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Effect of micro-electrolytic fillers on the oil removal efficiency in wastewater

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Abstract. Aims to degrease the oily wastewater, the micro-electrolysis treatment with modified fillers was applied in this paper. The effect of micro-electrolytic filler on the oil removal was studied to determine the optimum proportion of carbon-iron, and corresponding preparation conditions. The result shows a relatively greater oil removal rate as 81.4% with safe effluent quality.

1. Introduction

With the extensive oily source, the widespread oil application, the content of oil in wastewater has gradually increased and in China^[1]. By the various types and forms^[2,3], these oily wastes are very difficult to remove from the conventional wastewater treatment. Among the advanced technologies, the micro-electrolysis has been applied in the field of wastewater treatment because of its unique advantages, and achieved good results^[4]. When the micro-electrolytic filler in the solution, the Fe and C in the filler can generate a large potential difference to form a corrosive galvanic cell^[5,6], through a redox reaction^[7,8], physical adsorption^[9,10], the role of the collection^[11] treatment of pollutants in wastewater. However, there are problems such as passivation and slab bonding of the micro-electrolytic filler during the reaction, which has a certain influence on the treatment effect^[12]. Therefore, this paper focused on the modified fillers preparation for micro-electrolytic treatment, and the related oil removal efficiency in wastewater.

2. Research method

2.1. Instruments and materials

During the study, selected instruments included bench emulsifier, pen test pH meter, electronic balance, electric blast drying oven, box muffle furnace; main chemicals were reducing iron powder, activated carbon powder, bentonite, and ammonium bicarbonate. The water sample was simulated with oily wastewater, 10g 0# diesel oil and a small amount of emulsifier are placed in 10L distilled water. After mixing with high-speed emulsifier, about 1000mg/L of simulated oily wastewater is prepared and diluted to a certain concentration^[13].

2.2. Preparation of micro-electrolytic filler

The reducing iron powder and the activated carbon powder were mixed at a mass ratio of 3:1, then add 20% bentonite, 3% ammonium bicarbonate and ionized water and mix evenly to make of spherical particle with a diameter of 1cm^[14]. The prepared spherical particles were dried at 120°C for 20min,



then put it in a muffle furnace at 700°C for 2h and naturally cooled at room temperature to finally obtain a novel micro-electrolytic filler^[15].

2.3. Process of micro-electrolysis

The micro-electrolytic filler prepared according to different ratios was placed in a small beaker of 250mL, and the dosage was 200g/L. 200mL of the water sample was adjusted to pH=3 then carry out an aeration reaction. The reaction time is 60min. Take a small amount of water sample at intervals of 10 minutes and adjust the pH value to alkaline (pH 9~10) with 10% NaOH solution to flocculate and precipitate, then determine the oil content of the supernatant to determine the optimum ratio of micro-electrolytic filler.

3. Results and discussion

3.1. Effect of iron-carbon mass ratio

Under other conditions are unchanged to adjust the iron-carbon mass ratio of 1:1, 2:1, 3:1, 4:1, 5:1, 6:1, studied the effect of the research iron-carbon mass ratio on the removal rate of oily wastewater, research results are shown in Figure 1.

The results indicated that the oil removal rates of each ratio reached 75.7%, 77.1%, 81.4%, 74.3%, 68.6%, 65.7%. When the iron-carbon mass ratio is 3:1, the oil removal rate is the largest and the removal rate shows a decreasing trend as the ratio increases or decreases. The reason is that when the iron-carbon mass ratio is too high, the number of galvanic cells formed is relatively small, so that the treatment effect is lowered; when the iron-carbon mass ratio is too low, the iron powder is less in contact with the removed matter, which is disadvantageous for the reaction to be processed. The effect is reduced. Therefore, this experiment chooses iron to mass ratio of 3:1 as the best iron-carbon mass ratio.

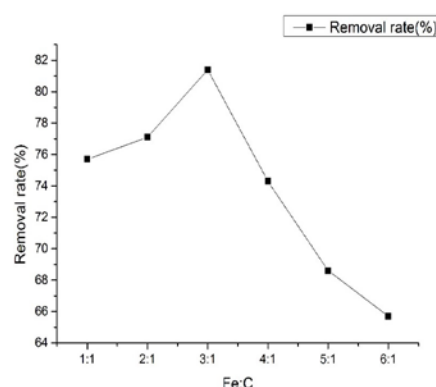


Figure 1. Effect of iron-carbon mass

3.2. Effect of bentonite content

The bentonite content was mixed at a ratio of 10%, 20%, and 30% under other conditions were unchanged, the effect of the research bentonite content on the removal rate of the oily wastewater was as shown in Table 1.

