INVESTIGATION OF THE WASTEWATER TREATMENT CAPACITY AFTER THE MINERAL EXPLOITATION BY USING AGRICULTURAL WASTES (SUGAR-CANE BAGASSE, PEANUT SHELLS AND COCONUT FIBERS)

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ABSTRACT

This research used agricultural wastes (sugar-cane bagasse, peanut shells and coconut fibers) as a low cost materials in order to remove the heavy metal in the wastewater after the mineral exploitation and in laboratory water which was mixed with a fix concentration of heavy metals (500 mg/l and 1000 mg/l). The results showed that sugar-cane bagasse, peanut shells and coconut fibers have a very well heavy metals adsorption capacity. When the amounts of the adsorption materials increase, the adsorption capacity of Cu,Pb also increase immediately. For example, with sugar-cane bagasse, the ability to absorb heavy metals is highest when sugar-cane bagasse entered is 900g, sugar-cane bagasse can absorb about 71.452% (Treatment 3 Pb F3Pb with the amount of sugar-cane bagasse is 900g), it increases about 1.66 times compared with the amount of Pb that it absorbed in treatment 1 Pb (F1Pb with the amount of sugar-cane bagasse is 300g). Similarly, the highest amount of peanut shells and coconut fibers to absorb the heavy metals is 900g and declining due to reducing the amount of peanut shells and coconut fibers.The heavy metals adsorption productivity achieved 30%-80% by comparing with the initial concentration. It is concluded that agricultural wastes can remove heavy metals (Pb, Cu) in the wastewater, coconut fibers showed the best heavy metals absorption capacity followed by sugar-cane bagasse and peanut shells.

Keywords: *sugar-cane bagasse, peanut shells, coconut fibers, water pollution, heavy metals*

INTRODUCTION

Nowadays, the problems of Heavy metals (HM) pollution is attracting more attention due to its directly affect to human health and all the organisms in the aquatic environment. Beside with the ongoing development of the mining industry, the size and the intensity of heavy metal pollution is also increasing. The waste water from the mining exploitation and processing of minerals have the large quantities and it often contains a lot of heavy metal ions such as Cu (II), Zn (II), Pb (II), etc. But before going out to the environment, most of them have not been treated or only preliminary treated. Therefore, the study and finding the methods to treat the heavy metal in water environment and contributing to environmental improvement is urgently needed. Recently, lignocellulose materials such as sugar-cane bagasse, peanut shells and coconut fibers... were studied and it showed that these materials have the heavy metals adsorption capacity (especially valence II) in wastewater is very high. This new method are mentioned as an advanced technology that used to handle wastewater with heavy metals. In our country, this is a new treatment method and it has not been much interested.

Sugar-cane bagasse, peanut shells and coconut fibers are popular materials in Vietnam and it has a large annual output. The advantages of this method are going from inexpensive raw materials, availability, simple process, the cost of handling is low, simultaneous separation many type of metal in the solution, recovery of metals and no added the toxic agents to environment.

MATERIALS AND METHODS

Materials: *Chemicals and agricultural wastes*

The main objects of this study are sugar-cane bagasse, peanut shells and coconut fibers which are the most available and abundant raw materials of our agriculture, which is used to study the absorption of heavy metal such as copper (Cu) and lead (Pb) in waste water.

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Chemicals: The solution of Cu^{2+} 1000 mg/l, The solution of Pb^{2+} 1000 mg/l, The solution of Cu^{2+} 500 mg/l, The solution of Pb^{2+} 500 mg/l

Methods

Collecting water samples, waste-product samples

Research materials: the waste-product such as sugar-cane bagasse, peanut shells and coconut fibers are purchased at markets.

Sampling of contaminated water surrounding areas of zinc-lead mining and processing factory in Tan Long, Dong Hy district, Thai Nguyen province.

