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Textile Wastewater Treatment by Electrocoagulation Method

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Electrocoagulation method with iron and aluminum electrodes was used to treat textile wastewater, and the effects of initial pH value, current density, electrocoagulation time on the final pH value, the removal rate of COD, power consumption and electrodes loss were investigated. The results showed that under the condition of initial pH value 7, after electrocoagulation by iron and aluminum electrodes the final pH value increased but not more than 8. When the current density was 7.5 mA/cm^2, COD removal rate of the iron electrodes could reach 72 %. When electrocoagulation time was 15 min COD removal rate of the iron electrodes could reach 76 % and the power consumption was lower than the aluminum electrodes. The optimal electrocoagulation conditions were as follows: iron electrodes were used, the initial pH value was neutral, the current density was 7.5 mA/cm^2 and electrocoagulation time was 15 min.

Keywords: Electrocoagulation, Textile wastewater, Iron electrodes, Aluminum electrodes.

INTRODUCTION

Textile wastewater is a high concentration organic wastewater with high concentration of COD and must be treated before discharging[1]. The common textile wastewater treatment methods are biological methods, chemical methods, physical methods and combination methods[2-4]. Because the composition of textile wastewater change frequently, most conventional technologies are difficult to achieve good treatment effect. Due to the increasing land cost and treatment cost of conventional processes, a simple and high efficiency textile wastewater treatment technology is necessary to be studied. Now the electrocoagulation method has the advantages of small volume, small occupation area, simple and flexible operation, so it is a potential method for waste water treatment. Iron electrodes or aluminum electrodes are used for positive electrodes. Soluble anode dissolves and produces a large number of cations which form a series of polynuclear hydroxyl complex and hydroxide through hydrolysis and polymerization. These products have strong adsorption capacity for contaminants of wastewater. Oxygen and hydrogen are produced on the anode and cathode and have strong adhesion capacity to brought contaminants to the water surface. In the current study, electrolytic oxidation reduction reaction will happen. At present, there are many electrocoagulation researches[5-7] about drinking water treatment, restaurant wastewater treatment, landfill leachate treatment. But electrocoagulation treatment for textile wastewater is still in the laboratory research. More factors of electrocoagulation still need further study such as electrode materials, current density, pH value, electric flocculation time. Iron and aluminum electrodes are used to treat textile wastewater and the influence of pH, current density and electrocoagulation time on electrocoagulation process are investigated in this paper.

EXPERIMENTAL

Electrocoagulation device is shown in Fig. 1. Organic glass are used for two same devices with 62 mm long, 62 mm wide and 120 mm high. One device is put into iron electrodes, another device is put into aluminum electrodes.The electrode spacing is 10 cm, the power is 30 V, 6 A power supply. The indoor temperature is 25 °C. Water tank is used for water supply and water pinch is used to control flow. Magnetic stirrer with speed of 200 rpm is used for electrocoagulation process. After 0.5 h precipitation the supernatant is used for COD test. After reaction the electrodes are washed and weighed. Sodium hydroxide and sulfuric acid are used pH value. The national standard methods are used for analyzed.

RESULTS AND DISCUSSION

Previous studies showed that, the pH value was an important factor affecting electrocoagulation process. pH values will change in the reaction process. This change depends on the value of the electrode materials and initial pH value. This

