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Application and Research on Treatment of Traditional Chinese Medicine Pharmaceutical Wastewater by Iron Carbon Internal Electrolysis

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Abstract: *Objective: To study the application of iron carbon internal electrolysis in the treatment of pharmaceutical wastewater from traditional Chinese medicine. Methods: Firstly, the iron-carbon micro electrolytic filler was prepared by drying and distillation method, followed by the reaction investigation method to analyze the treatment effect, and finally, the indicator detection method was used to determine various indicators for the treatment of traditional Chinese medicine wastewater, thereby completing the research on the treatment of traditional Chinese medicine wastewater by iron-carbon internal electrolysis. Results: As the proportion of clay in iron-carbon filler decreases, its treatment effect gradually increases, but the strength of the filler becomes lower and lower. Therefore, based on the comprehensive strength of the filler and the treatment effect of traditional Chinese medicine pharmaceutical wastewater, the initial PH selected for iron-carbon internal electrolysis treatment is 3, and the clay content is 30%. At this time, the treatment effect is optimal. Conclusion: Studying the treatment of pharmaceutical wastewater from traditional Chinese medicine by iron carbon internal electrolysis can effectively improve the treatment efficiency of wastewater, reduce the cost of wastewater treatment, and have certain application value in solving the pollution problem of pharmaceutical wastewater and maintaining the water ecological environment.*

Keywords: *Iron carbon internal electrolysis; Traditional Chinese medicine; Pharmacy; Wastewater; Handle; Research*

1. Introduction

After thousands of years of development, traditional Chinese medicine is a material and cultural treasure left over from Chinese history, and occupies an important position in the world medical field. In recent years, the Chinese medicine industry has developed vigorously [1], and the number of Chinese medicine factories is also increasing. However, the rapid development of Chinese traditional medicine industry has not synchronically developed Chinese traditional medicine wastewater treatment technology, resulting in backward treatment technology [2] and excessive discharge of Chinese traditional medicine wastewater. Studies have shown that traditional Chinese medicine wastewater contains cellulose, lignin and other biodegradable substances, which is difficult to treat. Excessive discharge will not only pollute water quality and endanger ecology, but also endanger human life and health [3]. Therefore, how to treat TCM wastewater efficiently and standardized has become the focus of current research, and the existing wastewater treatment technology should be optimized based on the current status of TCM pharmaceutical wastewater discharge [4].

During the production process of traditional Chinese medicine, effective ingredients are continuously extracted from raw materials rich in organic substances. Therefore, its wastewater is mainly generated in the processes of cleaning, steaming, and preparation of traditional Chinese medicine [5]. Studies on most traditional Chinese medicine pharmaceutical wastewater have found that the main pollutants are proteins, residues, cellulose, sugar, alkali, lignin, pigments, and the hydrolysates of raw materials after hydrolysis. Therefore, it is difficult to treat wastewater from traditional Chinese medicine pharmacy due to its unstable biochemical properties, large fluctuations, high NH3-N content, high chroma, toxicity, and high content of solid suspended substances. Currently, the treatment of traditional Chinese medicine wastewater in China is mainly carried out through pretreatment, biochemical treatment, and advanced treatment. However, most methods of wastewater treatment have high costs and do not meet current treatment requirements. Therefore, in order to reduce the cost of

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wastewater treatment of traditional Chinese medicine pharmacy and improve the treatment effect, this article studied the application of iron carbon internal electrolysis in the treatment of traditional Chinese medicine pharmacy wastewater.

2. Materials and Preparation

Combined with the experimental requirements, this paper selected PVC round pipe as the packing barrel of the iron-carbon micro-electrolytic reaction device. The barrel height was 300mm, the diameter was 110mm, the wall thickness was 3mm, the water depth was 240mm, and the packing height was 120mm, so as to design an effective reaction device, as shown in Figure 1 below.

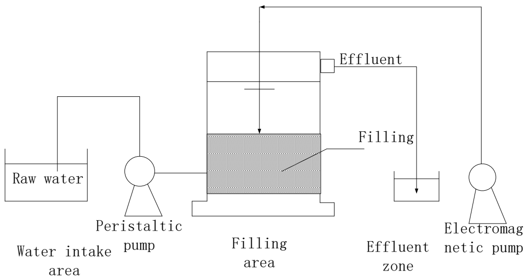

Figure 1: Experimental Reaction Device

As can be seen from Figure 1, the reaction device is divided into three parts: the water inlet area, the filler area, and the water outlet area. The method of water inlet from the lower part and water outlet from the upper part is adopted, and an electromagnetic pump is installed for aeration to ensure sufficient oxygen during the reaction process.

In this experiment, iron powder, powdered activated carbon, and auxiliary materials were selected as experimental fillers for pretreatment. They were placed in 5% hydrochloric acid for 45 minutes to remove oxides from the surface. In order to meet the actual treatment needs of traditional Chinese medicine pharmaceutical wastewater, the traditional Chinese medicine wastewater selected in this article is boiled from traditional Chinese medicine residues, with a COD value of 2385mg/L, a color value of 290 times, and a pH of 6.8. The test reagents and instruments used at this time are shown in Table 1 below.

