Metal [Cu (II) ion] Sorption from Aqueous Solution by Rice Husks

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Abstract

In this study, the Cu (II) ion from aqueous solution by using rice husks. It involved batch equilibrium sorption of Cu (II) ion onto treated rice husks powder. This investigation consists of preparation of rice husks powder. The raw rice husks powder were treated by 5 % w/v bleaching powder for 24 hours. The sorption properties of metal ion [Cu(II)] were spectrophotometrically determined by treated rice husks powder. In this paper, the effect of pH, contact time and dosage were also investigated for the removal of Cu (II) ion by using treated rice husks powder.

Key words : Rice husk, copper (II) ion, batch sorption, pH, contact time, dosage

Introduction

The water contamination caused by toxic metals through the discharge of industrial wastewaters is a worldwide environmental problem. The industries responsible for the discharge of wastewaters containing metals are mining and mineral processing, pigment manufacture, painting and photographic industries, metal-working and finishing processes. Since metals are non-biodegradable, and may be bio-accumulated in living tissues, their removal from wastewaters is nowadays legally imposed. The main techniques used for metals removal include chemical precipitation, electrolytic and membrane processes, ion exchange and adsorption.

Adsorption is an efficient separation process that can selectively and effectively remove adsorbates from a liquid phase onto a solid phase (sorbent). The technical utilization of the adsorption-absorption (sorption) phenomena mainly depends on the availability of suitable and cheap adsorbents.

Some copper contamination generally occurs from corrosion of household copper pipes, it cannot be detected or removed by the water

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system. Instead, Environmental Protection Agency (EPA) is requiring water system to control the corrosiveness of the water. For this reason, the level of copper has also been set at 1.00 ppm by EPA. This is the lowest level to which water systems can reasonably be required to control this contaminant.

The biosorbents can usually be obtained free of charge from the respective producers since they sometimes present disposal problems. They are cheaper than ion exchange resins and activated carbon because the only costs to be considered are those of transport and grinding. Several biosorbents from vegetable source have been tested for the removal of heavy metals, mainly agricultural wastes. Agricultural materials particularly those containing cellulose, show potential metal biosorption capacity, namely rice husks, wheat husks, coconut husks, walnut husks and almond shells.

Rice husks, one of the most abundant food industry waste products, are a natural low cost material able to fix metal ions. This material may be a potential alternative to commonly used sorbents. The main purpose of this study was the removal of copper (II) ion from aqueous solutions, using rice husks.

Aim and Objectives

Aim

To study the adsorption properties of rice husks powder to be used as an effective sorbent for the colour removal of Cu (II) ion from aqueous solution.

Objectives

- To collect the rice husks powder sample
- To treat the rice husks powder by 5 % w/v bleaching powder
- To study the sorption of Cu (II) ion by treated rice husks powder based on effect of pH, contact time and dosage method

Botanical Description of Rice

Fig. 1. Plant and Husks of *Oryza sativa* L.

Botanical name	:	*Oryza sativa* L.
Family	:	Gramineae
English name	:	Rice
Myanmar name	:	Manaw thu kha

Materials and Methods

Sampling and Preparation

The rice husks were collected from Kyaukse Township, Mandalay Region. Then it was washed with tap water to remove the attached dusts and other impurities. The washed rice husks were ground in the mechanical grinder to form the fine powder. The powder was sieved and a size fraction in the range 100-120 μm was used in all the experiments. This powder was soaked (0.01 g/mL) in 5 % w/v bleaching powder for 24 hours. The mixture was filtered and the powder residue was continuously washed with distilled water until the pH of the solution is nearly neutral. This filtered biomass was first dried, at room temperature and then in an oven at 105°C for 6-8 hours. The dried biomass was stored in air-tight glass bottles to protect it from moisture.

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Preparation of Copper (II) Solution

Chemical - Copper (II) sulphate

Apparatus - Electronic balance, Measuring cylinder (10 mL), Volumetric flask (1000 mL & 100 mL)

Procedure

A 1.96 g of copper (II) sulphate was dissolved in distilled water and made up to 1 L as 500 mg L^{-1} stock solution. This solution was made by serial dilution within the range between 10.0 to 200 mg L^{-1}.

