

Preparation and Application in Aniline Wastewater Treatment of FeCo/H-103 Resin

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Abstract

In this paper, FeCo/H-103 resins with magnetic properties were prepared through using FeSO₄·7H₂O and CoCl₂·6H₂O as raw materials and H-103 resin as the carrier. The FeCo/H-103 resin was characterized by infrared spectroscopy, the results showed that the FeCo alloy was successfully loaded on H-103 resin. The modified FeCo/H-103 resin was used to treat aniline wastewater. The effects of initial aniline concentration, adsorption temperature, pH value and adsorption time on adsorption efficiency were studied by orthogonal experiment. The experimental results showed that the weight of the four factors was pH > adsorption temperature > adsorption time > initial concentration. The optimum technological conditions were pH 5, adsorption temperature 30°C, adsorption time 3 h and initial aniline concentration 100 mg/L.

Keywords

FeCo alloy; H-103 resin; Aniline; Adsorption.

1. INTRODUCTION

Aniline is the most representative substance of aromatic amines. It is widely used in national defense, printing and dyeing, plastics, paints, pesticides and pharmaceutical industries[1, 2]. It is also a harmful substance that seriously pollutes the environment and endangers human health[3, 4]. It is a kind of "carcinogenic, teratogenic and mutagenic" tri substance. Because of its long-term residue, bioaccumulation and carcinogenicity, aniline has been listed as one of 129 pollutants under the priority control of EPA in the United States, which requires strict control in industrial drainage[5].

In the treatment of aniline wastewater, adsorption method is widely used in industrial production because of its simple operation and low energy consumption[6]. The most commonly used adsorbents are macroporous resin[7, 8], activated carbon[9], modified cellulose and so on. With the rapid development of polymer materials industry, more and more attention has been paid to macroporous adsorbent resin. It can enrich organic matter in wastewater, and separate and recover organic matter. The magnetic adsorbent resin can be prepared by combining the magnetic technology with the adsorptive property of the resin. It can combine the advantages of magnetic carrier technology with the advantages of adsorption and make the recovery of the resin easier.

In this paper, magnetic FeCo/H-103 resin was prepared. The optimum conditions for adsorption of aniline-containing wastewater by FeCo/H-103 resin were studied by orthogonal experiment. It can provide experimental data for wastewater treatment.

2. EXPERIMENTAL

2.1. Materials

H-103 resin was from Tianjin Bohong Resin Technology Co.Ltd. All chemicals used were of analytical reagent grade and obtained from Shanghai Chemical Reagent Station (Shanghai, China).

2.2. Preparation of FeCo/H-103 Resin

The H-103 resin and anhydrous ethanol were added to the cable extractor, treated for 5 hours to remove the organic compounds on the resin surface and then filtered. Finally, the resin was put into the drying box and dried for 12 hours at 50°C.

FeSO₄·7H₂O and CoCl₂·6H₂O with molar ratio of 1:1 were dissolved in 300 mL distilled water, and then adding KPH₄ drop by drop until no bubbles were formed. The FeCo alloy was obtained. The pretreated H-103 resin was immersed in 10% NaOH solution for 1 hour, and the same quality FeCo alloy was added. The mixture was soaked at room temperature for 30 minutes, then washed with deionized water. Finally, the product was dried at 50°C for 12 h in the vacuum drying chamber.

2.3. Treatment of Simulated Aniline Wastewater

FeCo/H-103 resin was used to treat simulated aniline wastewater by orthogonal experiment. Orthogonal experiments were carried out with the adsorption rate as the target index. The adsorption temperature, adsorption time, pH value and Initial aniline concentration were taken as four factors, and each factor took three levels. The factors and levels of orthogonal experimental are shown in Table 1.

Table 1. Factors and levels of orthogonal experimental

Levels	Factors			
	adsorption temperature	pH	adsorption time	Initial aniline concentration
	/°C A	B	/h C	/mg/L D
1	25	3	2.5	90
2	30	5	3.0	100
3	35	7	3.5	110

3. RESULTS AND DISCUSSION

3.1. FeCo/H-103 Resin Characterization

The infrared spectrum of FeCo/H-103 was measured by NICOLE380 Fourier Transform Infrared Spectrometer. The FT-IR spectra of H-103 resin and FeCo/H-103 resin are shown in Figure 1. The FT-IR spectrum of FeCo/H-103 resin shows a broad absorption band around 3400 cm⁻¹, which may be attributed to the O-H group. The bands near 1620 cm⁻¹ corresponded to the characteristic C=C stretching vibration of Aromatic rings in the resin. The bands at 1000 cm⁻¹ may be assigned to the stretching vibration of FeCo-O in FeCo/H-103 resin.

