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STUDY ON ADSORPTION PROPERTY OF MODIFIED DIATOMITE AGAINST CU2+ IN WASTEWATER

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ARTICLE DETAILS

ABSTRACT

Article History:

Received 26 June 2018 Accepted 2 July 2018 Available online 1 August 2018 The performance of adsorption for Cu2+ was carried out with Polyacrylamide modified diatomite as adsorbent. The experimental results show that the addition amount of modified diatomite, the time of adsorption and the initial concentration of Cu2+ have great influence on the adsorption effect of Cu2+. When the amount of modified diatomite was 10g/L, the adsorption effect was the best. The adsorption time of the modified diatomite on the adsorption of Cu2+ was saturated after 40min. With the increase of Cu2+ concentration, the modified diatomite on the removal rate of Cu2+ decreased gradually.

KEYWORDS

Modified diatomite, heavy metal ions, wastewater, polyacrylamide.

1. INTRODUCTION

In recent years, the problem of water pollution has become more and more serious. Especially the problem of excessive heavy metals in water has attracted more and more attention. Among them, Cu is a heavy metal that is harmful to the human body and living organisms. Cu has a high content in urban sewage, which mainly comes from the industrial wastewater of metallurgy, electroplating, and chemical industries [1]. Containing Cu wastewater into the human body will lead to hepatic disease in the liver, and even induce cancer [2]. In addition, Cu-containing wastewater has a greater harm to organisms in the water [3]. Therefore, how to reduce the content of Cu ion in water has become an urgent problem to be solved.

At present, the most commonly used methods for removing Cu ions from water are chemical precipitation, oxidation-reduction, electrolysis, membrane filtration, ion exchange, and adsorption, etc. [4-6]. Among them, the adsorption method is the most widely used. This method has the advantages of low cost, simple operation, and low secondary pollution [7].

Diatomite itself has more pores, which makes the specific surface area of the diatomite larger. Many researchers tend to use this cheap diatomite to treat heavy metals and harmful substances in the waste water [8-10]. However, it is not ideal to use diatomite to treat heavy metals in wastewater. The modified diatomite is used to study the influence factors of the modified diatomite on the adsorption properties of Cu2+ in wastewater after the treatment of polyacrylamide.

2. EXPERIMENT

2.1 Experimental materials and instruments

>800 polyacrylamide (molecular weight million). Cationic natural diatomite (Hua Xuechun), copper nitrate Cu (NO3) 2. 3H2O, nitric acid, hydrochloric acid, sodium hydroxide, deionized water. pHS-3C precision acidometer, 722s visible spectrophotometer, 8002 constant temperature water bath, JB90-D magnetic stirrer, temperature drying oven, electronic balance, vacuum pump.

2.2 Preparation of polyacrylamide modified diatomite

Diatomaceous earth was sequentially dried, crushed, ground, and then passed through a 200-mesh sieve. The diatomaceous earth having been sieved at a concentration of 1 mol/L hydrochloric acid was mixed at a molar ratio of 1:10, and the mixture was stirred for 48 hours. Impurities

were filtered, washed with water until neutral, and then dried.

Take 20 g of the treated diatomaceous earth, add 100 mL of a certain concentration of cationic polyacrylamide aqueous solution, and control the temperature at 45°C. and stir for 2 h, and then conduct suction filtration followed by drying to obtain polyacrylamide-modified diatomaceous earth.

2.3 Treatment of wastewater with Cu2+ in modified diatomite

Take 50 ml of Cu^{2+} containing solution of known concentration in a 250 ml Erlenmeyer flask, add a certain amount of modified diatomaceous earth, according to different experimental requirements, under the conditions of changing the experimental conditions, shake adsorption for 1 hour, adsorption is completed After that, the supernatant was taken, and its residual ion concentration was measured by visible spectrophotometry. Calculate the removal rate and the amount of adsorption using the formula below.

$$R = \frac{C_0 - C}{C_0} \times 100\% \qquad (1-1)$$

$$q = \frac{(C_0 - C)V}{m} \qquad (1-2)$$

$$q = \frac{(C_0 - C)V}{m} \tag{1-2}$$

3. RESULTS AND DISCUSSION

3.1 Effect of modified diatomite dosage

Under room temperature, take 50ml of 1.5mmol/L Cu2+ solution and change the amount of modified diatomite to 1g/L, 3g/L, 5g/L, 10g/L, 20g/L, 30g/L respectively. The solution was shaken for 1 h, then the concentration of Cu²⁺ in the solution was determined by centrifugation. The effect of the amount of modified diatomite on the adsorption of Cu2+ in the wastewater was investigated. The removal rate and the adsorption amount were calculated according to Formulas 1-1 and 1-2. The results are shown in Figure 1.

