such as pH and contact time.

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