RICE HUSK APPLICATION FOR BIOSORPTIVE REMOVAL OF CADMIUM IN DIFFERENT EXPERIMENTAL CONDITIONS

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ABSTRACT

Rice husk is one of the byproducts of rice production which could be used in biosorption processes for removal of toxic heavy metals from synthetic wastewaters. In this study the application of rice husk as a biosorbent was investigated for removal of cadmium ions from aqueous solutions. Several batch experiments were conducted with different values of test conditions including pH, temperature, contact time, sorbent concentration and size, and rotation speed. The results showed different efficiencies for different experimental conditions which confirm. The greatest removal percent was 34.50 and the least was 2.32 with *Q* value, milligram of metal removed per gram of sorbent, of 2.30 and 0.24, respectively. This suggests the importance of these parameters for the process, a point for future studies in batch or pilot scales.
Keywords: rice husk, biosorption, cadmium, batch experiments, removal percent

INTRODUCTION

The byproducts of crop production in some cases represent a major disposal problem for agriculture as well as the environment (Saikaew et al., 2009). One of these materials is rice husk which has extensively used in biosorption of environmental pollutants such as paraquat (Rahman et al., 2005), surfactants (Hosseinnia et al., 2006), and heavy metals (Sharma & Singh, 2008). In recent years, special attention has been focused on the use of natural adsorbents as an alternative to replace the conventional adsorbents.The abundance and availability of agricultural by-products make them good sources of raw materials for natural sorbents. Rice husk is one of these materials (El-Said etal., 20 10). Toxic heavy metals like cadmium pose a risk to human health due to their extensive release into the environment. (El-Said etal., 20 10). In this paper, the work aims to study the efficiency of cadmium biosorption onto untreated rice husk.

MATERIALS & METHODS

Biosorbent Preparation

Rice husk obtained from Lenjan, Isfahan Province, early in the summer of 2011, were ground to different sizes and sieved by ELE Sieve Series so that four sizes of rice husk were resulted. For facilitation, each size was donated with an alphabetical letter from A to D with Mesh No. of ELE Sieve Series between 4 and 10, 10 and 16, 16 and 20, and 20 and 30 for A, B, C, and D, respectively. All these biomaterials were dried in 80^{o}C and preserved before use.

Metal Solution Preparation

A cadmium solution with the concentration of 20 mg/L was prepared. The stock solution was made by dissolving calculated amount of $CdCl_2.H_2O$ (Merck, Germany) in distilled water.

Experimental Conditions

Eight experiments were conducted. Each experiment was done in a set of six parameters including pH, temperature, contact time, sorbent concentration, sorbent size, and mixing speed at four levels (Table 1)

TABLE 1. Experimental Conditions of Tests

Test No.	pH	Temperature (^oC)	Contact Time (min.)	Sorbent Concentration (g/L)	Sorbent Size	Mixing Speed (rpm)
1	3	25	15	2	A	80
2	5	30	45	2	D	200
3	6	35	180	3	C	200
4	7	40	90	3	B	80
5	3	25	180	5	B	160
6	5	30	90	5	C	120
7	6	35	15	4	D	120
8	7	40	45	4	A	160

Absorption Experiments

All the experiments were done in batch mode in 250 ml Erlenmeyer flasks containing 100 ml metal solution with initial concentration of 20 mg/L. For each experiment the pH of cadmium solution was adjusted by 0.1 N NaOH and 0.1 N H_2SO_4. Then, the desired amount of rice husk from appropriate size added to the solution and the flask was sealed with aluminum foil. The mixture was incubated in a shaker incubator (ParsAzma, Iran) with desired contact time and rotation speed. At the end of the process, pH of the mixture was adjusted to 3-3.5 immediately before filtration through a medium filter paper (Whatman, 40). The final concentration of metal in the filtrate was determined. Each of the eight tests mentioned in table 1 was done in duplicate.

Determination of Metal Concentration

The concentration of cadmium in the filtrate was analyzed using PG990 Atomic Absorption Spectrophotometer (PG Instruments, England) in Flame mode. The analyses were done with 326.1 nm wavelength, Flowrate of 1600 ml/min., and pressure of acetylene and air adjusted on 0.9 bar and 40 psi, respectively. The instrument was calibrated using standard solutions.

RESULTS

The final metal concentration at the end of the process was determined. Mean of duplicates was used for calculation of removal percent using the following formula:

$$\%Removal = \frac{C_0 - C_e}{C_0} \times 100$$

Where C_0 is the initial metal concentration and C_e is the mean of final metal concentration.
Also, the amount of removed metal per absorbent mass unit (mg/g) was calculated as below:

$$Q = \frac{(C_0 - C_e)V}{M}$$

Where V is the aqueous phase volume (L) and M is the amount of absorbent in the test flask (g).
The results for the biosorptive tests are presented in table 2.

TABLE 2. Efficincy of Biosorptive Application of Rice Husk in Different Conditions

Test No.	%Removal	*Q* (mg/g)	Test No.	%Removal	*Q* (mg/g)
1	2.32	0.24	**5**	5.82	0.26
2	7.84	0.92	**6**	31.31	1.22
3	34.50	2.30	**7**	15.02	1.00
4	17.33	1.04	**8**	19.45	1.12

As it is showed in table, the greatest removal percent was 34.50 (with *Q* of 2.30) for experiment 3 and the least was 2.32 (with *Q* of 0.24) for experiment 1.

DISCUSSION

Rice husk is an agricultural waste material generated in rice producing countries. The annual world rice production is approximately 500 million metric tons, of which 10 – 20% is rice husk (Ahmad Khan et al., 2004).The biosorption of Cd(II) is reported greater when is treated with chemicals. Also, adsorption of Cd (II) was shown to be dependent on different experimental conditions such as temperature and pH of the solution. The maximum adsorption is some studies was reported higher than 90% for this sorbent (Ahmad Knan et al., 2004). Some other authors have also studied rice husk for biosorption of zinc ions with maximum removal of 75% (Sharma & Singh, 2008). In some researches in this case the rice husk ash is used instead of raw rice husk (El-Said et al., 2010). So, further studies should be conducted to determine the contribution of each of the parameters examined in the present study to the process using untreated and chemically treated rice husk. This would introduce the best operational conditions for using such biomaterial for bioremediation of contaminated aqueous environments in batch and pilot scales.

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