Study on the Adsorption Properties of Rice Husk for Lead from Lead II Nitrate Solution

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Abstract

Lead is a heavy toxic metal for human beings. This research paper was aimed to study the adsorption properties of rice husks for the removal of lead. The rice husks were collected from rice mill in Taung Hlwe Village, Kyaukse Township, Mandalay Region. Firstly the rice husks were modified using tartaric acid. In this paper, the effect of sample weight on the adsorption of lead by using filtration method and shaking method was studied. It was found that the percentage of lead removal was higher in shaking method than that in filtration method. Moreover, the effect of shaking time at constant weight sample on the adsorption of lead was determined.

Key words : Lead, rice husk, adsorption properties

Introduction

Rice husk is an agricultural waste after rice production. It accounts for 20 % of the 649.7 million tons of rice produced annually worldwide. The chemical composition of rice husk is found to vary from one sample to another due to the differences in the type of paddy, crop year, climate and geographical conditions. It is a fibrous material containing cellulose as the major constituent, lignin and ash. Rice husks possess a granular structure, unique chemical composition, availability in abundance and low cost. Therefore it is a good adsorbent material for heavy metal removal.

Excessive release of heavy metals into environment due to industrialization, natural phenomena and human activities has posed a great problem to the world. Heavy metal ions do not degrade into harmless end products. So heavy metals can give bad effect to human body and environment itself. Adsorption is one of the most effective techniques to remove heavy metals.

Adsorption is the adhesion of a chemical species onto the surface of particles. In general, adsorption can be defined as accumulation of solute molecules at an interface. An adsorbent is a substance, usually porous in nature and with a high surface area that can adsorb substances into its surface by intermolecular forces. Orange peel, wheat shells, rice husk, groundnut shells, coconut shells, walnut shells, waste tea leaves have been tested for adsorption characteristic for dyne, heavy metal and other organic matter.

Heavy metals are elements having atomic weight between 63.5 and 200.6 and a specific gravity greater than 5.0. The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic at low concentrations. Among the heavy metals lead is ranked as second hazardous substance after arsenic.

Lead can enter human body through uptake of food, water, air and cosmetic. Exposure to excessive level to lead can cause encephalopathy, kidney damage, anemia and toxicity to the reproductive system.

Rice husks were used as an alternative to commonly available adsorbents for heavy metal ion removal. Shaking process and filtration method were conducted to study adsorption characteristic of rice husk for lead from lead II nitrate solution.

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Aim and Objectives

Aim

The main aim of this research is to study the adsorption properties of rice husk for lead from lead II nitrate solution.

Objectives

(i) To modify rice husk using tartaric acid
(ii) To determine the effect of sample weight on the adsorption of lead by filtration method
(iii) To investigate the effect of sample weight on the adsorption of lead by shaking method
(iv) To study the effect of the fixed sample weight with different shaking time on the adsorption of lead

Materials and Methods

Sample Collection

The sample rice husks were collected from rice mill in Taung Hlwe Village, Kyaukse Township, Mandalay Region.

Figure 1. Rice Husk

Preparation of Tartaric Acid Treated Rice Husk

The raw rice husk sample (100 g) was soaked in 0.1 M tartaric acid (500 mL) under stirring for 4 hr. After decantation and filtration the sample, it was washed with water until all the acids were undetected in the filtrate and then dried at room temperature. The dried rice husks were ground by using grinder and they were sieved by using 60 and 80 mesh size sieves. The resulting sample powder was stored in a plastic bottle and used throughout the research.

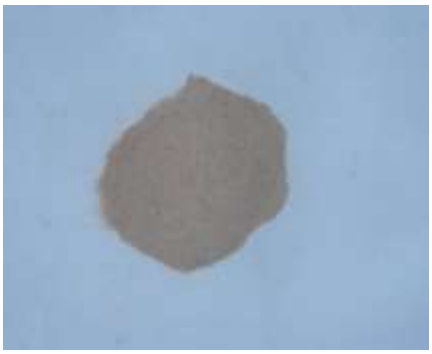

Figure 2. Tartaric Acid Treated Rice Husk Powder (60-80 mesh in size)

Determination of Adsorption Properties of Acid Treated Rice Husk Powder by using Filtration Method

Procedure

Preparation of 0.05 M $Pb(NO_3)_2$ Solution

$Pb(NO_3)_2$ (16.64 g) was accurately weighed and dissolved in distilled water (200 ml) and diluted to one liter in a volumetric flask to prepare 0.05 M. This solution was then standardized with standard EDTA solution.

