
Preparation and Wastewater Treatment Performance of FeCo/D301 adsorption resin

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Abstract

In this paper, FeCo/D301 adsorption resin was prepared by wet chemical oxidation. The structure and morphology of the modified adsorption resin were characterized by FTIR and transmission electron microscope. Orthogonal experiments were carried out to simulate the treatment of phenol wastewater by FeCo/D301 adsorption resin, the results showed: mass of FeCo/D301 resin 0.1g, pH 4, reaction temperature 30 °C, quality ratio of FeCo to resin 1:2 were the optimum process conditions.

Keywords

FeCo/D301 adsorption resin, preparation, characterization, phenol.

1. Introduction

Phenol is a common high toxic and refractory organic substance in industrial wastewater, which not only seriously endangers human health, but also destroys the natural ecological balance and causes serious environmental pollution^[1]. There are many methods to treat phenol, including extraction^[2, 3], biological method^[4, 5], chemical oxidation method^[6, 7], adsorption method^[8-11] and so on. The adsorb ability of resin is very outstanding, which is mainly manifested in its large adsorption capacity, low cost, long life, wide application range, certain selectivity, easy desorption and good strength. Resin is a commonly used adsorbent for wastewater treatment, but it is difficult to recover. In this paper, FeCo/D301 magnetic adsorption resin was prepared by wet chemical method with D301 resin as carrier, and orthogonal experiment of simulated wastewater treatment was carried out.

2. Experimental Section

2.1 Chemicals and reagents

D301 resin was from Nankai Resin Co. Ltd. (Tianjin, China). All chemicals used were of analytical reagent grade and obtained from Shanghai Chemical Reagent Station (Shanghai, China).

2.2 Preparation of FeCo/D301 Resin

The untreated D301 resin was soaked in 5% sodium hydroxide solution, 3.5% hydrochloric acid solution and 5% sodium hydroxide solution for 12 hours respectively. Finally, the resin was washed repeatedly with distilled water to neutral, and then the resin was put into the drying box and dried for 12 hours at 40 °C.

The treated D301 resin, FeCl₂·4H₂O and CoCl₂·6H₂O in a certain proportion were dissolved in anhydrous ethanol and stirred at a stirring speed until mixture was completely dissolved. The mixed solution was heated at 55 °C for 30 minutes. Then, NaOH solution (10 mol/L) was added in dropwise until the mixed solutions turned inky green. The solutions were continue stirred for 2 h at 55 °C. After

cooling to room temperature, it was filtered and washed with dilute hydrochloric acid and distilled water. Finally, the product was dried in a vacuum drying chamber and dried at 80°C for 3 h. The FeCo/D301 modified adsorbent resin was obtained.

2.3 Orthogonal Experiments on Treatment of Phenol Wastewater

Orthogonal experiments were carried out with the adsorption rate as the target index. The amount of FeCo/D301 resin, pH, the ratio of FeCo to resin and the adsorption temperature were selected as four factors. Each factor took three levels. The level of orthogonal experimental factors is shown in Table 1.

Table 1 Factors and levels of orthogonal experimental

Levels	Factors			
	mass of FeCo/D301 resin /g A	pH B	quality ratio of FeCo to resin C	adsorption temperature /°C D
1	0.1	6	1:2	25
2	0.2	4	2:1	30
3	0.3	2	1:3	40

3. Results and discussion

3.1 FeCo/D301 resin characterization

The FT-IR spectra of FeCo/D301 resin, FeCo alloy and D301 resin are shown in Figure 1. The FT-IR spectrum of FeCo/D301 resin shows a broad absorption band around 3300 cm^{-1} , which may be attributed to the O-H group. The bands near 2922 cm^{-1} corresponded to the characteristic C-H stretching vibration of amine groups in the resin. The bands near 1630 cm^{-1} corresponded to the characteristic C-O stretching vibration of amine groups in the resin. The bands at 627 cm^{-1} may be assigned to the stretching vibration of FeCo-O in FeCo/D301 resin. Figure 2 shows the TEM micrograph of the FeCo/D301 resin. The black part is FeCo alloy, while the light part is D301 resin. It clearly shows that FeCo alloy adheres to the resin surface.

