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The preparation and the research of Copper-chelex chitosan for removal ammonia-nitrogen from the drinking water

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Abstract. In order to remove ammonia-nitrogen from drinking water and reduce its threat to human health, Copper-chelex chitosan that is to be the new ammonia-nitrogen remover was prepared by chelating chitosan with copper acetate. In this paper, we measure the effect of this remover with pH= 7.5, 8.5, 9.5 and the concentration of ammonia-nitrogen, such as 1.5mg/L,2.5mg/L,5mg/L,10mg/L and 100mg/L. From the result of this experiment, we draw a conclusion that the removal efficiency of ammonia-nitrogen is about 80% when the pH is greater than 7.5 and the water inflow concentration of ammonia-nitrogen is 100mg/L. as the initial concentration ammonia-nitrogen is increasing, the removal rate is improved regularly.

Introduction

Ammonia-nitrogen contamination of water bodies is a widespread environmental problem. When the concentration of ammonia-nitrogen is greater than 50mg/L, it necessary inhibits the natural nitrification, which causes the lack of oxygen in the water. Undoubtedly, the concentration of ammonia greater than 0.04mg/L will cause the death of the fish in the water[1]. Meanwhile, ammonia-nitrogen promotes eutrophication, which is fatal to aquatic life and a hindrance to the disinfection of water supplies. Recently, there is a large area of the surface water and the ground water in the different polluted range. The concentration of ammonia-nitrogen is must not higher than 0.5mg/L that is specified by the sensory attributes and the general chemical index in《Health standard for domestic》 GB5749-2006 in China[2].

The treatments of ammonia-nitrogen in drinking water include two main groups processes: biological and physical-chemical. Biological denitrification is an eco-friendly and cost-effective method by which facultative anaerobic denitrify bacteria reduce nitrate into harmless nitrogen gas in the absence of oxygen[3]. The biological denitrification process is slow, particularly for the drinking water containing low concentrations of nitrate and for low temperatures. Some people have used SBR method short-course biological denitrification to remove ammonia-nitrogen waste penetrant, the removal efficiency is above 60%[4]. Others applied biological aerated filter to reseach of removal ammonia-nitrogen in wastewater reuse[5]. In this paper, we used the copper-chelex chitosan to adsorb ammonia-nitrogen in the drinking water, Meanwhile, it has a research on adsorption properties according to copper-chelex chitosan. We believe that it will offer the guide for the developing and utilizing this newly adsorption material.

Materials

Main reagents. Acetic acid, Copper acetate, Sodium carbonate, Chitosan(the degree of deacetylation> 95%)

Main equipment. Electronic balance, Centrifuge, Vacuum drying oven, Uv visible spectrometer, PH meter

Methods

The preparation of copper-chelex chitosan. Quantitative chitosan and metal salt in a certain primitive ratio were stirring in the concentration 5% of acetic acid and deionized water. After 5 hours, the chelate reaction was finished. The copper metal complex formed gelatinous alkaline beads of the particle size in different pH. Filtrating the formed metal complex in vacuum, after centrifugal separation, we used the vacuum drying oven to drying sample under a certain pressure. The temperature was 50^0C initially. Then, the solid colloidal beads after drying were grinded in the grinder, in order to form powdery particles.

Results

The relationship between the initial pH and the concentration of ammonia-nitrogen in the effluent water $[NH_3\text{-}N]_E$. The initial pH is the important factor in the process that effects copper-chelex chitosan to chelate with ammonia-nitrogen. It determines the degree and speed in transformation of NH_4^+ to NH_3. In order to have a thoroughly research on the effect, 0.1mol/L sodium carbonate and 0.1mol/L acetic acid were used to adjust pH in initial water.

In the four different influent quality condition, we mearsured the changes of the concentration of ammonia-nitrogen Ce so that drawing a curve point by point(Fig. 1). From the graph, the change rate dC/ dpH is different in defferent pH of influent water. When the pH of influent water was between 6.5 and 7, the change rate was zero. While the pH of the influent water was greater than 7, and less than 7.5, the change rate dC/dpH was varying slowly. As the pH was between 7.5 and 10.5, the change rate varied sharply. It means that among this pH, as the increasing of alkaline in the influent water, we can see the equation(1) :

$$NH_4^+ + OH^- \Leftrightarrow NH_3 + H_2O \qquad (1)$$

Because the balance gone to the left, the ration of NH_4^+ was increased. It maked d orbit in copper ion of copper-chelex chitosan to chelate with lone pair electrons in NH_3. When the adsorption capacity was enhanced, the concentration of ammonia-nitrogen would fall faster. We can see that the pH>10.5, the change rate was from gentle to straight, the treatment effect had been not obvious. In order to obtain the better treatment effect, pH should be controlled in the range of 7.5 to 10.5.