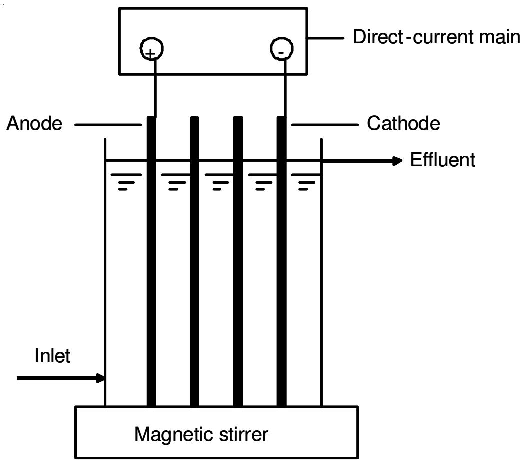

Fig. 1. Electrocoagulation device

experiment was conducted to study under the iron and aluminum two electrodes condition, the final pH variation, the COD removal rate, power consumption and electrode loss caused by the initial pH value of solution. Under the conditions of solution COD 3122 mg/L, initial pH value 3, 5, 7, 9, 11, finally solution pH value and COD removal rate were shown in Fig. 2a and Fig. 2b. As shown in Fig. 2a, along with the continuous increase of the initial pH value, the final pH value increased. When the initial pH value is less than 7, the final pH of iron electrodes value is higher than the final pH of aluminum electrode. When the pH value is greater than 7, the final pH value of iron electrodes is lower than the final pH value of aluminum electrodes. This shows that the solution has certain pH buffering capacity and the buffer ability of the aluminum electrodes is strong. As shown in Fig. 2b, with the increase of the pH value, COD removal rate of the aluminum electrodes decreases. When the pH value is 3, the removal rate of COD is 65.2 % and when the pH value is 11, the removal rate of COD decreases to 32.3 %. With the increase of the pH value, the COD removal rate of iron electrodes increases first, then decreases. When pH value is 3, the removal rate of COD is 48.1 %, when pH value is 7 the removal rate of COD is up to 76.2 % and wheh the pH value is 11, the removal rate of COD decreases to 26.2 %. From the treatment effects of two kinds of electrodes, at pH 7 the iron electrodes reaches maximal removal rate 76.2 % and at pH 3 the aluminum electrodes reaches maximal removal rate 26.2 %. This shows that the effects of the iron electrodes are not only better than that of aluminum electrodes, but also without adjusting the pH value of the solution at maximal removal rate.

Under the conditions of solution COD 3122 mg/L, initial pH value 3, 5, 7, 9, 11, electric energy consumption and electrode loss were shown in Fig. 2c and Fig. 2d. As shown in Fig. 2c, with the increase of the initial pH value, electric energy consumption of the aluminum electrodes is increasing. Electric energy consumption increased from 0.85 kWh/kg COD to 1.65 kWh/kg COD with pH changes from 3 to 11. With the increase of the initial pH value, electric energy consumption of the iron electrodes declines first, when pH is greater than 8 power consumption increases rapidly. This shows that at pH 7, power consumption of iron electrodes is lower than aluminum electrodes for textile wastewater treatment. As shown in Fig. 2d, with the increase of the initial pH value, the loss of the aluminum electrode material increases from 0.1 kg iorn/kg COD to 0.2 kg aluminum/kg COD aluminum. With the increase of the initial pH value, the loss of the iron electrode material decreases at first and then kept stable, when the pH value is greater than 9, the loss of electrodes increases rapidly. Generally speaking, the loss of the iron electrodes is more than that of the aluminum electrodes, but at pH 6-8 range, the iron electrodes loss is slightly higher than the aluminum electrode. Because the price of the iron electrodes is lower than that of the aluminum