Determination of Maximum Wavelength of Copper (II) Solution

Chemical - Copper (II) sulphate

Apparatus - Digital Spectrophotometer (Biochron-Model S-104 D)

Procedure

The spectrophotometer was first calibrated with blank solution of distilled water. Maximum wavelength of copper (II) sulphate solution (200 mg L^{-1}) was determined by spectrophotometer at various wavelengths. From the spectrum curve absorbance versus wavelength, λ_{max} for copper (II) (200 mg L^{-1}) was found out. Spectral curve for copper (II) sulphate is presented in Figure (2). The maximum wavelength (λ_{max}) of copper (II) is 640 nm.

Construction of Calibration Curve

Chemical - Copper (II) sulphate

Apparatus - Digital Spectrophotometer

(Biochron-Model S-104 D)

Procedure

Series of standard solution will prepare by serial dilution. The absorbances of standard solutions were measured at the wavelength of 640 nm by means of spectrophotometer. The measured absorbance is presented in Table (2) and Fig. (3).

Effect of pH on Adsorption of Copper (II) Ion by Treated Rice Husks

Sample - Treated rice husks

Chemical - Copper (II) sulphate, 0.1 M sulphuric acid, 0.1 M sodium hydroxide

Apparatus - Electronic balance, pH meter, Glasswave (Pyrex), Digital spectrophotometer (Biochron-Model S-104 D)

Procedure

The standard stock solution (200 mg L^{-1}) of copper (II) sulphate solution at various pH (1, 2, 3, 4, 5, 6) were prepared by adding 0.1 M sulphuric acid and 0.1 M sodium hydroxide. A fixed amount of sample, 0.4 g was added to 20 mL of 200 mg L^{-1} copper (II) sulphate solution at different at pH and stirred occasionally for 2 hours at room temperature. Then the mixture was filtered and copper (II) ion in the filtrate was determined by spectrophotometrically at 640 nm. The resulting data are presented in Table (4) and Fig. (5).

Effect of Contact Time on Adsorption of Copper (II) Ion by Treated Rice Husks

Sample - Treated rice husks

Chemical - Copper (II) sulphate, 0.1 M sulphuric acid, 0.1 M sodium hydroxide

Apparatus - Electronic balance, pH meter, Glasswave (Pyrex), Digital spectrophotometer (Biochron-Model S-104 D)

Procedure

Accurately weighed treated rice husks (0.40 g) were placed in separate beakers. Then 20 mL of copper stock solution (200 mg L^{-1}) at pH 4 was added into each beaker and stirred occasionally. The contact time at time interval of 20, 40, 60, 80, 100, 120, 140, 160 and 180 min. The sample solutions were separated by filtration. The residual copper content in the solution was determined by spectrophotometrically at 640 nm. The resulting data are presented in Table (5) and Fig. (6).

Effect of Dosage on Adsorption of Copper (II) Ion by Treated Rice Husks

Sample - Treated rice husks

Chemical - Copper (II) sulphate, 0.1 M sulphuric acid, 0.1 M sodium hydroxide

Apparatus - Electronic balance, pH meter, Glasswave (Pyrex), Digital spectrophotometer (Biochron-Model S-104 D)

Procedure

Treated rice husks sample of various masses ranging from 0.20 g to 1.20 g were placed in the beakers and 20 mL of standard copper (II) sulphate solution (200 mg L^{-1}) was added to each flask at pH 4.

In order to attain complete equilibrium, the solutions were stirred occasionally for two hours at room temperature. The sample solutions were removed from the sorbent by filtration. The residual content of copper in the solution was determined by spectrophotometrically at 640 nm. The resulting data are presented in Table (6) and Fig. (7).

Table (1) Determination of Maximum Wavelength for Copper (II) Sulphate (200 mg L^{-1}) at pH = 3.5

No.	Wavelength (nm)	Absorbance
1.	600	0.37
2.	610	0.37
3.	620	0.38
4.	630	0.39
5.	640	0.40
6.	650	0.39
7.	660	0.39
8.	670	0.39
9.	680	0.39
10.	690	0.39
11.	700	0.39