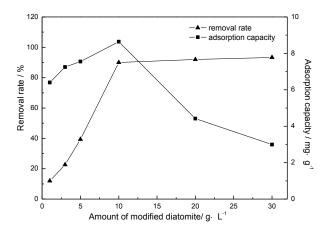


Figure 1: Addition amount of modified diatomite influence on adsorption of Cu^{2+}

It can be seen from Figure 1 that the removal rate of Cu2+ by modified diatomite increases with the increase of the amount of diatomite, and the amount of adsorption increases first and then decreases with the increase of the amount of diatomite. When the amount of diatomaceous earth was 1g/L, 3g/L and 5g/L respectively, the removal rates of Cu²⁺ were 12.00%, 22.67% and 39.33%, and the adsorption capacities were 6.40, 7.25, and 7.55 mg/g, respectively. The rate and amount of adsorption become larger with the increase of the amount of diatomaceous earth. When the amount of diatomaceous earth was 10 g/L, the removal rate and the adsorption amount were 90.00% and 8.64 mg/g, respectively, and the modified diatomite had the largest adsorption capacity for Cu2+. When the amount of diatomaceous earth was increased to 20 g/L and 30 g/L, the removal rate was basically unchanged, and the adsorption amount gradually decreased. This shows that when the adsorption balance is formed between the powder and Cu2+ in the waste water, the amount of added water will increase but it will cause waste. Therefore, the mass concentration of modified diatomite introduced into 1.5mmol/L Cu²⁺ wastewater was selected to be 10g/L.

3.2 Effect of adsorption time

At room temperature, 50ml of 1.5mmol/L Cu^{2+} solution was taken and 0.5g of modified diatomaceous earth was added and shaken and adsorbed for different times (2min, 5min, 10min, 20min, 40min, 70min, 120min, respectively), followed by centrifugation. The concentration of Cu^{2+} in the solution was studied to investigate the effect of adsorption time on the adsorption of Cu^{2+} in wastewater. Calculate the removal rate and the adsorption amount according to Equations 1-1 and 1-2. The experimental results are shown in Figure 2.

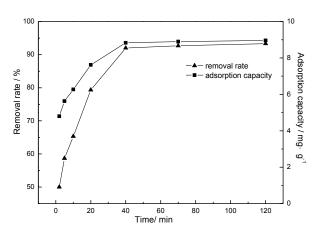


Figure 2: Adsorption time influence on adsorption of Cu²⁺

It can be seen from Figure 2 that the removal rate and the adsorption capacity of the modified diatomaceous earth increase with the increase of the adsorption time, and after 40 minutes, the modified diatomite tends to stabilize the Cu^{2+} adsorption and removal rate. The state, which shows that after 40min, the modified diatomaceous earth has a basically saturated state of Cu^{2+} adsorption.

3.3 Effect of adsorption temperature

Take the concentration of 1.5mmol/LCu $^{2+}$ solution 50ml, add 0.5g modified diatomaceous earth, experiment at constant temperature of 10, 20, 30, 40, and 50°C respectively, shake for 1 hour, and investigate the effect of temperature on the adsorption performance. The experimental results are shown in Figure 3.

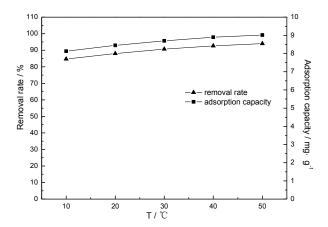


Figure 3: Adsorption temperature influence on adsorption of Cu2+

According to Figure 3, it can be concluded that with the increase of temperature, the removal rate of Cu^{2+} in wastewater and the adsorption capacity of modified diatomite are gradually increasing, but there is no obvious change. At 10°C , the removal and adsorption of Cu^{2+} by diatomite has reached 84.67% and 8.13 mg/g. With the increase of temperature, at 40°C and 50°C , the removal rate reached 92.67% and 94.00%, and the adsorption capacity was 8.90 mg/g and 9.02 mg/g. Therefore, the temperature has little effect on the removal rate and adsorption amount of Cu^{2+} in wastewater.

