研究简报

Fenton

1,2 2 1 1 3 1

1 318000 2 210098
3 317300

3A-Fe XRD
3A-Fe H_2O_2 Fenton
pH H_2O_2
3A-Fe Fenton pH 2 10
Fenton 3A-Fe Fenton
94.1% COD_{Cr} TOC 78.6% 60.5%
Fenton

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Performance of heterogeneous Fenton-like system for degradation of nitrobenzene-containing wastewater

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Abstract: A heterogeneous Fenton-like catalytic system, consisted of 3A-Fe zeolite catalyst that was prepared in the laboratory and characterized by SEM, EDS and XRD, and H_2O_2 was used for degradation of nitrobenzene-containing wastewater. The effects of pH, H_2O_2 and nitrobenzene concentration, and catalyst dose on degradation of nitrobenzene were studied. An attempt to reveal the degradation mechanism was also done. The results showed that nitrobenzene had been significantly degraded in this Fenton-like system provided that pH value of wastewater was in the range of 2 to 10. No dissolved Fe(Ⅱ/Ⅲ) was detected for the Fenton-like system, indicating that nitrobenzene was directly degraded on surface of 3A-Fe zeolite catalyst rather than by the aqueous Fenton system. The 3A-Fe zeolite catalyst exhibited good stability in repeat use and the degradation rate of nitrobenzene could reach 94.1%, and the removal rate of COD_{Cr} and TOC, under the optimal conditions, were 78.6% and 60.5% respectively.

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Key words: Fenton-like system; zeolite; wastewater; hydrogen peroxide; degradation

[1]

Fenton [2]

[3-5] Fenton pH 2 4 [6-9]

Fenton [10-13]

Fenton pH

Fenton [14-16]

3A-Fe

Fenton

1

1.1

3A

UV-7504 DELTA-320 pH KYC-1102C TOC S-4800 D8 advance X

1.2

1.2.1 3A-Fe

Na_2CO_3 2.5 g · L^{-1} $FeSO_4$ (1:1.1) (1:2) 1 1.2 h Na_2CO_3 $FeSO_4$ 3A 400 1 h 3A Na_2CO_3 $FeSO_4$ 5 6 h 2 3 3A-Fe [17]

1.2.2 3A-Fe

S-4800 SEM D8 advance X (XRD)

1.3

COD TOC TOC pH pH

1.4

Fenton

500 ml 100 mg · L^{-1} H_2O_2 th( ) 0.50 g H_2O_2 CO_2 H_2O H_2O_2 1 1 th 30% H_2O_2 0.61 ml · L^{-1}

$$2C_6H_5NO_2 + 29[O] = 12CO_2 + 2NO_2 + 5H_2O \quad (1)$$

2

2.1

1 3A 3A SEM 1 3A Fe

2(b) 3A-Fe Fe

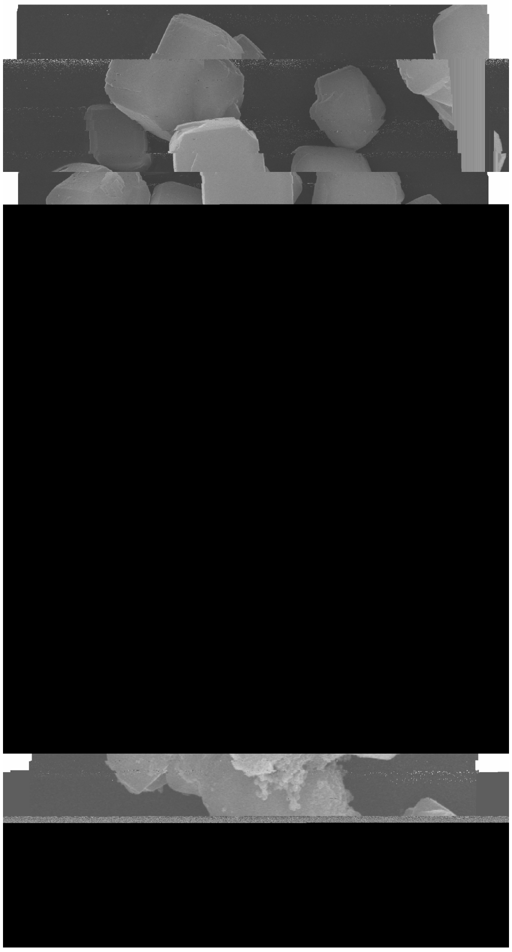
2 3A 3A-Fe 3A-Fe 1 3A-Fe 3A Fe Fe 11.03% 3A