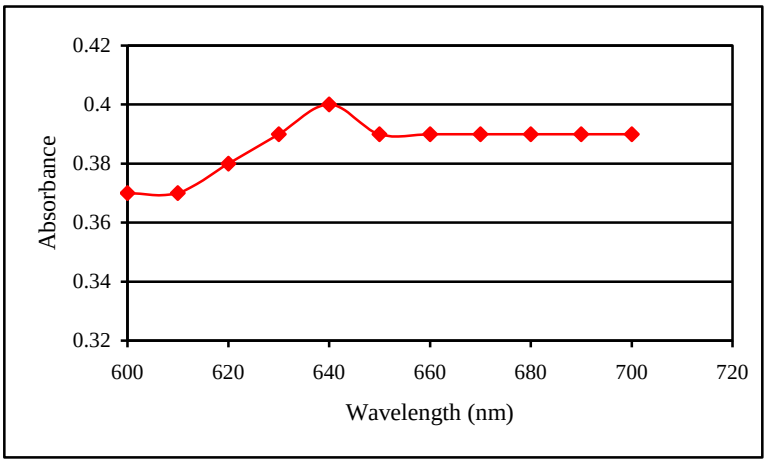


Fig. 2. Absorbance as a Function of Wavelength for Copper (II) Sulphate (200 mg L^{-1})

Table 2. Data for Absorbance with Different Concentration of Copper (II) Sulphate

λ_{max} = 640 nm, pH = 3.5

No.	Concentration (mg/L)	Absorbance
1.	10	0.02
2.	20	0.04
3.	40	0.08
4.	60	0.12
5.	80	0.16
6.	100	0.20
7.	200	0.40

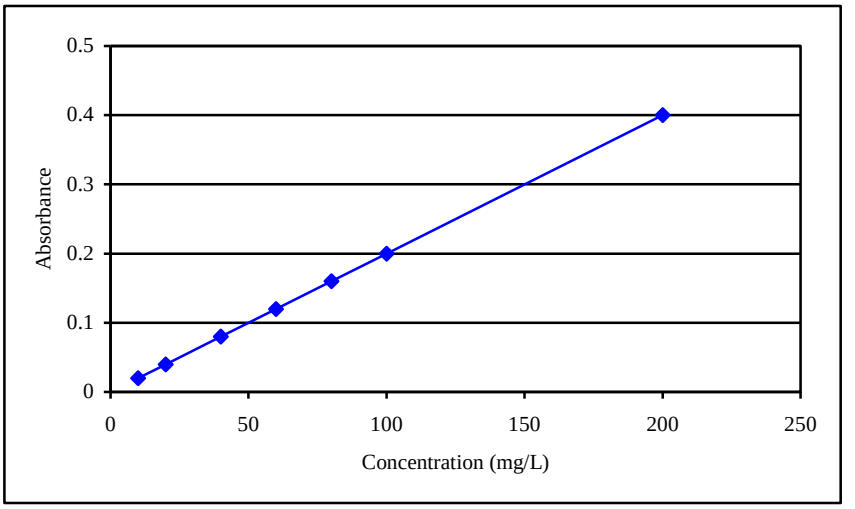
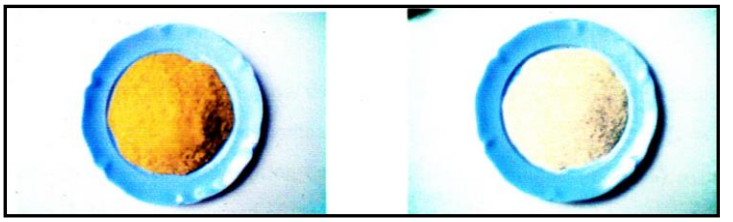


Fig. 3. Calibration Curve for Copper (II) Sulphate

Results and Discussion

Aspect of the Preparation of Rice Husks Powder

In this term paper, clean dried rice husks powder was treated by 5 % w/v bleaching powder. Fig. 4. (a) and (b) show photographs of before and after treatment of rice husks. The colour of the treated rice husks was so much lighter than before.



(a) (b)

Fig. 4. Photos of Rice Husks Powder

(a) before treatment

(b) after treatment

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Effect of pH

The pH of solution is one of the most significant operating parameters affecting the sorption process. Table (4) and Figure (5) show the percent removal of Cu (II) ion by treated rice husks. In the case, the removal of Cu (II) ion increased with increasing pH and the highest adsorption was observed at pH 4. Above the pH 4, the precipitation of metal ion as oxide or hydroxide was observed and the precipitate may be interfered in the sorption process. So the adsorption of Cu (II) ion by treated rice husks was just done at pH 4.