Preparation of 0.001 M Ethylene Diamine Tetraacetate (Sodium Salt) Solution

Disodium salt of ethylene diamine tetraacetic acid (0.37225 g) was accurately weighed and dissolved in distilled water (200 ml) and diluted to one litre in a volumetric flask. This gave an approximate strength of 0.001 M.

Preparation of Xylenol Orange Indicator

Xylenol orange (0.5 g) was accurately weighed and dissolved in 100 mL of distilled water.

Titration Procedure

Firstly, a small piece of cotton wool was inserted and tamped at the bottom of the burette (100 ml).

Rice husk powder sample (1 g) was added into this burette. 100 mL of $Pb(NO_3)_2$ (0.05 M) solution was poured down into the burette in which sample powder has already been packed. The $Pb(NO_3)_2$ solution was filtered to adjust the flow rate to be 22 drops per minute. Then the filtrate was collected in the conical flask and this filtrate was stored for the determination of adsorptive properties.

The resulting filtrate (10 ml) was taken in a conical flask and a drop of xylenol orange indicator was added. The color of the solution was changed from colorless to wine red. A few drop of diluted nitric acid was added in this solution. The color of solution was turned to yellow. A few amount of hexamine powder was added and then the color was found to be orange red. Finally the orange red color solution was titrated with 0.001 M EDTA solution. At the end point, the color of solution was changed to yellow. The titration procedure was repeated three times.

By using above procedure, the adsorptive properties of 2 g, 3 g, 4 g, 5 g, 6 g, 7 g and 8 g of rice husk powder were determined. The data were shown in Table (1).

Determination of Adsorption Properties of Acid Treated Rice Husk Powder by using Shaking Method

Procedure

Rice husk powder sample (1 g) was added into conical flask (150 ml) and 100 ml of 0.05 M $Pb(NO_3)_2$ solution was added into this flask. And then it was shaken for about one hour by using shaker at 300 rpm. After shaking, it was filtered by using filter paper. The resulting filtrate was titrated with 0.001 M EDTA solution to determine the adsorptive properties.

The resulting filtrate (10 ml) was taken in a conical flask and a drop of xylenol orange indicator was added. The color of the solution was changed from colorless to wine red. A few drop of diluted nitric acid was added in this solution. The color of solution was turned to yellow. A few amount of hexamine powder was added and then the color was found to be orange red. Finally the orange red color solution was titrated with 0.001 M EDTA solution. At the end point, the color of solution was changed to yellow. The titration procedure was repeated three times.

By using above procedure, the adsorptive properties of 2 g, 3 g, 4 g, 5 g, 6 g, 7 g and 8 g of rice husk powder were determined. The data were shown in Table (2).

Determination of Adsorption Properties of Acid Treated Rice Husk Powder at Constant Weight and Different Shaking Time

Procedure

Rice husk powder sample (5 g) was added into conical flask (150 ml). 100 ml of $Pb(NO_3)_2$ (0.05 M) solution was added into this flask and it was shaken for about two hours by using shaker at 300 rpm. After shaking, it was filtered and the filtrate was used to determine the adsorptive properties of sample

Another 5 g of sample was prepared as described above. It was shaken for three hours by using shaker at 300 rpm and it was filtered. The filtrate was used to estimate the adsorptive properties. .

The resulting filtrate (10 ml) was taken in a conical flask and added a drop of xylenol orange indicator. The color of the solution was changed from colorless to wine red. A few drop of diluted nitric acid was added in this solution. The color of solution was turned to yellow. A few amount of hexamine powder was added and then the color was found to be orange red. Finally the orange red color solution was titrated with 0.001 M EDTA solution. At the end point, the color of solution was changed to yellow. The titration procedure was repeated three times.

