

Adsorption of Cu^{2+} and Pb^{2+} By Biological Carbon from Mixed Waste

HUA Shucong^a, FU Ying^{*b}

School of Civil Engineering and Architecture, University of Jinan, Jinan 250022, China

^a864095816@qq.com, ^bcea_fuy@ujn.edu.cn

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Abstract. The sewage sludge and banana peel are typical solid wastes. In this paper, sewage sludge and banana peel blends were used as raw materials for the preparation of mixed waste biological carbon. Adsorption performance of Cu^{2+} and Pb^{2+} at different raw material ratios were investigated. The results showed that there is no linear relationship between the adsorption performance of mixed waste biological carbon on Cu^{2+} and Pb^{2+} and the raw materials ratios. In this experiment, the optimized adsorption performance highest Cu^{2+} and Pb^{2+} removal capacity over 90% when the raw material ratios of the sewage sludge and banana peel was 4:1.

Introduction

The amount of sewage treatment in municipal wastewater treatment plants has increased greatly with the acceleration of economic development and urbanization what followed was a sharp increase in the production of sludge. According to the statistics of the advance seminar on technology and application of municipal sludge treatment and disposal in China, by the end of June 2017, the annual output of sludge in China is more than 50 million tons (80% water content). The characteristics of sewage sludge in different regions has the large mud quality and high sand content, so the treatment of sewage sludge is very difficult. The sludge contains not only harmful substances such as heavy metals, pathogenic microorganisms, refractory organic matter, but also a large number of organic matter that can be used. If it is used effectively, it will produce very considerable economic and social benefits [1-2]. At present, the main problems to be solved in sludge treatment are sludge reduction, stabilization, harmless and resource treatment, and pyrolysis is one of the effective ways to solve this problem. [3]. In recent years, the application of sewage sludge biochar is becoming more and more widely in the environment protection. At present, it is mainly used as a soil modifier [4-5], heavy metal adsorbent [6-7], treatment of landfill leachate [8] and so on. With the increase of ash content and volatilization of sewage sludge, there are some problems in the process of pyrolysis such as incomplete pyrolysis, poor volatilization, poor application performance and so on [9]. Similarly, banana peel as a solid waste, which contains a large amount of cellulose, hemicelluloses and lignin, has good pyrolysis characteristics. The co-pyrolysis of sewage sludge and banana peel blends can make up the deficiency of the separate pyrolysis of the sewage sludge and to prepare the mixed waste biological carbon with better adsorption properties [10-11].

Heavy metal pollution is also an environmental problem in the process of economic development. Using mixed waste bio carbon as an adsorbent to treat heavy metal wastewater, compared with traditional heavy metal wastewater treatment methods, such as chemical precipitation method, ion exchange method, electrolytic deposition method and reverse osmosis membrane method, it has the advantages of faster, more efficient and low cost. And it can also achieve the purpose of eliminating waste by waste.

In this paper, the mixed waste biological carbon was prepared by the sewage sludge and banana peel blends. The adsorption effects of the mixed waste biological carbon on Cu^{2+} and Pb^{2+} in aqueous solution were studied. The effects of the raw materials ratios on the adsorption properties of the mixed waste biological carbon were investigated.

Materials and methods

Preparation of mixed waste biological carbon. The sewage sludge for mixed waste biological carbon was collected from a sewage treatment plant. The banana peel is taken from the market. The sewage sludge was dried in the outdoor, crushed and filtered through a 100-mesh sieve, and finally packed in a sealed plastic bag and spare. Then, mixing the sewage sludge and banana peel according to the four proportion of 5:1, 4:1, 2:1 and 1:0 respectively. Pyrolysis of the sewage sludge and banana peel blends was carried out in a high temperature box type resistance furnace. After pyrolysis, the resultant mixed waste biological carbon with different raw material ratios and transferred into a sealed plastic bag.

Experiment design.

Preparation of experimental water samples. Cu^{2+} stock solution 1000ml was prepared by dissolving 10g $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (AR) in pure water. Pb^{2+} stock solution 1000ml was prepared by dissolving 1.599g $\text{Pb}(\text{NO}_3)_2$ (AR) in pure water. Afterwards, Cu^{2+} and Pb^{2+} -experimental solutions were prepared by diluting the stock solutions to required concentrations as an experimental water sample according to the experimental requirements.

Adsorption test procedure. Approximately 1g of mixed waste biological carbon was placed into a 250mL conical bottle. Then, 100 mL of Cu^{2+} or Pb^{2+} -experimental solutions was added and put in a adjustable constant temperature rocking bed at a certain rate and temperature. And then take a sampling solution at different time points between 0h-48h. After that, the mixed waste biological carbon was separated from the sampling by filtration with a $0.45\mu\text{m}$ filter membrane. Next, the concentration of the remaining Cu^{2+} or Pb^{2+} in the solution was measured by Atomic Absorption Spectrophotometer, and the removal percentage of Cu^{2+} or Pb^{2+} at different time points was calculated.

