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The Study of Natural Nano-Composite Filter for Industrial Wastewater Treatment

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Abstract

Due to the rapid development of industry, the amount of industrial wastewater and water pollution is a serious problem for environment. Along with the economic development, the complications of wastewater treatment and drainage have been raised. For examples, textile printing and dyeing wastewater as model system, we utilized natural nano-composite filter adsorption test under different concentrations of dye liquid, different times with nano-composite powder, and observed the solutions with spectrophotometer.

The manufacture of natural nano-composite filter was from a variety of mineral flour in accordance with the specific proportion of ore combination, and its inside appearance was like a sponge structure with many nano-sized pores, which increased its adsorption capacity. The production procedure of this natural nano-composite was much simpler than activated carbon, and the failure rate is relatively low, so the cost is lower twice than functional activated carbon. Because it is made of natural mineral powder, it will not cause second pollution to the environment. The final results show that methylene blue and no.257 black dye adsorption capacity of natural nano-composite filter was more effective in high temperature 55℃. Conclusively, we used the absorption curves to demonstrate the absorption kinetics.

Keywords: natural nano-composite filter, textile wastewater, industrial wastewater, adsorption test

1. Introduction

There are many industries that use dyes to stain their products and create a lot of industrial waste. These wastewaters lead to the decrease of transmissibility of rivers and affect the photosynthesis of aquatic organisms. They contain heavy metals and chemical components that promote the toxicity of water and further cause the biological damage to the entire biological chain [1].

A variety of industrial enterprises in the production process of wastewater discharge, including the process of water, machinery and equipment cooling water, flue gas washing water, equipment and site cleaning water and waste production. Wastewater contained in the impurities includes waste, residue and some raw materials, semi-finished products, and by-products. The composition is extremely complex and the content of pollutants varies greatly.

The strict classification of industrial wastewater is very difficult, because the same type of industry can release several different types of sewage at the same time. What more, sewage can have different substances and different pollution effects. Therefore, the industrial wastewater can be divided into two categories according to the ingredients: (1) wastewater containing inorganic substances, including wastewater from metallurgy, building materials and chemical inorganic acid-base

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production; (2) Wastewater containing organic matter, including food industry, petrochemical industry, soymilk, coking, gas, pesticides, plastics, dyes and other factory drainage [2].

This study focuses on the treatment of textile dye wastewater; wastewater dye water quality is complex, according to the characteristics of wastewater and its emission requirements, the selection of appropriate treatment methods. Removal of solid impurities and inorganic, coagulation and filtration can be used; decolorization can generally be coagulation and adsorption process consisting of composition; removal of toxic substances or organic matter, the main chemical oxidation, biological and reverse osmosis; Removal of heavy metals, available ion exchange method, etc. Chemical coagulation: Acid, alkali, salt and organic matter of the low concentration of dye wastewater, the first by the average precipitation, adding an appropriate amount of alkali or acid, and then coagulant flocculation and precipitation. Biological method: Commonly used biological method activated sludge method, biofilm method, oxidation pond method and anaerobic biological method. Adsorption method: Commonly used adsorbents are activated carbon, activated diatomaceous earth, activated coal, and activated clay, lignite and polymer adsorbents. Oxidation method: This method is through a strong oxidation, to destroy the organic matter in wastewater, to achieve a more complete bleaching, detoxification, deodorization and odor purposes [3, 4].

However, so far there is no single method for completely and successfully removing the color from wastewater. Adsorption is the simplest method of removal. The most effective and most commonly used adsorbent is activated carbon, but its high manufacturing and recycling costs, for the large-scale use of the business, it is not cost-effective. [5, 6].

Natural nano-composite filter is a kind of natural ore, after washing with sulfuric acid and baking at high temperature, it can be processed into granules. For example, by adding natural adhesive can make the powder into filter particles. The appearance of the ore powder is milky white powder, odorless, tasteless, non-toxic, strong adsorption, can absorb colored matter, organic matter; has a larger specific surface area and pore volume, with special adsorption capacity and ion exchange performance, more Strong decolorization ability and activity, and good stability after decolorization. The advantage of using Natural nano-composite filter is that its selective adsorption capacity, and production costs lower than activated carbon [7, 8].

The dyes used in this study are methylene blue and cationic dyestuffs No. 257 black; Cationic dyestuffs does not contain acidic groups in the chemical structure and is cationic in water, also known as cationic dyes. Dye is more stable in acidic solution, with the pH value is not stable, and even precipitation or decomposition. The advantages of good coloring effect, you can dye dark, bright colors, variety, etc [9].