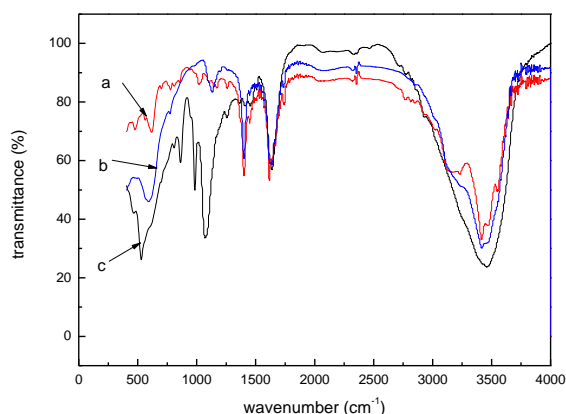


Figure 1 Infrared Spectra of FeCo/D301 Resin, FeCo Alloy and D301 Resin
(Note: a-FeCo/D301 resin; b-FeCo alloy; c-D301 resin)

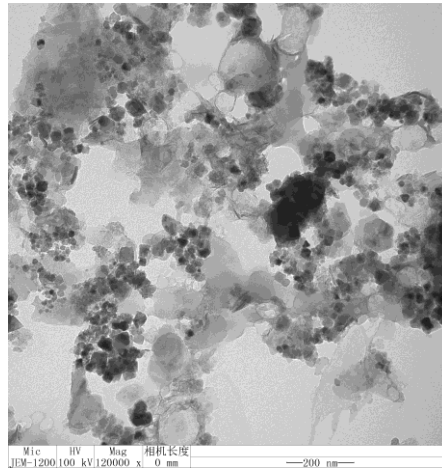


Figure 2 TEM photographs of FeCo/D301 resin

3.2 Orthogonal Experiments on Treatment of Phenol Wastewater

Table 2 Orthogonal experimental results and range analysis

number	mass of FeCo/D301 resin /g A	pH B	quality ratio of FeCo to resin C	adsorption temperature /°C D	adsorption rate /%
1	0.1	6	1:2	25	51.051
2	0.1	4	2:1	30	55.906
3	0.1	2	1:3	40	44.912
4	0.2	6	2:1	40	38.199
5	0.2	4	1:3	25	40.762
6	0.2	2	1:2	30	46.304
7	0.3	6	1:3	30	43.39
8	0.3	4	1:2	40	49.595
9	0.3	2	2:1	25	34.262
I	151.869	132.64	146.95	126.075	
II	125.265	146.263	128.367	145.6	
III	127.247	125.478	129.064	132.706	
I/3	50.632	44.213	48.983	42.025	
II/3	41.755	48.754	42.789	48.533	
III/3	42.416	41.826	43.021	44.235	
R	8.877	6.928	6.194	6.508	
Optimization conditions	A1	B2	C1	D2	

The results of orthogonal experimental and range analysis are shown in Table 2. Results indicated that the range of adsorption rate varies from 6.194% to 8.877%. The range is larger which is greater the influence of this factor on the experimental results. The weight of the four factors on the adsorption rate of wastewater is mass of FeCo/D301 resin > pH > adsorption temperature > quality ratio of FeCo to resin. The purpose of this experiment is to obtain the optimum process conditions for the treatment of phenol wastewater by FeCo/D301 resin. The experimental results show that the best treatment conditions are mass of FeCo/D301 resin 0.1g, pH 4, reaction temperature 30°C, quality ratio of FeCo to resin 1:2.

4. Conclusion

FeCo/D301 adsorbent resin was successfully prepared by wet chemical method using $\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$, $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ and D301 resin as raw materials. FeCo alloys adhere to the D301 resin surface. The characteristic absorption peaks of FeCo/D301 adsorbent resin appear at 627 cm^{-1} , 1630 cm^{-1} and 3300 cm^{-1} . The orthogonal experimental results of wastewater treatment showed that the optimum technological conditions were mass of FeCo/D301 resin 0.1g, pH 4, reaction temperature 30°C, quality ratio of FeCo to resin 1:2.

Acknowledgements

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