Method of collecting and processing water samples: collected samples based on the specific of time as shown in the table below and contained in 500ml bottles then stored under optimum temperature.

Table 1. *The time for taking the water samples*

Time	Sugar-cane bagasse	Peanut Shells	Coconuts fibers
1	7 days	7 days	7 days
2	14 days	14 days	14 days

Experiments

The experiment was conducted in the laboratory. Each sample of water placed in a styrofoam box (10-L volume is appropriate). It's included 15 experiments along with 3 different formulas and each formula repeated 3 times, then the total number of Styrofoam box needed are 135 boxes (15 experiments x 3 formulas x 3 times = 135 experiments). For these experiments were conducted in the laboratory, the metal concentrations tested was 500mg/l and 1000mg/l.

All agricultural wastes (sugar-cane bagasse, peanut shells and coconut fibers) were pretreated by soaking in distilled water from 3 to 4 hours. Then, washing agricultural wastes become more cleaner and drying for 24 hours.

Setting time for collecting water after the experiment finished: the time of each experiment depend on the structural and the decomposition levels of materials.

Heavy metal concentration of 500 mg/l was conducted in laboratory from experiment 1 to 6 respectively as follows:

Experiment 1

Pour $Pb(NO_3)_2$with the concentration of 500 mg/l into 10 L of water and contained in 3 Styrofoam boxes. Then put the specific amount of sugar-cane bagasseinto 3 Styrofoam boxes corresponding with 3 formulas and each formula is arranged with 3 replicates. For formula 1 put 300g of sugar-cane bagasse, formula 2 put 600g of sugar-cane bagasseand formula 3 put 600g of sugar-cane bagasse.

Experiment 2

It is similar with experiment 1, instead of pouring $Pb(NO_3)_2$ I have put $Cu(NO_3)_2$with the same concentration

Experiment 3

Pour $Pb(NO_3)_2$ with the concentration of 500 mg/l into 10 L of water and contained in 3 Styrofoam boxes. Then put the specific amount of peanut shells into 3 Styrofoam boxes corresponding with 3 formulas and each formula is arranged with 3 replicates. For formula 1 put 300g of peanut shells, formula 2 put 600g of peanut shells and formula 3 put 900g of peanut shells.

Experiment 4

It is similar with experiment 3, instead of pouring $Pb(NO_3)_2$ I have put $Cu(NO_3)_2$ with the same concentration

Experiment 5

Pour $Pb(NO_3)_2$ with the concentration of 500 mg/l into 10 L of water and contained in 3 Styrofoam boxes. Then put the specific amount of coconut fibers into 3 styrofoam boxes corresponding with 3 formulas and each formula is arranged with 3 replicates. For formula 1 put 300g of coconut fibers, formula 2 put 600g of coconut fibers and formula 3 put 900g of coconut fibers.

Experiment 6

It is similar with experiment 5, instead of pouring $Pb(NO_3)_2$ I have put $Cu(NO_3)_2$ with the same concentration

Heavy metal concentration of 1000 mg/l was conducted in laboratory from experiment 7 to 12 respectively as follows:

Experiment 7

Pour $Pb(NO_3)_2$with the concentration of 1000 mg/l into 10 L of water and contained in 3 styrofoam boxes. Then put the specific amount of sugar-cane bagasseinto 3 styrofoam boxes corresponding with 3 formulas and each formula is arranged with 3 replicates. For formula 1 put 300g of sugar-cane bagasse, formula 2 put 600g of sugar-cane bagasseand formula 3 put 900g of sugar-cane bagasse.

Experiment 8

It is similar with experiment 7, instead of pouring $Pb(NO_3)_2$ I have put $Cu(NO_3)_2$with the same concentration

Experiment 9

Pour $Pb(NO_3)_2$ with the concentration of 1000 mg/l into 10 L of water and contained in 3 styrofoam boxes. Then put the specific amount of peanut shells into 3 styrofoam boxes corresponding with 3 formulas and each formula is arranged with 3 replicates. For formula 1 put 300g of peanut shells, formula 2 put 600g of peanut shells and formula 3 put 900g of peanut shells.