Results and discussion

According to the effect of adsorption test, the relation curves of the removal percentage of Cu^{2+} and Pb^{2+} and time onto different raw material ratios of mixed waste biological carbon, as shown in Fig. 1 and Fig. 2.

According to Fig. 1 and Fig. 2, the raw material ratios is one of the main factors that affect the adsorption performance of mixed waste biological carbon. As the proportion of banana peel increased, the adsorption performance of Cu^{2+} and Pb^{2+} by mixed waste biochar showed a great change.

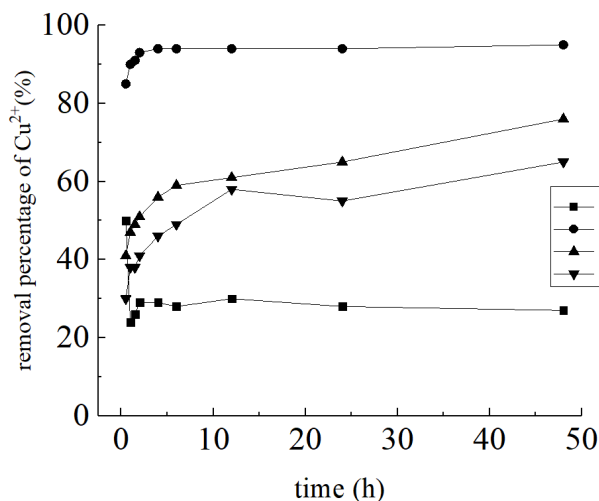


Fig. 1 Relation curves of removal percentage of Cu^{2+} and time

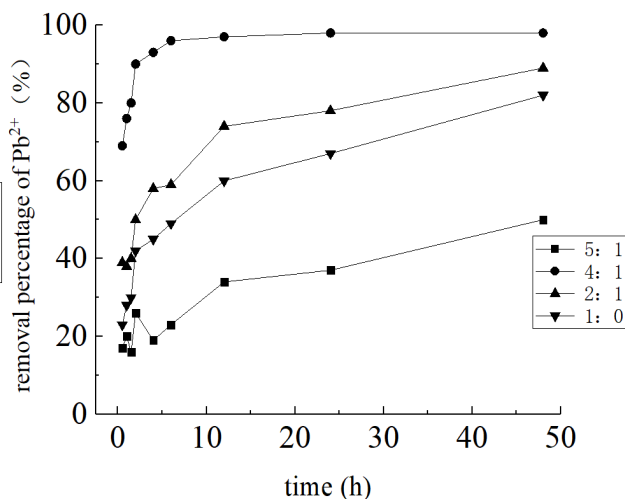


Fig. 2 Relation curves of removal percentage of Pb^{2+} and time

According to the change of the curve, when the raw material ratios is 4:1, the removal percentage of Cu^{2+} and Pb^{2+} is the largest, all of which are above 90%. In addition, the adsorption equilibrium can be reached earlier when the raw material ratios is 4:1. When the raw material ratios is 5:1, the removal percentage of Cu^{2+} and Pb^{2+} is lower than that of mixed waste biological carbon with the raw material ratios of 1:0. When the raw material ratios is 2:1, the removal percentage of Cu^{2+} and Pb^{2+} by mixed waste biological carbon is between 4:1 and 1:0.

The reason why the removal percentage different is that the mixed waste biological carbon was prepared by co-pyrolysis of sewage sludge and banana peel blends with rich carbon content. In the process of pyrolysis, the sewage sludge and banana peel are not only a simple physical mixture, but a certain synergistic effect which makes the adsorption performance of mixed waste biological carbon change.

As a biomass material, banana peel will increase the content of carbon in the sewage sludge. After the pyrolysis, it will help to produce more abundant pore structure, and also enhance the adsorption performance of the mixed waste biological carbon. However, it is also found that there is not have linear relationship between the raw material ratios and the removal percentage. In addition, when the ratio of the sewage sludge to banana peel is 5:1, the removal percentage of Cu^{2+} and Pb^{2+} is even lower than that without the banana peel. The mechanism still remains to be explored.

Conclusions

Sewage sludge and banana peel blends were used as raw materials for the preparation of mixed waste biological carbon and it has strong adsorption performance for heavy metal ions in water.

In this experiment, when the raw material ratios is 4:1, the removal percentage of Cu^{2+} and Pb^{2+} is the largest, and the adsorption equilibrium can be reached earlier. There is no linear relationship between the raw material ratios and the removal percentage. The relationship between them is still to be explored.

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