3.4 Effect of pH on Adsorption

At room temperature, the initial pH of the solution is 4, the concentration is 1.5mmol/LCu²+ solution 50ml, and the amount of modified diatomaceous earth is 10g/L. The pH is adjusted with HNO₃ and NaOH solution to avoid the solution. Precipitation occurs. The pH range of this study is within 2-6. After 1h of shaking adsorption, the concentration of Cu²+ in the solution was measured directly with a visible spectrophotometer by centrifugation, and the effect of the initial pH of the solution on the adsorption of Cu²+ was studied. The experimental results are shown in Figure 4.

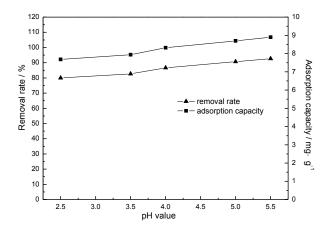


Figure 4: pH value influence on adsorption of Cu2+

From Figure 4, it can be seen that with the increase of the initial pH of the solution, the removal rate and the amount of Cu^{2+} in the wastewater from the modified diatomite increase. When the initial pH value of the solution is 2.5, the removal rate and the adsorption capacity of Cu^{2+} in the wastewater by the modified diatomite are 80.00% and 7.68 mg/g, respectively; when the pH values are 5 and 5.5, the removal rate and the adsorption amount are respectively It is 90.67%, 92.67% and 8.70 mg/g, 8.90 mg/g. The maximum adsorption capacity of diatomite for Cu^{2+} is 8.90 mg/g. It shows that the modified diatomite not only has better adsorption effect on Cu^{2+} in waste water under weak acid condition, but also has better adsorption effect on Cu^{2+} in waste water under the condition of strong acid.

3.5 Effect of initial concentration of solution

At room temperature, 50 ml of Cu^{2+} solution with different concentrations were taken and shaken for 1 hour under the condition that the amount of modified diatomaceous earth was 10 g/L, that is, 0.5 g of diatomaceous earth, and the concentration of Cu^{2+} in the solution was measured by centrifugation. The experimental results are shown in Figure 5.

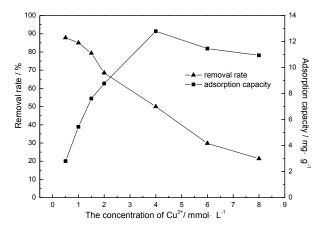


Figure 5: Initial concentration influence on adsorption of Cu²⁺

According to Figure 5, with the increase of the initial concentration of the solution, the removal rate of Cu^{2+} in the wastewater from the modified diatomite gradually decreases. When the initial concentration of Cu^{2+} was 0.5 mmol/L, the removal rate was 87.80% and the adsorption amount was 2.81 mg/g. When the initial concentration of Cu^{2+} was increased to 8 mmol/L, the minimum removal rate was 21.38% and the adsorption amount was 10.94 mg/g. When the ion concentration was increased to 4 mmol/L, the adsorption amount decreased slightly, indicating that the diatomaceous earth had reached a saturated adsorption capacity.

4. CONCLUSION

The factors influencing the Cu^{2+} sorption in the wastewater were studied by using cationic polyacrylamide modified diatomite. The three factors, such as the amount of modified diatomite, the adsorption time and the initial concentration of Cu^{2+} , had a great influence on the adsorption of Cu^{2+} . The experimental results show that: (1) When Cu^{2+} concentration is 1.5mmol/L, the best adsorption effect is when the dosage of modified diatomite is 10g/L, that is, 0.5g of modified diatomaceous earth is added to 50ml of Cu^{2+} solution. (2) The increase of adsorption time is beneficial to improve the adsorption of Cu^{2+} by modified diatomite. After 40 minutes, the adsorption of Cu^{2+} on the modified diatomite reaches a saturation state. (3) As the concentration of heavy metal ions increases, the removal rate of metal ions by modified diatomite gradually decreases.

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