Experiment 10

It is similar with experiment 9, instead of pouring $Pb(NO_3)_2$ I have put $Cu(NO_3)_2$with the same concentration

Experiment 11

Pour $Pb(NO_3)_2$ with the concentration of 1000 mg/l into 10 L of water and contained in 3 styrofoam boxes. Then put the specific amount of coconut fibers into 3 styrofoam boxes corresponding with 3 formulas and each formula is arranged with 3 replicates. For formula 1 put 300g of coconut fibers, formula 2 put 600g of coconut fibers and formula 3 put 900g of coconut fibers.

Experiment 12

It is similar with experiment 11, instead of pouring $Pb(NO_3)_2$ I have put $Cu(NO_3)_2$ with the same concentration

The concentration of Pb is 55.654 mg/l in waste-water from mining has been determined then conducted 2 experiments named experiments from 13 to 15:

Experiment 13

Put directly the specific amount of sugar-cane bagasseinto 3 styrofoam boxes contained waste-water from mining corresponding with 3 formulas and each formula is arranged with 3 replicates. For formula 1 put 300g of sugar-cane bagasse, formula 2 put 600g of sugar-cane bagasseand formula 3 put 900g of sugar-cane bagasse.

Experiment 14

Put directly the specific amount of peanut shells into 3 styrofoam boxes contained waste-water from mining corresponding with 3 formulas and each formula is arranged with 3 replicates. For formula 1 put 300g of peanut shells, formula 2 put 600g of peanut shells and formula 3 put 900g of peanut shells.

Experiment 15

Put directly the specific amount of coconut fibers into 3 styrofoam boxes contained waste-water from mining corresponding with 3 formulas and each formula is arranged with 3 replicates. For formula 1 put 300g of coconut fibers, formula 2 put 600g of coconut fibers and formula 3 put 900g of coconut fibers.

Analytical method in laboratory

Analysis targets in water

The concentration of Pb and Cu in waste-water from mining is determined by ASS M6 - Thermo.

In fact, there are many methods to determine the concentration of heavy metals such as volumetric analysis, method of atomic absorption spectrometry,... In this project we used the method of atomic absorption spectrometry (AAS) to determine the concentration of heavy metals (Cu^{2+}, Pb^{2+}).

AAS method is used to determine the amount of heavy metals in the inorganic and organic compounds with various objects. The nonmetal virtually undetected because their spectral lines is outside the spectral region of the machine conventional atomic absorption.

Data analyst

Data are aggregated, analyzed and processed by Microsoft Excel.

Adsorption Productivity

Absorption productivity is the ratio between the concentration of the solution is absorbed and the concentration of the initial solution.

$$H\% = \frac{C_o - C_{cb}}{C_o} . 100\%$$

H%: Adsorption Productivity (%)

C_o: the concentration of the heavy metal absorbed at the initial time (mg/l)

C_{cb}: the concentration of the heavy metal absorbed at the equilibrium time (mg/l)

Target tracking

The capacity of sugar-cane bagasse, peanut shells and coconut fibers for absorb heavy metal such as Cu, Pb in waste-water samples contaminated heavy metals before and after conducting experiments.

RESULT AND DISCUSSION

Assessment the ability to absorb heavy metals in the water which is mixed with a certain concentration of heavy metals (500 mg/l and 1000 mg/l) of sugar-cane bagasse, peanut shells and coconut fibers

The result of HM concentration in water after absorbed by sugar-cane bagasse, peanut shells and coconut fibers with HM concentration filled up corresponding, there will present respectively in Table 1 and Table 2.