3 XRD 3A 3A-Fe 6 21.7° 24.0° 27.1° 29.9° 32.5° 34.1° 3A 3A-Fe

1 3A 3A-Fe

Table 1 Element mass percentage of 3A and 3A-Fe/%

Zeolite	Fe	C	O	Na	Al	Si	K
3A	0	13.11	52.69	5.69	11.04	12.31	5.16
3A-Fe	11.03	16.52	46.34	4.04	8.60	9.68	3.79



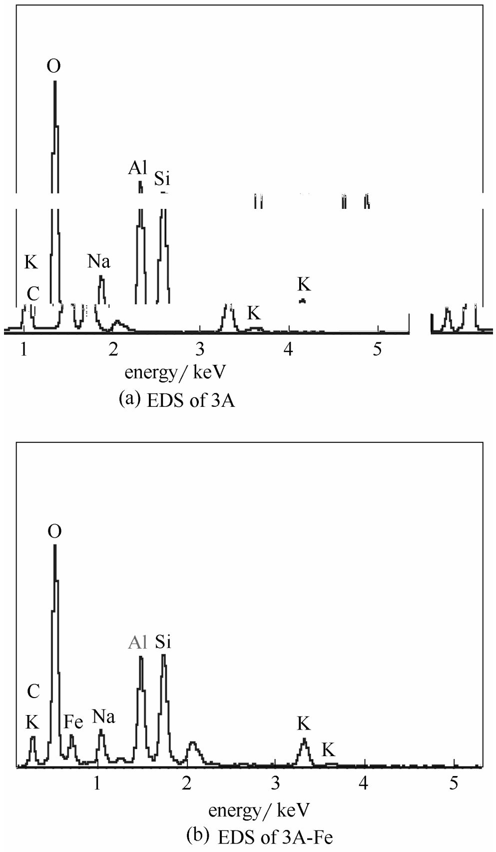
1 3A 3A-Fe SEM

Fig.1 SEM patterns of 3A and 3A-Fe

Â 3A-Fe β 3A ἳ β 3A 3A Â

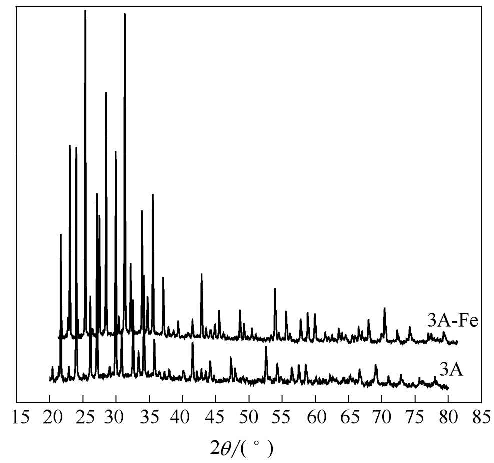
2.2 Fenton

2.2.1 pH 3A-Fe . ƅ H_2O_2 Fenton Ӣ pH ч 2 à 4 à 6 à 8 à 10 4 Â ͸ a˜ ˝ pH 2 10 Fenton ἳ pH ч 4 ч 100% pH ч 2 à 6 à 8 à 10 ч 94.1% à 91.7% à 88.4% à 87.3% Â [18-20] Fenton . ln(/ 0)= – Â Fenton . 4(b) Â ɫ 0.017 0.038 min^{-1} ↔ [21] Ti/SnO_2- Sb [22] . . 2,4-DNT Â ч pH 4 > pH 2 > pH 6 > pH 8 > pH 10 Fenton pH 2 10 ἵ Fenton Fenton pH Â