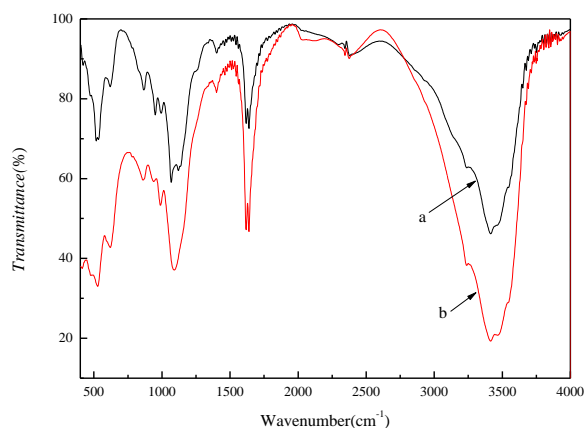


Figure 1. Infrared Spectra of H-103 Resin and FeCo/H-103 Resin

(Note: a-H-103 resin; b-FeCo/H-103 resin)

The magnetic properties of Fe-Co/H-103 resin were tested by magnet. Magnetic detection photographs of H-103 resin and FeCo/H-103 resin are shown in Figure 2. It can be seen that FeCo/H-103 resin can be attracted by magnets, but H-103 resin cannot. The color of FeCo/H-103 resin is different from the color of H-103 resin, and its surface is black, which proves that FeCo/H-103 resin has been successfully prepared and has magnetism.

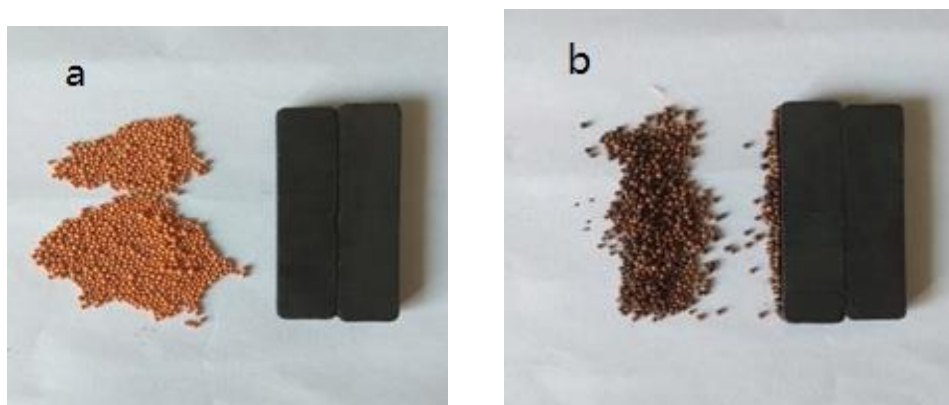


Figure 2. Magnetic Detection Photographs of H-103 Resin and FeCo/H-103 Resin

(Note: a-H-103 resin; b-FeCo/H-103 resin)

3.2. Treatment of Simulated Aniline Wastewater

The results of orthogonal experimental and range analysis are shown in Table 2. It can be seen that the range of adsorption rate varies from 0.521-8.365. The range is larger which is greater the influence of this factor on the experimental results. The weight of the four factors affecting the adsorption of aniline by FeCo/H-103 resin is pH > adsorption temperature > adsorption time > initial aniline concentration. The aim of this experiment is to find the optimum technological conditions for the adsorption of aniline by FeCo/H-103 resin. The experimental results showed that the optimum technological conditions are pH 5, adsorption temperature 30°C, adsorption time 3 h and initial aniline concentration 100 mg/L.

Table 2. Orthogonal experimental results and range analysis

Experimental serial number	adsorption temperature /°C A	adsorption time /h B	pH C	Initial aniline concentration / mg/L D	adsorption rate /%
1	25	2.5	3	90	73.830
2	25	3	5	100	83.340
3	25	3.5	7	110	73.028
4	30	2.5	7	100	75.684
5	30	3	3	110	82.392
6	30	3.5	5	90	86.374
7	35	2.5	5	110	79.482
8	35	3	7	90	75.388
9	35	3.5	3	100	77.442
I	230.198	228.996	233.610	235.592	
II	244.450	241.120	249.196	236.466	
III	232.312	236.844	224.100	234.902	
I/3	76.732	76.332	77.203	78.531	
II/3	81.483	80.373	83.065	78.822	
III/3	77.437	78.948	74.700	78.301	
R	4.751	4.041	8.365	0.521	
Optimization conditions	A2	B2	C2	D2	

4. CONCLUSION

FeCo/H-103 resin with magnetic properties was successfully prepared by using FeSO₄·7H₂O and CoCl₂·6H₂O as raw materials and H-103 resin as carrier. The characteristic absorption peaks of FeCo/H-103 resin appear at 1000 cm⁻¹, 1620cm⁻¹ and 3400cm⁻¹. The orthogonal experimental results of wastewater treatment showed that the optimum technological conditions were pH 5, adsorption temperature 30°C, adsorption time 3 h and initial aniline concentration 100 mg/L.

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