2. Materials and Methods

2.1. Preparation of adsorbent

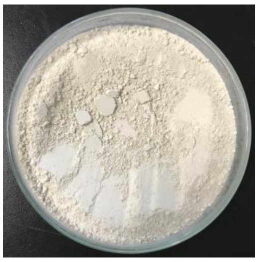

Fig. 1 Natural nano-composite powder

Natural nano-composite filter is a kind of powder (Fig. 1). In order to test the accuracy of the data, you need to go through the washing steps. Weigh 10 g of nano-composite filter in a 50 ml centrifuge tube and add 40 ml of distilled water. Mix well and centrifuge for 5 minutes (3000 rpm, 25℃). Dispense the supernatant and add 10 ml of distilled water into a glass Petri dish and finally oven baked at a high temperature (85℃) overnight.

2.2. Dye solution preparation

In this study, the cationic dye methylene blue was chosen as the control group. The cationic dyestuffs No. 257 black cationic dye was selected as the control group to compare the practicality of the nano-composite filter. A stock solution of 1000 ppm was obtained by dissolving a precisely weighed dye sample in distilled water. Dilute the dye stock solution (1000ppm) to the desired concentration with distilled water if other concentrations are required. All the experiments were without any pH adjustment.

2.3. Experimental method

2.3.1. Adsorption balance time

Weigh 1 g washed with water nano-composite filter placed in 50 ml centrifuge tube and then add 50 ml 300 ppm concentration of the dye solution, mix well, the use of 125rpm operation of the temperature control vibrator bottle placed at 25 ± 2℃ , the sampling interval at different times from the shaker. After centrifugation (3000 rpm, 25℃, 5 min), the residual concentration of the dye solution was measured to use an ELISA at a wavelength of 660 nm (methylene blue) and 600 nm (cationic dyestuffs No. 257 black), respectively.

2.3.2. Effect of pH on adsorption

In a series of 50 ml centrifuge tubes were added 300 ppm dye solution, respectively, adjust the pH, methylene blue to adjust the pH 2 ,3 ,4, 6, 7, 8 25d black cationic dyestuffs adjusted to pH 1, 2, 3, 6, 7, 8; and then add 1 g nano-composite filter, after mixing, using a temperature controlled vibrator operating at 125rpm bottle placed at 25 ± 2℃, shaking 3h. After centrifugation (3000 rpm, 25℃, 5 min), the residual concentration of the dye solution was measured at 660 nm and 600 nm using ELISA(Multislan GO Version 100.40) , respectively.

2.3.3. Effect of different temperature on adsorption

Add 300 ppm of dye solution to a series of 50 ml centrifuge tubes, add 1 g of nano-composite filter, mix well, and place the bottle at 25℃, 30℃, 35℃ using a temperature controlled shaker operated at 125 rpm, 40℃, 45℃, 50℃, 55℃, shock 3h. After centrifugation (3000 rpm, 25℃, 5 min), the dye solution absorbance was measured at 660 nm and 600 nm by using ELISA, respectively.

3. Results and Discussion

The following experimental results for the control group of distilled water, absorbance value is 0.0393.

3.1. Adsorption balance time

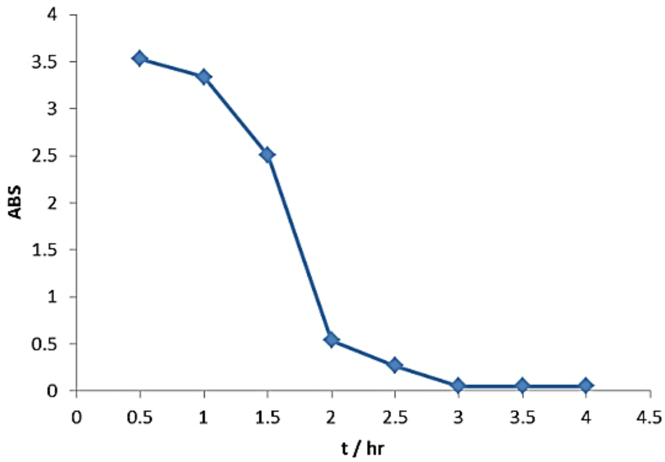

Fig. 2 Adsorption balance time

According to Fig. 2, the absorbance of the supernatant decreases with time and tends to be constant after 3 h. The results show that at room temperature nano-composite filter adsorbed about 3 h equilibrium, and the following experiment selected 3 h adsorption equilibrium times.

3.2. *Effect of pH on adsorption*

The initial pH of Methylene blue solution is pH5. According to Fig. 3, nano-composite filter shows better adsorption when the methylene blue solution pH is 4-6.