The data in table 1 and table 2 show us that, the concentration of Cu^{2+}, Pb^{2+} in water tends to sharply decrease after used of absorbent materials (sugar-cane bagasse, peanut shells and coconut fibers). Especially, the HM adsorption capacity in the second time have the high AP than that in the first time in both of 2 HM concentration but it is not significantly. For example, the AP of Sugar-cane bagasse in F1 Cu in the first time is 43.012 % whereas in the second time, it is 55.734 %. It is similar with that in Peanut shells and coconut fibers. Therefore, sugar-cane bagasse and peanut shells, coconut fibers are suitable materials to improve water resources contaminated by HM. When fill up more absorbent materials, the ability to absorb HM in the water will be high. In addition, we can see that with the same amount of agricultural by-products filled up, with the same time and the same concentration of HM in the water, coconut fibers have the HM adsorption capacity is higher than peanut shells. For example, with content of HM in water after mix is 1000 mg/l, in F3 Pb, the AP of coconut fibers is 85.087 %, while in F3 Pb, the AP of peanut shells is only 59,087 %. Besides, we could see that with both concentrations of HM filled up, sugar-cane bagasse, peanut shells and coconut fibers have capacity to absorb Pb better than to absorb Cu, because the contents remained in water of Cu more than Pb in both treatrment.

Assessment ability to absorb Heavy metal in wastewater after the mineral exploitation of banana peels, peanut shells and coconut fibers

Based on the successful application of the use of banana peels , peanut shells and coconut fibers in the HM domestic absorption experiments with HM concentrations are given in 500 mg / l and 1000 mg /l and it provided a high efficiency, we have applied in reality to absorb the heavy metal in the waste water after the mineral exploitation in mining area in lead, zinc in Hich village in Tan Long commune, Dong Hy district, Thai Nguyen. The application of technology to the adsorption on the domestic heavy metal after the mining exploitation also in high results. HM concentration measurement results in wastewater remaining after mining is presented in Table 3 and Figure 1, Figure 2 and figure 3.

Table 2: *The ability to absorpting the HM of sugar-cane bagasse, peanut shells and coconut fibers with HM concentration is 500 mg/l*

Treatment		Content of HM in water after mix (mg/l)	Test 1		Test 2	
			Content of HM remained in water after a period of time (mg/l)	Adsorption productivity AP (%)	Content of HM remained in water after a period of time (mg/l)	Adsorption productivity AP (%)
Sugar-cane bagasse	F1 Pb	500 mg/l	284.94 + 0.43	43.012	221 33 ± 0.95	55 734
	F2 Pb		198.39 ± 0.54	60.322	186.89 ± 0.58	62 622
	F3 Pb		142.74 ± 0.79	71.452	129.04 ± 0.14	74.192
	F1 Cu		301.21 ± 0.17	39.758	298.71 ± 0.091	40.258
	F2 Cu		204.65 ± 0.478	59.07	197.57+0.35	60.486
	F3 Cu		159.79 + 0.709	68.042	148.42 + 0.451	70.316
Peanut shells	F1 Pb	500 mg/l	309.46 ± 0.05	38.108	297.75 ± 0.499	40,45
	F2 Pb		250.56± 0.324	49.887	245.09 ± 0.093	50.982
	F3 Pb		209.23 ± 0.364	58.154	204.47 ± 0 38	59.106
	F1 Cu		395.2 ± 0.872	20.96	378.05 ± 0.704	24.39
	F2 Cu		268.385 ± 0.58	46.323	259.607 ± 0.404	48.0786
	F3 Cu		199.23 ± 0.215	60.152	188.76 ± 0.417	62.248
Coconut fibers	F1 Pb	500 mg/l	235.2 ± 0.22	52.96	228.38 ± 0.35	54.34
	F2 Pb		120.09 ± 0.045	75.982	116.23 ± 0.943	76.754
	F3 Pb		84.38 ± 0.208	83.124	78.37 ± 0.43	84.326
	F1 Cu		267.21 ± 0.17	46.558	252.70 ± 0.09	49.46
	F2 Cu		141.31 ± 0.148	71.738	139.645±0.459	72.071
	F3 Cu		95.46 = 0.199	80.908	86.75 ± 0.365	82.649