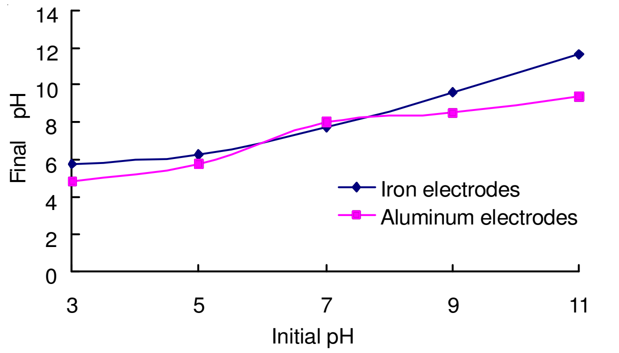

Fig. 2(a). Relationship between the initial pH value and the final pH value

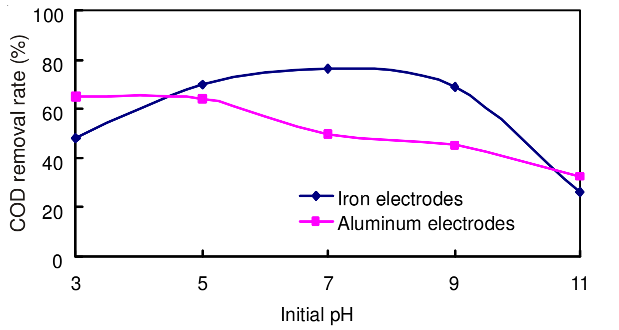

Fig. 2(b). Relationship between the initial pH value and COD removal rate

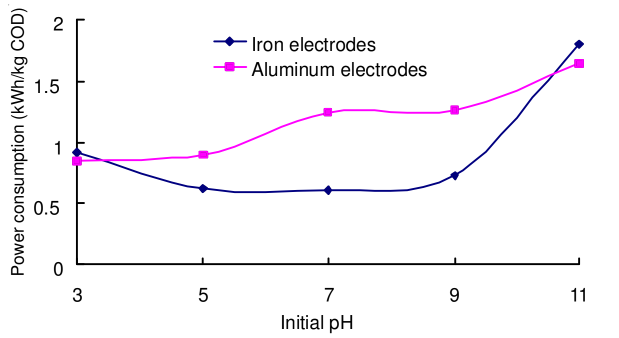

Fig. 2(c). Relationship between the initial pH value and power consumption

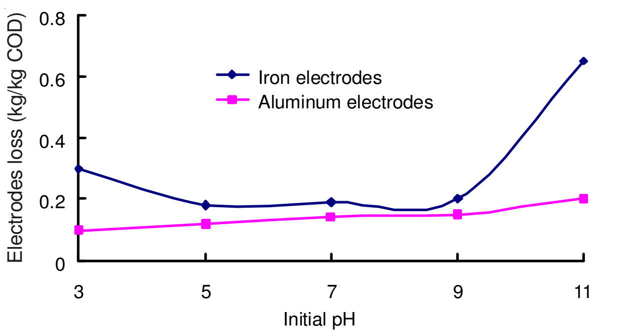

Fig. 2(d). Relationship between the initial pH value and electrodes loss electrodes, the iron electrodes is better than the aluminum electrodes for textile wastewater treatment.

Effects of current density: Current density changes with current strength and the experiment was conducted to study the impacts of the COD removal rate density, power consumption and electrodes loss. As shown in Fig. 3a, when the current density is increased from 5 mA/cm^2 to 15 mA/cm^2, the COD removal rate of aluminum electrode is increasing from 11 to 65 %. When the current density increases from 5 mA/cm^2 to 7.5 mA/cm^2, the removal rate of iron electrodes increased from 57 to 72 % and removal rate has been stable at around 72 % and the optimal current density for iron electrodes is 7.5 mA/cm^2. For the aluminum electrodes when current density increased the COD removal rate rising, but the electric energy consumption is also large with the increasing current density. The removal rate of the iron electrodes is higher than that of the aluminum electrodes under the same current density. As shown in Fig. 3(b), when the current density increases from 5 mA/cm^2 to 15 mA/cm^2, the power consumption of the aluminum electrodes increases from 1.2 kWh/kg COD to 2 kWh/kg COD, the power consumption of the iron electrodes increases from 0.55 kWh/kg COD to 0.82 kWh/kg COD. It is visible that electric energy consumption of the iron electrodes remains low and relatively stable, the power consumption of iron electrodes is less than that of aluminum electrodes at the same current density. As shown in Fig. 3c, when the current density increases from 5 to 15 mA/cm^2, electrode loss of aluminum electrode increases from 0.09 kg aluminum/kg COD to 0.20 kg alumimum/kg COD, the electrode loss of iron increases from 0.11 kg iron/kg COD to 0.26 kg iron/kg COD. It is obvious that under the same current density the iron electrodes loss is higher than that of aluminum electrodes. Because the price of the iron electrodes are low so that the total cost is not higher.