Effect of Contact Time

Table (5) and Figure (6) show the percent adsorbed of Cu (II) ion by treated rice husks with various contact time from 20 to 180 minute. It was found that the maximum adsorption occured within 100 minute (47.50 %). After 100 minute, the percent adsorbed of metal ion was nearly constant.

Effect of Dosage

In this term paper, the effect of dosage on the adsorption of Cu (II) ion on the treated rice husks was studied. It was found that the removal of Cu (II) ion from 200 mg L^{-1} of copper (II) sulphate solution increase from 35.00 % to 55.50 % with an increase in dose of sample from 0.20 g to 1.20 g. It was apparent that the percent removal of metal ion increase with increase in dose due to great availability of the sorbent.

Table 4. Effect of pH on Adsorption of Cu (II) Ion by Treated Rice Husks

No.	pH	Absorbance	C_e (mg L^{-1})	Percent Cu (II) adsorbed (percent removal)
1.	1	0.34	171.00	14.50
2.	2	0.31	156.00	22.00
3.	3	0.28	142.00	29.00
4.	4	0.24	116.00	42.00
5.	5	0.33	167.00	16.50
6.	6	0.36	180.00	10.00

Initial Concentration = 200 mg L^{-1}

Volume of Solution = 20 mL

Weight of Sample = 0.4 g

Contact Time = 2 hr

λ_{max} = 640 nm

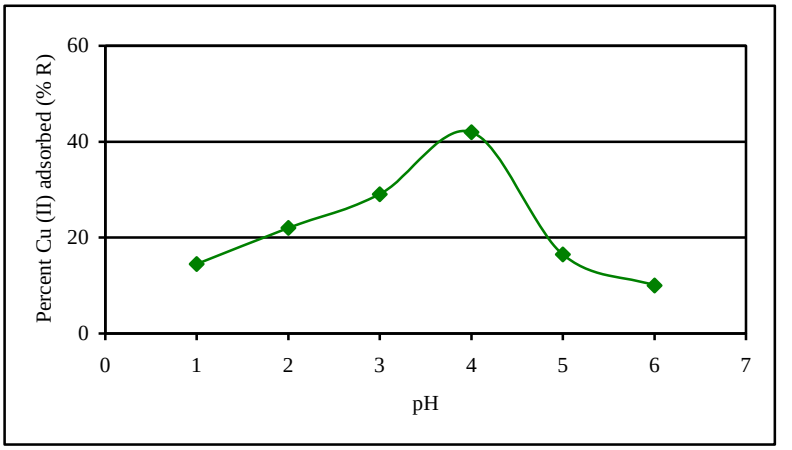

Fig. 5. Effect of pH on Adsorption of Cu (II) Ion by Treated Rice Husks

Table 5. Effect of Contact Time on Adsorption of Cu (II) Ion by Treated Rice Husks

λ_{max} = 640 nm

No.	Time (min)	Absorbance	C_e (mg L^{-1})	Percent Cu (II) adsorbed (percent removal)
1.	20	0.38	190.00	5.00
2.	40	0.36	180.00	10.00
3.	60	0.31	155.00	22.50
4.	80	0.26	130.00	35.00
5.	100	0.23	105.00	47.50
6.	120	0.23	105.00	47.50
7.	140	0.23	105.00	47.50
8.	160	0.23	105.00	47.50
9.	180	0.23	105.00	47.50

Initial Concentration = 200 mg L^{-1}

Volume of Solution = 20 mL

Weight of Sample = 0.4 g

pH = 4

λ_{max} = 640 nm

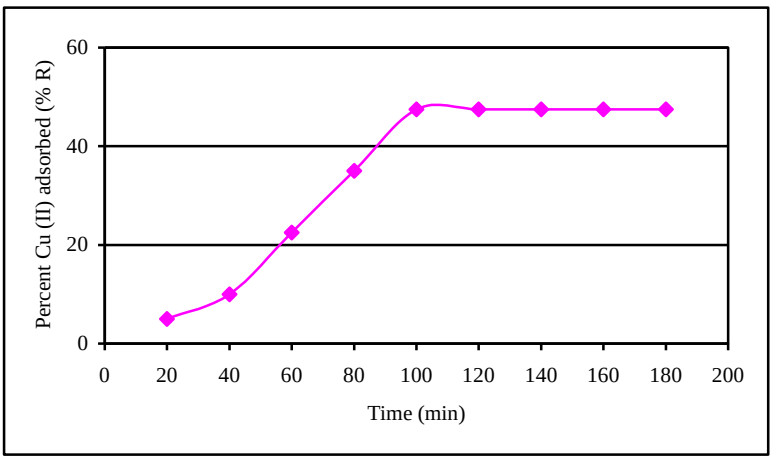

Fig. 6. Effect of Contact Time on Adsorption of Cu (II) Ion by Treated Rice Husks