Table 3: *The ability to absorb the heavy metalof sugar-cane bagasse, peanut shells and coconut fibers with heavy metal concentration is 1000 mg/l*

Treatrment		Content of HM in water after mix (mg/l)	Test 1		Test 2	
			Content of HM remained in water after a period of time (mg/l)	Adsorption productivity AP (%)	Content of HM remained in water after a period of time (mg/l)	Adsorption productivity AP (%)
Sugar-cane bagasse	F1 Pb	1000 mg/l	529.46 ± 0.05	47.054	519.42 ± 0.492	48.058
	F2 Pb		410.563 ± 0.325	58.944	405 09 ± 0.092	59.491
	F3 Pb		309.23 ± 0.364	69.077	304.47±0.38	69.553
	F1 Cu		595.2 ± 0.871	40.48	578.05 ± 0.704	42.195
	F2 Cu		468.385 ± 0.58	53.162	459.51±0.404	54.049
	F3 Cu		339.24 ± 0.215	66.076	318.76 ± 0.416	69.124
Peanut shells	F1 Pb	1000 mg/l	529.46 ± 0.05	47.054	519.42 ± 0.492	48.058
	F2 Pb		502,563 ± 0,325	49,744	497,094 ± 0,092	50,2906
	F3 Pb		418,23 ± 0,364	58,177	409,13 ± 0,312	59,087
	F1 Cu		793,53 ± 0,305	20,647	786,05 ± 0,325	21,395
	F2 Cu		537,051 ± 0,020	46.2949	529,173 ± 0,230	47,0827
	F3 Cu		400,238 ± 0,215	59,9762	388,76 ± 0,417	61,124
Coconut fibers	F1 Pb	1000 mg/l	497.87 ± 0.67	50.213	465.38 ± 0.35	53.462
	F2 Pb		325.09 ± 0.045	67.491	316.23 ± 0.94	68.377
	F3 Pb		184.38 ± 0.20	81.562	175.13± 0.312	85.087
	F1 Cu		567.21 ± 0.17	43.279	521.70 ± 0.09	47 83
	F2 Cu		413.31 ± 0.14	58.669	398.145±1.166	60.186
	F3 Cu		258.46 ± 0.199	74.154	245.42 ± 0.45	75.458

Table 4: *The ability to absorb heavy metal Pb in waste water after exploitation of sugar-cane bagasse and peanut shells, coconut fibers*

Formula		Content of HM in water (mg/l)	Test 1: Content of HM remained in water after a period of time (mg/l)	Test 1: Adsorption productivity AP (%)	Test 2: Content of HM remained in water after a period of time (mg/l)	Test 2: Adsorption productivity AP (%)
Sugar-cane bagasse	F1 Pb	55.654 mg/l	24.04± 0.072	56.8	22.077± 0.071	60.33
	F2 Pb		18.11± 0.113	67.45	15.847 ± 0.086	71.53
	F3 Pb		12.41± 0.036	77.701	10.132± 0.097	81.79
Peanut shells	F1 Pb	55.654 mg/l	30.196± 0,107	45.74	28.5104±0.395	48.77
	F2 Pb		21.085± 0,0164	62.11	19.065 ± 0.055	65.743
	F3 Pb		16.148 ± 0,074	70.98	13.118 ± 0.38	76.429
Coconut Fibers	F1 Pb	55.654 mg/l	20.087± 0,035	63.91	18.51± 0 395	66.741
	F2 Pb		15.084 ± 0,016	72.90	13.065± 0.553	76.524
	F3 Pb		10.08± 0,12	81.89	9.004± 0 045	83.821