Effects of electrocoagulation time: Electrocoagulation time is an important factor affecting the electrocoagulation effect and cost. This experiment is conducted to study the effect of electrocoagulation time on the removal rate of COD, power consumption and the electrode loss. As shown in Fig. 4a, when electrocogulation time increases from 5 min to 30 min, the COD removal rate of aluminum electrodes increases from 24.7

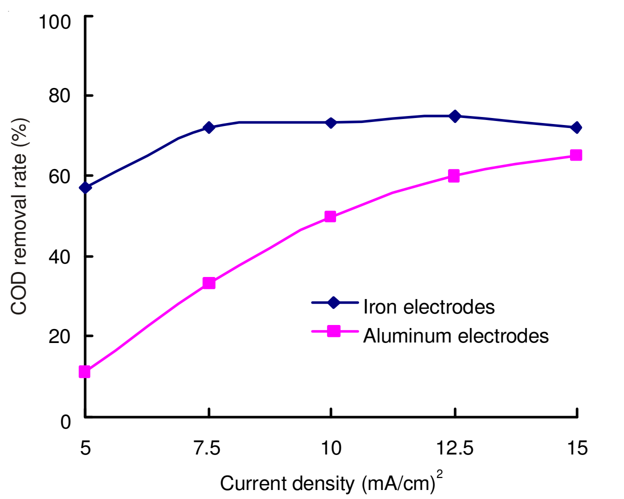

Fig. 3(a). Relationship between the current density and COD removal rate

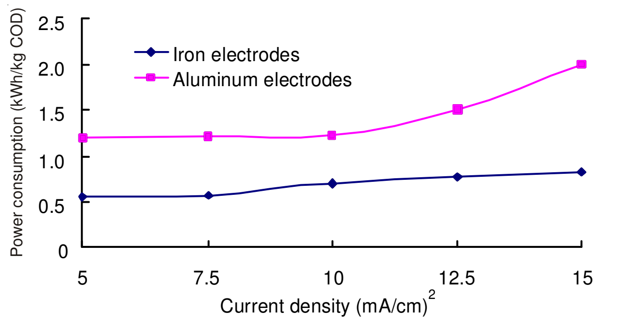

Fig. 3(b). Relationship between the current density and power consumption

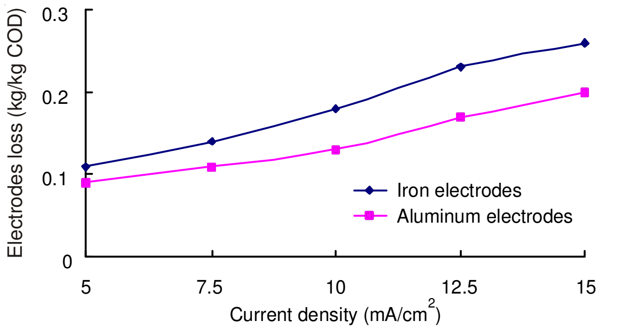

Fig. 3(c). Relationship between the current density and electrodes loss

to 66.2 %. The COD removal rate of iron electrodes has already reached 60 % when electrocogulation time is 5 min and the COD removal rate of iron electrodes reaches 76 %. Therefore, the iron electrodes could get higher COD removal rate in a relatively short period of time. The longer is the electrocogulation, the greater is the power consumption. So from the electrocogulation time point of view, the iron electrode is better than aluminum electrode and the 15 min is the optimal time for iron electrode. As shown in Fig. 4b, with electrocogulation time increasing from 5 min to 30 min, the power consumption of the aluminum electrodes increases from the 1.25 kWh/kg COD to 2.6 kWh/kg COD, the power consumption of the iron electrodes increases from the 0.31 kWh/kg COD to 2 kWh/kg COD. This shows that with increasing electrocogulation time, the energy consumption of aluminum electrodes and iron electrodes is increasing, but the at the same electrocogulation time conditions, the power consumption of the iron electrodes is lower than that of the aluminum electrodes. As shown in Fig. 4c, with electrocogulation time increasing from 5 min to 30 min, the aluminum electrodes loss increases from 0.15 kg aluminum/kg COD to 0.42 kg aluminum/kg COD, the iron electrodes loss increases from 0.12 kgiron/kg COD to 0.56 kg iron/kg COD. The two kinds of electrodes loss all increase with the increase of electric flocculation time, the electrodes loss of aluminum are higher than iron when flocculation time is less than 10 min, but more than 10 min flocculation of former 10 min aluminum, the electrodes loss of iron is higher than that of aluminum.