Table 1. Effect of bentonite content.

Bentonite content(%)	Removal Rate(%)
10	73.4
20	81.4
30	70.5

The results show that when the bentonite content is 20%, the oil removal effect is the best, reaching 81.4%. As the ratio increases or decreases, the removal rate shows a decreasing trend. The reason is that the hardness of the filler with a bentonite content of 10% is small and it is easy to be damaged in the research, which affects the removal effect; the hardness of the bentonite with a ratio of 30% is too large that the mixture is difficult to penetrate into the filler. Therefore, the research selected bentonite content of 20% as the best ratio.

3.3. Effect of pore former content

Ammonium bicarbonate was mixed at a ratio of 0%, 0.5%, 1.0%, 2.0%, 3.0%, 4.0% and other conditions were unchanged, and the effect of the research pore-forming agent content on the removal effect of the oily wastewater was tested. The research results are shown in Figure 2.

The results demonstrated that when the ammonium bicarbonate content is 3.0%, the oil removal rate is the highest. When the content of ammonium bicarbonate is less than 3.0%, the oil removal effect of the filler increases sharply with the increase of the addition amount and the removal rates are 10.9%, 38.4%, 51.6%, 68.5%, 81.4%. Above 3.0%, the effect was reduced, the removal rate was 72.4% and the filler was easily broken during the test. The reason is that the increase of the pore-forming agent increases the amount of soluble ions in the filler, and the filler is more susceptible to corrosion, but the excessive dissolution of the soluble ions affects the strength of the matrix of the filler, making the filler more susceptible to breakage during the reaction. Therefore, this experiment selects ammonium bicarbonate content of 3.0% as the best pore former content.

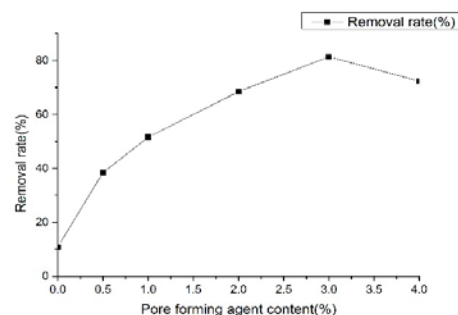


Figure 2. Effect of pore former content.

3.4. Effect of calcination temperature

The materials in the filler are mixed in an optimal ratio, and the calcination temperatures are selected to be 500°C, 600°C, 700°C, 800°C, 900°C, other conditions were unchanged. The research roasting temperature has an effect on the removal rate of the oily wastewater and results are shown in Figure 3.

The results reveal that when the calcination temperature increases, the removal rate increases at first and then decreases, which are 70.3%, 72.6%, 81.4%, 82.0% and 53.6%. The reason is that the calcination temperature is too high or too low, which will affect the strength of the filler and a large amount of damage during the treatment, thereby affecting the removal effect. When the calcination temperature is 700°C and 800°C, the removal rate difference is only 0.6%. From the perspective of energy saving, the calcination temperature is 700°C is the optimum calcination temperature.

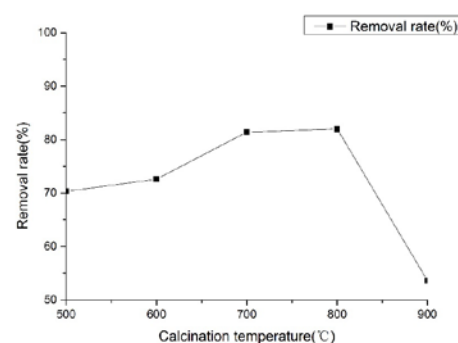


Figure 3. Effect of calcination temperature.

4. Conclusion

The following conclusions can be drawn from the research:

- (1) Preparation of spherical particles by micro-electrolytic filler can solve the phenomenon of knotting and passivation of traditional micro-electrolytic fillers.
- (2) The best preparation method of micro-electrolytic filler: mass ratio of reducing iron powder and activated carbon powder: 3:1, bentonite: 20%, ammonium bicarbonate: 3%, calcination temperature: 700°C.
- (3) According to the optimal preparation method, the micro-electrolytic filler prepared by the optimal preparation method is 200g/L, the influent pH is 3.0, and the reaction time is 60min, the oil removal rate in the wastewater can reach 81.4%.

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