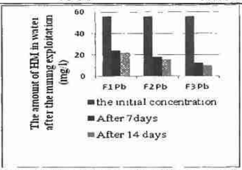

Figure 1: *The ability to absorb heavy metal of sugar-canebagasse with different contents*

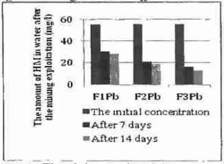

Figure 2: *The ability to absorb heavy metal of peanut shells with different contents*

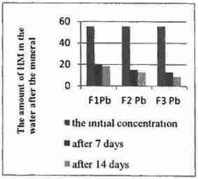

Figure 3: *The ability to absorb heavy metal of coconut fibers with different contents*

From this three figures, we can see that the concentration of heavy metals which extanted in the wastewater has dropped greatly. Its mean that sugar-cane bagasse, peanut shells and coconut fibers absorbed a large number of heavy metal. This results show that most of heavy metal extanted in water are over the standard regulation.

CONCLUSION

In conclusion, results shown in the thesis clearly indicate the absorption capacity of sugar-cane bagasse, peanut shells and coconut fibers. The absorption of Pb^{2+} and Cu^{2+} by using agricultural wastes was examined and analyzed. After conducting the experiment, the results showed that agricultural wastes have the ability to absorb the heavy metal Cu^{2+} and Pb^{2+} in wastewater and if we conduct the experiment many times repeatedly, we can reduce the amount of heavy metal in wastewater to allowable limit. By comparing the using of agricultural wastes like sugar-cane bagasse, peanut shells and coconut fibers for removal the heavy metal ion in the wastewater, we can use F3 (with the highest amount of agricultural by-products in both HM concentration) in order to handle Pb^{2+} and Cu^{2+} in wastewater because it have showed the best results in improving the water quality. This agricultural by-products is not only applied to absorb Pb^{2+} and Cu^{2+}, but it can also apply to remove other heavy metals like Zn^{2+}, Cd^{2+}, Ni^{2+}... Therefore, the study and application of the agricultural wastes will open a new direction in the improving the water resources quality.

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TÓM TẮT

NGHIÊN CỨU KHẢ NĂNG XỬ LÝ NƯỚC THẢI SAU KHAI THÁC KHOÁNG SẢN BẰNG MỘT SỐ PHẾ PHỤ PHẨM NÔNG NGHIỆP (BÃ MÍA, XƠ DỪA, VỎ LẠC)

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Nghiên cứu này đã sử dụng phế phụ phẩm nông nghiệp (bã mía, vỏ lạc, xơ dừa) để hấp thu các kim loại nặng trong nước thải sau khai thác khoáng sản và trong nguồn nước thí nghiệm được pha với một nồng độ kim loại nặng nhất định (500mg/l, 1000mg/l). Kết quả cho ta thấy rằng, bã mía, vỏ lạc và xơ dừa có khả năng hấp thụ ion kim loại nặng rất tốt. Từ đó so sánh, đánh giá hàm lượng kim loại nặng Pb, Cu có trong nước trước và sau khi tiến hành thí nghiệm Khi khối lượng vật liệu hấp thụ tăng thì khả năng hấp thụ các kim loại nặng trong nước cũng tăng. Ví dụ với vỏ chuối, khả năng hấp thụ kim loại nặng cao nhất là khi lượng bã mía cho vào là 900g, vỏ chuối có thể hấp thụ được khoảng 71,452%F3 Pb bm=900g) gấp 1,66 lần so với lượng kim loại năng được hấp thụ ở F1 Pb bm=300g.

Kim loại nặng di động cũng có kết quả khá cao, khả năng hấp thụ đạt hiệu suất 30% - 80% so với ban đầu. Bã mía, vỏ lạc và xơ dừa có khả năng xử lý Pb cao nhất, tiếp đó là Cu.

Từ khóa: *bã mía, vỏ lạc, xơ dừa, ô nhiễm nước, kim loại nặng*

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