The data were shown in Table (3).

Results and Discussion

Determination of Adsorption Properties of Acid Treated Rice Husk Powder by using Filtration Method

The effect of sample weight on the adsorption of lead by using filtration method was studied and the results were shown in Table (1) and Figure (3).

Table 1. Percent Removal of Lead from Lead II Nitrate Solution by Acid Treated Rice Husk Powder (by using Filtration Method)

No.	Weight of sample (adsorbent) (g)	Initial weight of lead (g/100 mL)	Remaining weight of lead (g/100 mL)	Removal weight of lead (g/100 mL)	Percent removal of lead (%)
1.	1	0.9117	0.6009	0.3108	34.0902
2.	2	0.9117	0.5802	0.3315	36.3606
3.	3	0.9117	0.5387	0.373	40.9125
4.	4	0.9117	0.4973	0.4144	45.4535
5.	5	0.9117	0.4558	0.4559	50.0055
6.	6	0.9117	0.4351	0.4766	52.2759
7.	7	0.9117	0.3729	0.5388	59.0983
8.	8	0.9117	0.3315	0.5802	63.6393

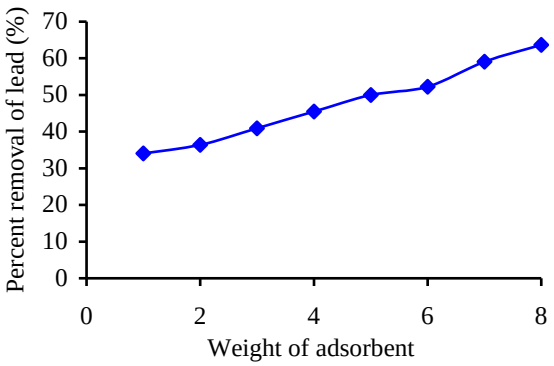

Figure 3. The Percent Removal of Lead from Lead (II) Nitrate Solution by Acid Treated Rice Husk Powder (by using Filtration Method)

According to these data and graph it can be seen that there is a sharp increase in percent removal of lead with increase in adsorbent weight by using filtration method.

Determination of Adsorption Properties of Acid Treated Rice Husk Powder by using Shaking Method

The effect of sample weight on the adsorption of lead by using shaking method was determined and the results were shown in Table (2) and Figure (4).

Table 2. Percent Removal of Lead from Lead II Nitrate Solution by Acid Treated Rice Husk Powder (by using Shaking Method)

No.	Weight of sample (adsorbent) (g)	Initial weight of lead (g/100 ml)	Remaining weight of lead (g/100 ml)	Removal weight of lead (g/100 ml)	Percent removal of lead (%)
1.	1	0.9117	0.2901	0.6216	68.1803
2.	2	0.9117	0.2486	0.6631	72.7322
3.	3	0.9117	0.2279	0.6838	75.0027
4.	4	0.9117	0.2072	0.7045	77.2732
5.	5	0.9117	0.145	0.7667	84.0956
6.	6	0.9117	0.1036	0.8081	88.6366
7.	7	0.9117	0.0828	0.8289	90.9180
8.	8	0.9117	0.0414	0.8703	95.4590

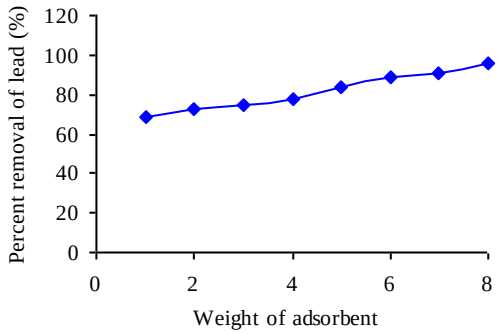

Figure 4. The Percent Removal of Lead from Lead (II) Nitrate Solution by Acid Treated Rice Husk Powder (by using Shaking Method)

From Table (2) and Figure (4), it can be found that removal of lead increase with increasing in weight of adsorbent by using shaking method, this is clear because of the more exposed surface size of higher amount of adsorbent being used.