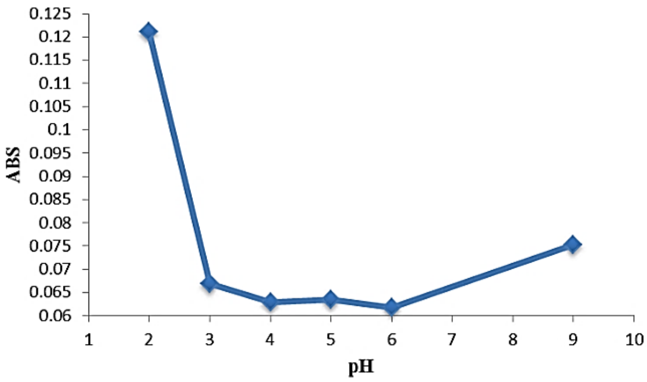

Fig. 3 Effect of pH on adsorption by methylene blue

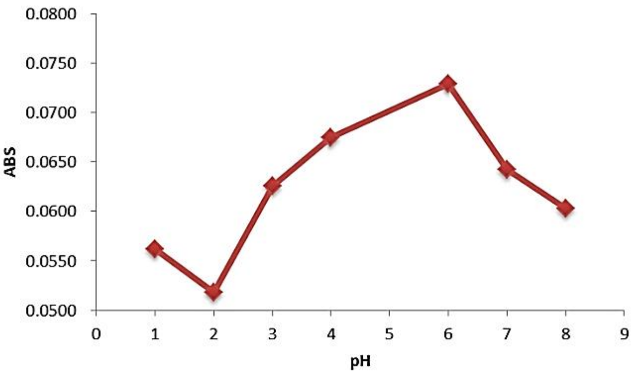

Fig. 4 Effect of pH on adsorption by No.257 black

The initial pH of Cationic dyestuffs No.257 black solution is pH4. According to Fig. 4, the nano-composite filter has the best adsorption when the cationic dyestuffs No.257 black solution is pH 2.

The above results indicate that nano-composite filter for different dyes at different pH results are not the same. It will be different for different agents in different pH value of the adsorption effect has changed, for the methylene blue pH 4-6, nano-composite filter adsorption is the best; cationic dyestuffs No.257 black pH 2, nano- composite filter adsorption effect is also the best, with the pH value increased to 6 the worse the adsorption effect, pH7-8 effect was significantly increased.

3.3. *Effect of different temperature on adsorption*

According to Fig. 5, the result shows that the adsorption capacity of nano-composite filter increases with temperature after 45 ℃, and the best adsorption temperature is 55 ℃. However, the effect is good at room temperature (25 ℃).

Methylene blue is significantly more sensitive to temperature than cationic dyestuffs No.257 black. Methylene blue has a particularly large line-up. In contrast, cationic dyestuffs No.257 black have different results with temperature, but the line undulations are not as big.

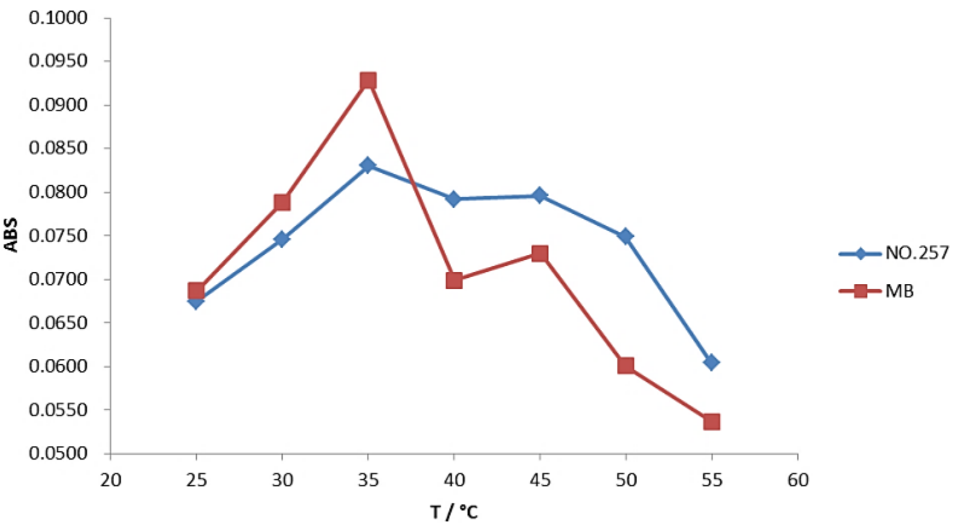

Fig. 5 Effect of different temperature on adsorptio

4. Conclusions

The results show: (1) nano-composite filter adsorption equilibrium time of 3h. (2) nano-composite filter adsorption in acidic environment is better. (3) nano-composite filter At high temperature (> 45 ℃), the adsorption effect increased significantly.

Nano-composite filter manufacturing process is simple, the commodity plasticity is very high. In the future can be made into a filter module, the filter module is able to in the water pipe, put it for adsorption, decolorization; its water-insoluble features, can be added to clean products, to achieve a mild exfoliating effect.

Through another utilization of nano-composite filter adsorption capacity, we could use it into the middle part of a mask to achieve the effect of adsorption of polluted particles. This environmentally friendly material can be used to prevent air pollution of the PM2.5 particles. This product will be the best candidate to prevent pollutions when in the future, the world's water and air are seriously polluted. Our next goal will be exploring the possibility of future applications of this nano-composite material in the field of air and environmental pollutions.

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