Conclusions

• Aluminum electrodes and iron electrodes are used to treat textile wastewater and the performance of two electrodes are studied. The iron electrodes and aluminum electrodes can be used as electrodes material, but the iron electrodes can get higher COD removal rate, less power consumption under the

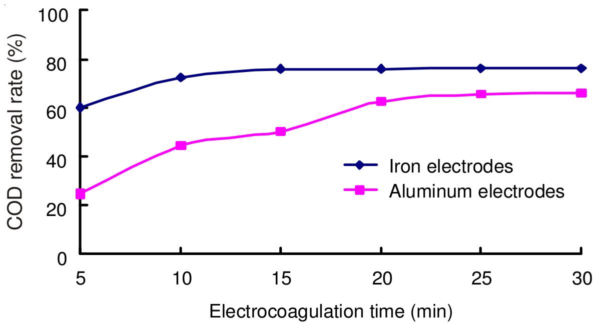

Fig. 4(a). Relationship between electrocogulation time and COD removal rate

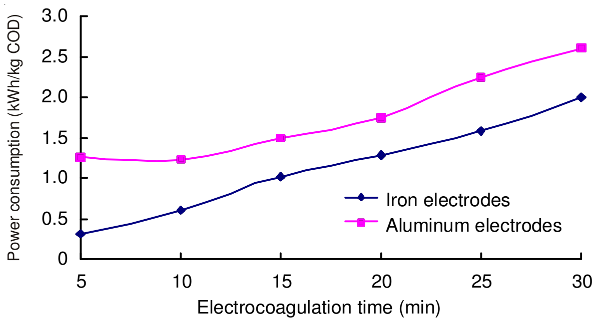

Fig. 4(b). Relationship between electrocogulation time and power consumption

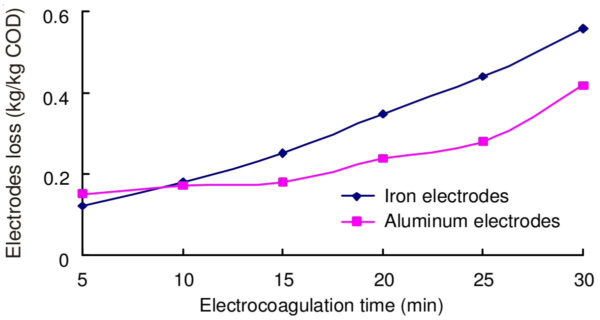

Fig. 4(c). Relationship between electrocogulation time and electrodes loss

same conditions; therefore iron electrodes can be preferable electrodes materials for the treatment of textile wastewater.

• At the same initial pH value, after electrocogulation by aluminum electrodes and iron electrodes, but pH values are less than 8 without adjusting the pH values. With the increase of pH value, power consumption and electrodes loss of aluminum electrodes increases and power consumption and electrodes loss of iron electrodes firstly decreases and then increases.

• The COD removal rate, power consumption and electrodes loss increases with the increase of current density. Under the same current density conditions, the iron electrodes acquires high removal rate of COD, low power consumption, low electrodes loss. When the current density is 7.5 mA/cm^2, the removal rate of COD of iron electrodes can reach 72 %. Along with the increase of electrocogulation time, iron and aluminum electrodes get high COD removal rate, high power consumption and high electrodes loss. Under the same electrocogulation time, iron electrodes get high removal rate of COD, low power consumption, high electrodes loss. When the electrocogulation time is 15 min, the iron electrodes removal rate of COD reaches 76 %.

• The optimum test conditions is as follow: electrode material is iron electrodes, raw textile wastewater pH value is neutral, current density was 7.5 mA/cm^2, the electrocogulation is 15 min.

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