Table 1: Experimental Reagents

Name	Specifications
Concentrated hydrochloric acid	Analytically pure
COD reagent C1　C2	Analytically pure
Sodium hydroxide	Analytically pure
Peristaltic pump	JJ-1
Electromagnetic pump	JCM1
Electronic balance	FA124
Ma Fulu	SX2-25-12
Pelletizing machine	WLXM-360
Acidity meter	Phs-2f
COD tachometer	6B-200A
Special digestion device for COD determination	6B-30
Electronic balance	FA2104N

From Table 1, it can be seen that the above reagents and instruments meet the subsequent experimental requirements and can be used for subsequent experiments on wastewater treatment from traditional Chinese medicine manufacturing.

3. Experimental method

At the early stage of wastewater treatment, it is necessary to prepare iron-carbon micro-electrolytic filler. At this time, it is necessary to fix the iron-carbon ratio of 1:1, add a certain proportion of clay and metal powder, and use the pellet mechanism to form iron-carbon filler with a diameter of 3cm, which is put into Muffle furnace and fired at a high temperature of 800 degrees. Dry to constant weight, and

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then into a 1L measuring cup, with a measuring cylinder into the distilled water and constantly add, keep the water submerged filler. At this time, iron-carbon filler with a mass of M should be taken and placed in the reactor to treat the wastewater of traditional Chinese medicine under certain conditions. After 15 days of continuous operation, iron-carbon filler should be taken out and its packing density measured as follows: Take the iron-carbon packing, weigh its mass with A balance, put the packing into a 1L measuring cup, add an appropriate amount of water to precisely flood the packing, and read the volume of the water surface scale. At this time, the iron-carbon packing density ρ is shown in (1) below.

$$\rho=\frac{M}{V_1} \tag{1}$$

In formula (1), M represents the mass of iron carbon filler, and V_1 represents the water surface scale. At this time, the iron and carbon filler can be taken out, washed with distilled water at 105 ℃, dried and weighed, and the annual loss rate a of the iron and carbon filler obtained is shown in (2) below.

$$a=\frac{M-M_t}{15M}\times 365\times 100\% \tag{2}$$

In formula (2), M_t represents the mass of the final iron-carbon filler. At this time, the traditional Chinese medicine wastewater can be passed through the peristaltic pump with a certain flow through the iron-carbon micro-electrolytic reaction device to investigate the effect of pH and the initial concentration of wastewater on the removal rate of COD and chroma, and to determine the pH value of the wastewater. The flow chart is shown in Figure 2 below.

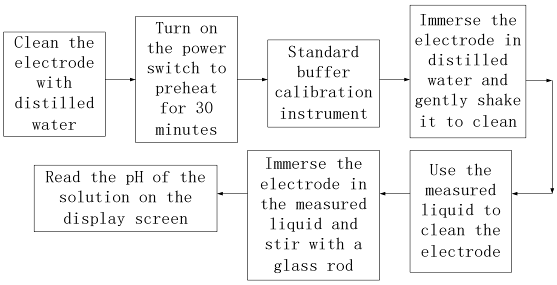

Figure 2: Flow Chart for pH Measurement

It can be seen from Figure 2 that after the pH value is determined, COD needs to be measured, as shown in Figure 3 below.

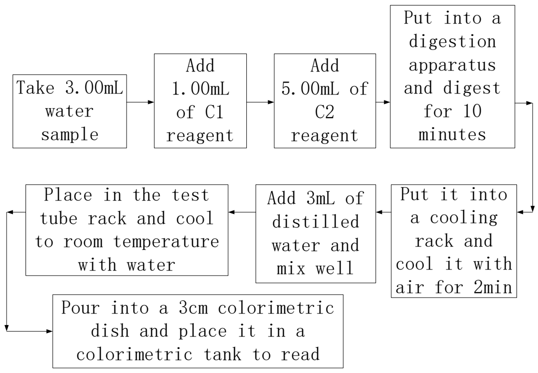

Figure 3: Determination of COD

According to the measurement process in Figure 3, the COD removal rate D_{COD} of wastewater can be further calculated, as shown in (3) below.

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$$D_{COD} = \frac{C - C_1}{C} \tag{3}$$

In formula (3), C represents the COD value before treatment, and C_1 represents the COD value after treatment. At this time, the chromaticity of wastewater can be further measured and the chromaticity removal rate S can be calculated, as shown in (4) below.

$$S = \frac{Y - Y_0}{Y} \tag{4}$$

In Formula (4), Y represents the color of raw water and Y_0 represents the color of supernatant after treatment. The final experimental results can be obtained after the above indexes are calculated.