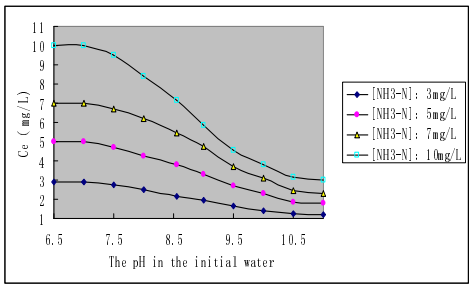

Fig.1. The relationship of pH in the initial concentration of ammonia nitrogen in the effluent water.

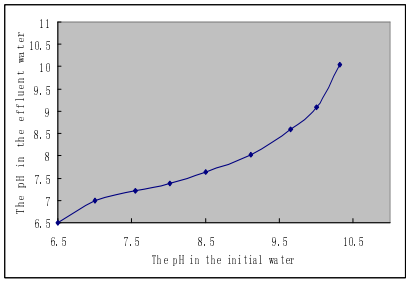

Fig.2. The relationship of pH in the water and the initial water and the pH in the effluent water.

The relationship between the initial pH and the effluent pH. We can see the trend of the effluent pH to decrease (Fig.2) . When the initial pH was alkaline, the effluent pH in which the copper-chelex chitosan adsorbed the ammonia-nitrogen was decreased. The reason is that a part of hydroxyl has token a part in the process of copper-chelex chitosan adsorbing the ammonia-nitrogen. For instance, the pH was 7.5、8.02、9.65 in the initial water, while the pH was 7.2、 7.38、 8.59. However, when the pH was weak acidic, the pH had kept constant. The result shows that the complex reaction of copper-chelex chitosan adsorbing the ammonia-nitrogen was suitable in the alkaline medium.

The effect of $[NH_3\text{-}N]_I$ to $[NH_3\text{-}N]_e$. Obviously, as the $[NH_3\text{-}N]_I$ was increasing, the $[NH_3\text{-}N]_e$ was enhanced (Fig.3). From the graph, we can see while $[NH_3\text{-}N]_e$ is increased, $d[NH_3\text{-}N]_I/d[NH_3\text{-}N]_e$ reduced slowly. It means that the adsorption effect of the copper-chelex chitosan to the ammonia-nitrogen was enhanced, when the initial concentration of ammonia-nitrogen was increasing. When $[NH_3\text{-}N]_e$ is 1.5mg/L, the removal rate was only about 30%, while $[NH_3\text{-}N]_e$ was 10mg/L, the removal rate was enhanced to about 60%, comparing $[NH_3\text{-}N]_e$ was 100mg/L, the removal rate was up to 80%. It meets the need of pretreatment in the waterworks basically.

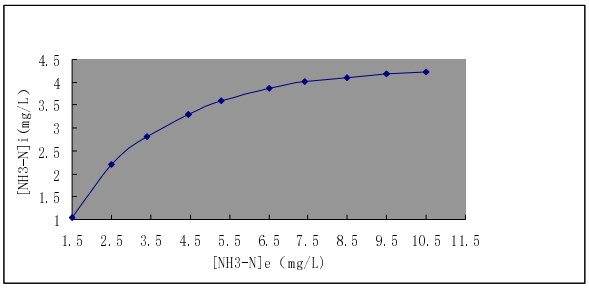

Fig.3. The relationship of $[NH_3\text{-}N]_e$ and $[NH_3\text{-}N]_I$

Summary

In this paper, we used the modified chitosan to cross link the copper ion, in order to prepare a metal complex to adsorb ammonia-nitrogen and reduce the concentration of ammonia-nitrogen.

In the experiment, when the pH in the entering water is from 7.5 to 10, the modified metal complex has a better adsorption properties. Corresponding, the different pH in the effluent water have all depressed trend, that offers the convenience for the subsequent treatment. However, when the initial concentration of ammonia-nitrogen is from 1mg/l up to 10mg/l, the removal rate is increasing thereupon. While the initial concentration of ammonia-nitrogen is 100mg/L, the removal rate is about 80%, that meets the need of pretreatment in the waterworks basically to remove the ammonia-nitrogen.

Through the rearch above, we realized the adsorption properties of copper-chelex chitosan to the ammonia-nitrogen the first time. It is believed that it will provide guidance for the future study.

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