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Zinc (Zn) Removal from Textile Wastewater by Saw Dust Fixed Bed Column

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Abstract

The textile industry has been recognized as one of the industries that produces high discharged rate of wastewater with high volume and composition of contaminants to the environment. Zinc (Zn) is one of the contaminant that commonly found in textile wastewater. An investigation on the capability of saw dust to remove Zn in the textile wastewater was done. The abundance of saw dust produced from the saw mill will bring adverse effects on the environment. In this study, an investigation of Zn removal was carried out by using saw dust fixed bed column. The effect of types of sawdust, adsorbent dosage and adsorbent particle size to the Zn removal was studied. The results showed that the carbonized sawdust with 15g of adsorbent dosage and 150µm of adsorbent particle size gives the highest percentage of Zn removal with lowest time taken. This study indicates that sawdust has the potential to be employed as an adsorbent for Zn removal in textile wastewater.

1. Introduction

The textile industry is one of the industries that contribute to water quality problem. Many chemicals used in the textiles industry cause environmental and health problems (Khan & Malik, 2013). Zinc (Zn) is a lustrous bluish-white and reactive metal commonly found in the wastewater. Zn will combine with oxygen and other non-metals (Lenntech, 2008), producing another compound that could highly harm the the environment. Disposal of textile wastewater that contains Zn to the environment without any prior treatment may deteriorate quality of water and is harmful to the aquatic ecosystem and its biodiversity. Therefore, it is crucial to have a proper textile wastewater treatment before being disposed to the environment.

Adsorption treatment using by-product as the raw matrials to treat wastewater has been a popular choice because of its low cost and easy to get. The abundance of sawdust as a by-product can be used as an adsorbent agent to treat the textile wastewater. Sawdust refers to the tiny-sized and powdery wood waste produced by the sawing of wood with no profitable use and can cause serious environmental problems if disposed of inadequately (Couto et al., 2011). The contact with the sawdust can cause conjunctivitis, hay fever, asthma, coughing, hypersensitivity pneumonia and other respiratory diseases (McCann & Babin, 1995). Therefore, this study was aim to remove Zn contaminant in textile wastewater, which then could help reduce the abundance of saw dust that have bad effect to both human and environment.

2. Materials and Methods

2.1. Sample Collection

Textile wastewater was collected from textile workshop while saw dust was collected from wood workshop that located in Bachok, Kelantan. The textile wastewater was collected in polypropylene bottle that was rinsed with hydrochloric acid (HCl) to avoid contamination. The samples were then put in icebox and transfer to the laboratory for further analysis. Saw dust that was collected from the wood workshop was put in a zipper bag and then transferred to the laboratory for further process.

2.2. Sample Preparation

The collected sawdust was washed with distilled water and dried at 80°C for 24 hours before it was grinded and sieved into two different sizes (150 and 600µm) (Vinodhini & Das, 2010). Then, about 500 g of grinded saw dust was carbonized in a furnace at 500°C for 1 hour (Geçgel et al., 2013). The raw and carbonized sawdust were then stored in a separate tight lid container (Raffiea et al., 2012) for further process.

2.3. Fixed Bed Column Experiment

The fixed bed column experiment was made using a transparent polyethylene tube with 5cm diameter,

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25cm long and 17.67cm^2 surface area which holds vertically by the retort stand. The bottom of the column was closed by nylon filter mesh (<150µm) in order to hold the sawdust in the column.

2.4. Textile Wastewater Treatment

The initial concentration of Zn in the textile wastewater was analyzed using Colorimeter DR900. Then, the fixed bed column experiments were conducted to remove the Zn in textile wastewater at room temperature (Evans, 2010). The experiment was conducted in two set. Raw saw dust was used in Set A and carbonized saw dust was used in Set B with different weight of absorbent and different size of adsorbent particle as shown in Table 1. 100mL of textile wastewater was passed through the column with flow rate of 37.5mL/min by using burette for both set of experiment.

Table 1: Fix bed column experiments

Parameter	Set A	Set B
Type of sawdust	Raw	Carbonized
Size particle (µm)	150 and 600	150 and 600
Adsorbent weight (g)	5 and 15	5 and 15

The percentage of Zn removal was calculated as Equation 1 (Selvanathan et al., 2015).

$$\%\, removal = \left(\frac{C_o - C_t}{C_o}\right) x\ 100 \qquad \text{Equation 1}$$

Where C_o is the Zn value before the wastewater treated, while C_t is the Zn value after the wastewater treated.

3. Results and Discussion

The fixed-bed column experiment was done in two sets. Each set has four columns with different parameters as shown in Table 1. The height of the saw dust and time taken for 100mL of textile wastewater completely went through the adsorbent for each column were shown in Table 2.

Table 2: Height and time taken

	Set A				Set B			
Size (µm)	150		600		150		600	
Dosage (g)	5	15	5	15	5	15	5	15
Height (cm)	4.1	11.5	3.5	10.0	4.7	17.5	4.3	13.5
Time Taken (min)	7	14	142	660	9	10	42	62

The highest height of adsorbent is from carbonized sawdust with 15g of dosage and 150µm of the size particle. The fastest time taken for the textile wastewater to completely go through the adsorbent are from raw sawdust with the size of particle 150µm and 5g of dosage for about 7 minutes while the slowest to complete the experiment are from raw sawdust with 600µm and 15g with the time of 660 minutes.

After the fix-bed column experiment, the concentration of Zn in the textile wastewater was once again measured using DR900 Colorimeter in order to analyse the effect of the type of adsorbent, adsorbent dosage and adsorbent particle size in Zn removal. The Zn removal percentage of each set of fixed-bed column experiment was calculated and shown in Figure 1.

The results indicate that the type and particle size of the adsorbents did not give a big influence in Zn removal in the textile wastewater. This is because the difference of Zn removal percentage was only between 1 to 5%. However, the weight of the adsorbents did give a big influence in the Zn removal. This is because the difference of Zn removal percentage was between 40 to 50%. Meaning that the more adsorbent used, the more Zn will be removed from the textile wastewater.

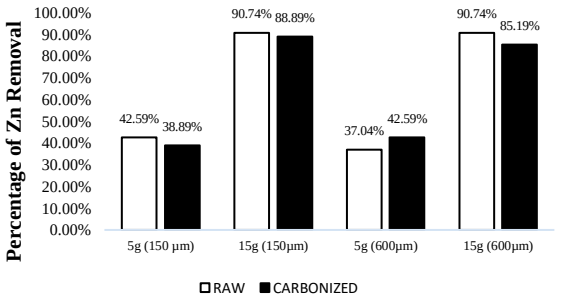

Figure 1: Effect of type, dosage and particle size of Zn removal

The highest percentage of Zn removal (90.74%) in textile wastewater is by raw saw dust fixed-bed column with 15g of adsorbent dosage and 150 and 600µm adsorbent particle sizes. However, from the experiments it can be concluded that the best fixed-bed column set for Zn removal in textile wastewater is by the carbonized fixed-bed column with 15g of adsorbent dosage and 150µm adsorbent particle sizes. This is because the time taken for Zn removal by 150µm adsorbent particle sizes is only 10 minutes with 88.89% Zn removal.

4. Conclusion

Based on the results and discussion in this research, it shows that saw dust could be employed as a potential adsorbent for the Zn removal from the textile wastewater. The sawdust has successfully removed the Zn from textile effluents in this research with highest removal percentage of 90.74%.

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