4. Experimental results

To explore the impact of solution pH on traditional Chinese medicine wastewater treatment technology and determine the optimal pH value, adjust the initial pH value of the wastewater to 1, 2, 3, 4, 5, and 6, and then treat traditional Chinese medicine wastewater with different pH values using iron and carbon fillers. The comparison results are shown in Table 2.

Table 2: Effect of pH on removal rate

pH	Effluent COD	COD removal rate	Effluent chromaticity	Chroma removal rate
1	1052	55.9%	135	53.6%
2	897	62.4%	115	60.4%
3	591	75.2%	78	73.2%
4	684	71.3%	86	70.5%
5	778	67.4%	103	64.4%
6	756	68.3%	102	64.9%

As shown in Table 2 above, pH has a great influence on the removal rates of COD and chroma. With the change of pH value, the removal rates of COD and chroma rise first and then decline. When pH is 3, the removal rates of COD and chroma reach the maximum, which are 75.2% and 73.2% respectively. Therefore, overall consideration, when the pH of the solution is 3, the treatment effect is better.

Then explore the impact of iron carbon fillers with different clay ratios on wastewater treatment. Under the condition of a fixed iron carbon ratio of 1:1, add clays with a mass fraction of 10%, 20%, 30%, and 40%, mix the materials evenly, and prepare iron carbon fillers with different clay ratios. Use fillers with different clay ratios to treat traditional Chinese medicine wastewater with a pH of 3 and observe the appearance changes of iron carbon fillers during use. The relationship between the clay ratio, COD removal rate, and chromaticity is shown in Table 3 below.

Table 3: Effect of iron carbon filler clay ratio on wastewater treatment

Clay ratio	Effluent COD	COD removal rate	Effluent chromaticity	Chroma removal rate
10%	580	75.7%	77	73.4%
20%	634	73.4%	81	71.9%
30%	653	72.6%	85	70.8%
40%	789	66.9%	107	63.2%

As can be seen from Table 3, the lower the clay proportion of iron probe filler, the higher the COD removal rate and chroma removal rate, which proves that the optimal proportion of iron carbon filler clay for the treatment of traditional Chinese medicine pharmaceutical wastewater is 10%. The morphologic changes of fillers under different clay proportions were obtained, as shown in Table 4 below.

As can be seen from Table 4, the higher the clay content, the lower the removal rate. When the clay content is 20% and 30%, there is little difference in the removal rate of COD and chroma, the chroma removal rate is 71.9% and 70.8% respectively. When the clay content is small, the content of iron and carbon in the filler is higher, and the active component is higher. With the progress of the reaction, more Fe2+ and Fe3+ are produced, which greatly reduces the COD and chroma, and improves the removal rate. When the clay content is higher, the filler strength is greater and not easy to loose, easier to form. When the clay content is 20%, the COD and chroma removal rates are as high as 73.4% and 71.9%, but the clay content is too low, the filler is not suitable for forming, the strength is low, and cracks appear after running for a period of time. When the clay content is 30%, the removal rate is slightly less than 20%, but the filler strength should be better and not easily broken. Overall consideration, determine the best clay content is 30%.

Table 4: Filler Morphology under Different Clay Proportions

Clay ratio	Filler morphology					
	2 days	4 days	10 days	15 days	30 days	60 days
10%	complete	dehiscence	loose	-	-	-
20%	complete	complete	complete	dehiscence	loose	-
30%	complete	complete	complete	complete	complete	complete
40%	complete	complete	complete	complete	complete	complete

In conclusion, it can be proved that when the PH of important wastewater solution is 3 and the proportion of iron-carbon filler clay is 30%, the treatment of its waste liquid has a good effect.

5. Conclusion

As the proportion of clay in the iron carbon filler decreases, its treatment effect gradually increases, but the strength of the filler becomes lower and lower. Therefore, in the iron carbon internal electrolysis treatment, when the initial pH value of the waste liquid is set to 3 and the optimal clay content is 30%, the iron carbon filler has the best effect, with COD removal rates of 72.6% and chromaticity removal rates of 70.8%, respectively. It can be proved that the proposed method has a good treatment effect on traditional Chinese medicine pharmaceutical wastewater and has certain application value.

6. Discussion

To sum up, at present, China's medicine is developing rapidly, and the total value of the traditional Chinese medicine industry has increased. In this context, the discharge of traditional Chinese medicine wastewater is increasing, causing a significant impact on the ecological environment. However, due to the complex pollutants, unstable biochemical properties, and high content of suspended substances in traditional Chinese medicine wastewater, its treatment is difficult. Although coagulation, iron filings reduction, hydrolysis, electrolytic pretreatment, and air flotation methods have been proposed at home and abroad, most of the treatment methods have low treatment quality and high treatment costs. Therefore, this article studies the application of iron carbon internal electrolysis in the treatment of traditional Chinese medicine pharmaceutical wastewater, making a certain contribution to improving the treatment effectiveness of wastewater and reducing treatment costs.

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