Determination of Adsorption Properties of Acid Treated Rice Husk Powder at Constant Weight and Different Shaking Time

The effect of shaking time on the adsorption of lead was investigated and the results were shown in Table (3) and Figure (5).

Table 3. Percent Removal of Lead from Lead II Nitrate Solution by Acid Treated Rice Husk Powder at Constant Weight and Different Shaking Time

No.	Weight of sample (adsorbent) (g)	Different shaking time	Initial weight of lead (g/100 mL)	Remaining weight of lead (g/100 mL)	Removal weight of lead (g/100 mL)	Percent removal of lead (%)
1.	5	1 hr	0.9117	0.145	0.7667	84.0956
2.	5	2 hr	0.9117	0.1036	0.8081	88.6366
3.	5	3 hr	0.9117	0.0828	0.8289	90.9180

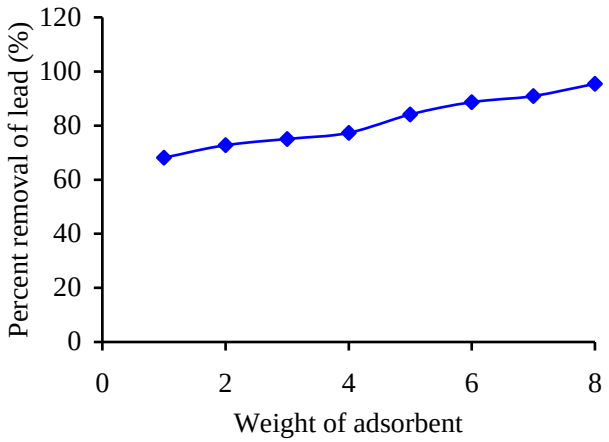

Figure 5. Percent Removal of Lead from Lead (II) Nitrate Solution by Acid Treated Rice Husk Powder at Constant Weight and Different Shaking Time

According to Table (3) and Figure (5), it is noted that there is increasing of percent removal of lead with increasing the shaking time from that time onward and the percent removal becomes dependent of time.

Conclusion

In this research, the adsorption properties of tartaric acid treated rice husk powder for lead from lead II nitrate solution were experimentally determined. Firstly, the adsorption effect of weight of adsorbent (rice husk powder) on the removal of lead by the filtration method was studied. From the determination it can be seen that the percent removal of lead increases with increasing the weight of adsorbent. The percent removal of lead was found to be 34.0902 % to 63.6393 %.

In addition, the effect of sample weight on the adsorption of lead by using shaking method was also determined. In this experiment, the percentage of lead removal increased with the increase in adsorbent weight. The percentage of lead removal was 68.1803 % to 95.4590 %. However the adsorption effect of the filtration method is lower than that of shaking method. In shaking method, the mixture was shaken continuously and good interaction between the solid solute (adsorbent metal ion) was achieved.

Finally, the effect of the fixed sample weights with different shaking time on the adsorption of lead was investigated. The shaking times were 1 hr, 2 hr and 3 hr respectively. The percent removal was found to be 84.0956 % to 90.9180 %. From that time onward, the percent removal become higher for longer contact time.

From Table (1) and (2) it can be seen that the shaking method is more effective for the same weight of sample (e.g, 5 g) than the filtration method. Again, comparison of Table (2) and (3) shows that the shaking time is more effective if the weight of sample is fixed (e.g, 5 g). Thus the longer the shaking time, the greater the frequency of collision between species, and increasing the adsorption properties.

It was reported that rice husk (natural form) was used as adsorbent using filtration method, shaking method and different shaking time for removal of lead from lead compound. The results were 27.26 % to 59.08 % (filtration method) 59.08 % to 86.36 % (shaking method) and 72.72 % to 86.36 % (different shaking time) respectively.[1]

From the comparison of rice husk (natural form) and tartaric acid treated rice husk, it can be seen that the higher adsorption capacity is achieved when the tartaric acid treated rice husk was used as adsorbent. It can be concluded that tartaric acid treated rice husks are suitable adsorbent for removal of lead from effluent in term of low cost and effective, alternative for commercial adsorbents.

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