Table 6. Effect of Dosage on Adsorption of Cu (II) Ion by Treated Rice Husks

No.	Weight of sample (g)	Absorbance	C_e (mg L^{-1})	Percent Cu (II) adsorbed (percent removal)
1.	0.20	0.26	130.00	35.00
2.	0.40	0.23	105.00	47.50
3.	0.60	0.20	100.00	50.00
4.	0.80	0.18	89.00	55.50
5.	1.00	0.18	89.00	55.50
6.	1.20	0.18	89.00	55.50

Initial Concentration = 200 mg L^{-1}

Volume of Solution = 20 mL

Contact Time = 2 hr

pH = 4

λ_{max} = 640 nm

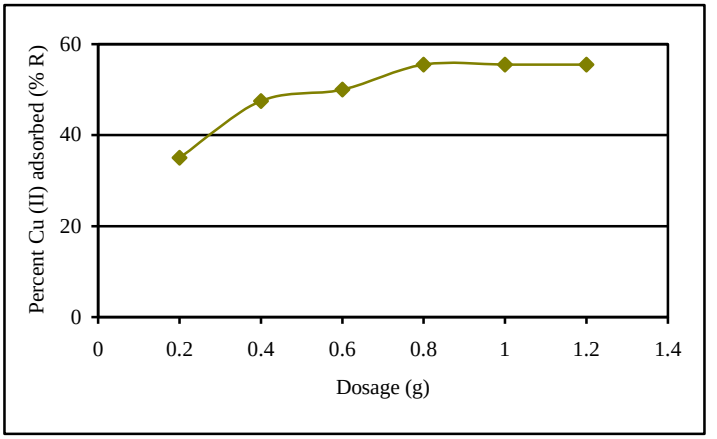

Fig. 7. Effect of Dosage on the Removal of Cu (II) Ion by Treated Rice Husks

Conclusion

In this paper, treated rice husks were used for the removal of Cu (II) ion in aqueous solution. On the aspect of removal of Cu (II) ion by treated rice husks powder, the removal percent depends on pH, the mass of used adsorbent and the time contact between sorbent and sorbate. In the effect of pH, the optimum pH for the removal of Cu (II) ion was observed at pH 4. Sorption experiments which were based on the mass of adsorbent dose were conducted. The main observation was that the percent removal of metal ion increase with increase in mass of adsorbent dose. It was found that the equilibrium time for the removal of Cu (II) ion was 100 min in contact with treated rice husks powder and metal ion solution. Therefore rice husks powder can be regarded as a biosorbent which has the ability to remove Cu (II) ion from waste water.

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References

Aydin H, Bulut Y and Yerlikaya C, (2008), "Removal of Copper (II) from aqueous solution by adsorption onto low-cost adsorbents", *J. Environ. Manage*, **87**, 37-45.

Egon Eiberg, Nis Wiberg. Amold Frederick Holleman (2001), "Inorganic Chemistry", Academic Press, p. 1263

FAO (1997), “Rice By-Products in Asia”, RAP Publication, The UN-RAP Bangkok, Thailand.

Gordon, R.B., Bertran, M., Graedel, T.E. (2006), "Metal stocks and sustainability", *PNAS*, **103**(5): 1209-1214.

Holleman, A.F., Wiberg, E., (2001), "Inorganic Chemistry", Academic Press: San Diego, ISBN 0-12-352651-5

Martin, Susan R. (1995), "The State of Our Knowledge About Ancient Copper Mining in Michigan", *The Michigan Archeologist* **41** (2-3): 119.

Stelter, M., Bombach, H. (2004), Process Optimization in Copper Electrorefining", *Advanced Engineering Materials* **6**(7): 558.