2 3A 3A-Fe

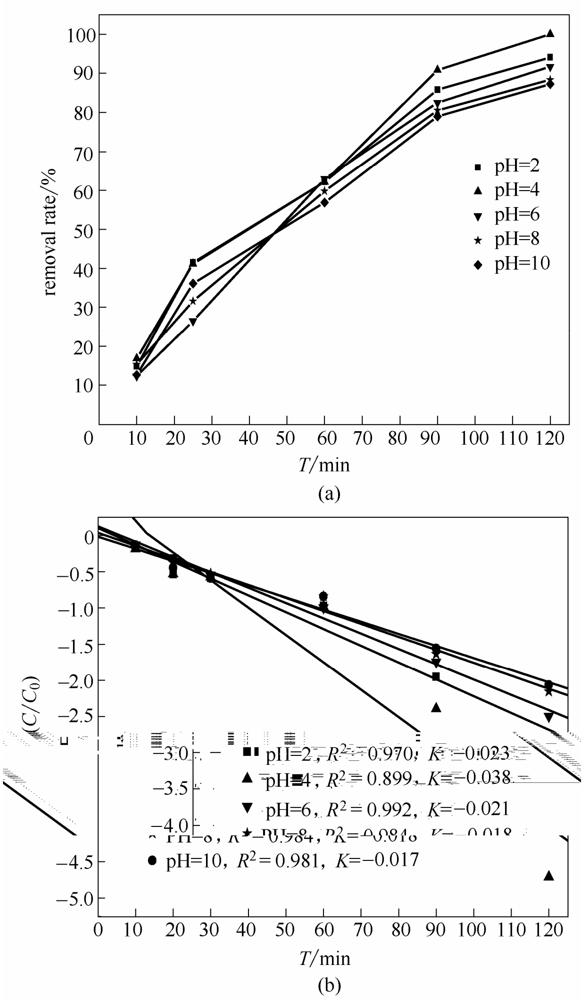
Fig.2 EDS of 3A and 3A-Fe



3 3A 3A-Fe . XRD

Fig.3 XRD patterns of 3A and 3A-Fe catalysts

2.2.2 H_2O_2 3A-Fe



4 pH

Fig.4 Effects of pH values on degradation of nitrobenzene

. ѣ H_2O_2 Fenton

. ч 0.5 g pH ч 10 H_2O_2 ѵ

500 ml ч 100 mg · L^{-1}

5 Â

5˜ H_2O_2 ѵ ч th à1/2 th à1/5 th à

1/7 th 1/10 th 120min Ư

ч 97.9% à97.6% à90.9% à79.7% 66.7%'

ч 0.037 à0.034 à0.023 à0.013

0.010 min^{-1} Â H_2O_2 ѵ ˆ 1/10 th˜ 120

min 60% ⁛

Fenton ˧ ɣ H_2O_2 ѵ

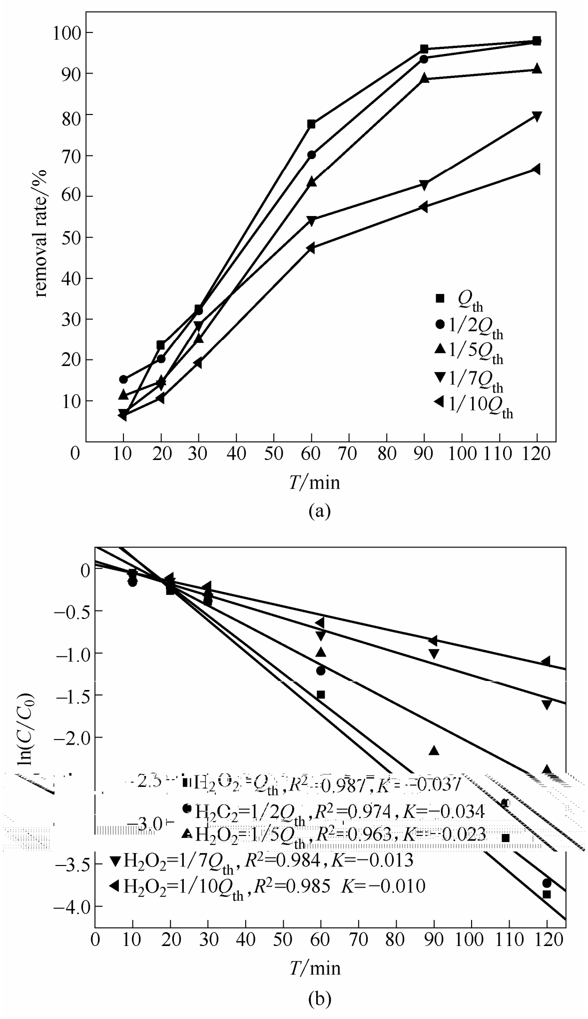
. ỉ ' H_2O_2 ѵ

' H_2O_2 ѵ ч ѵ 1/2

ч ѵ 1/2 0.3 Â

H_2O_2 ѵ ѣ Fenton .

· OH



5 H_2O_2 ѵ

Fig.5 Effects of H_2O_2 concentration on degradation of nitrobenzene

ɾ . '

H_2O_2 ѵ Ư 1/2 th˜

ѵ ѣ Â [23]

H_2O_2 H_2O_2 · OH .

ɣ HO_2 ·[(2)] HO_2 · à ·OH[(3)]

ɣ Â H_2O_2 ѵ

H_2O_2 · OH ˜ Â ɾ

H_2O_2

ѵ ч 1/2 th Â

$$H_2O_2 + \cdot OH \longrightarrow HO_2\cdot + H_2O \quad (2)$$

$$HO_2\cdot + \cdot OH \longrightarrow H_2O + O_2 \quad (3)$$

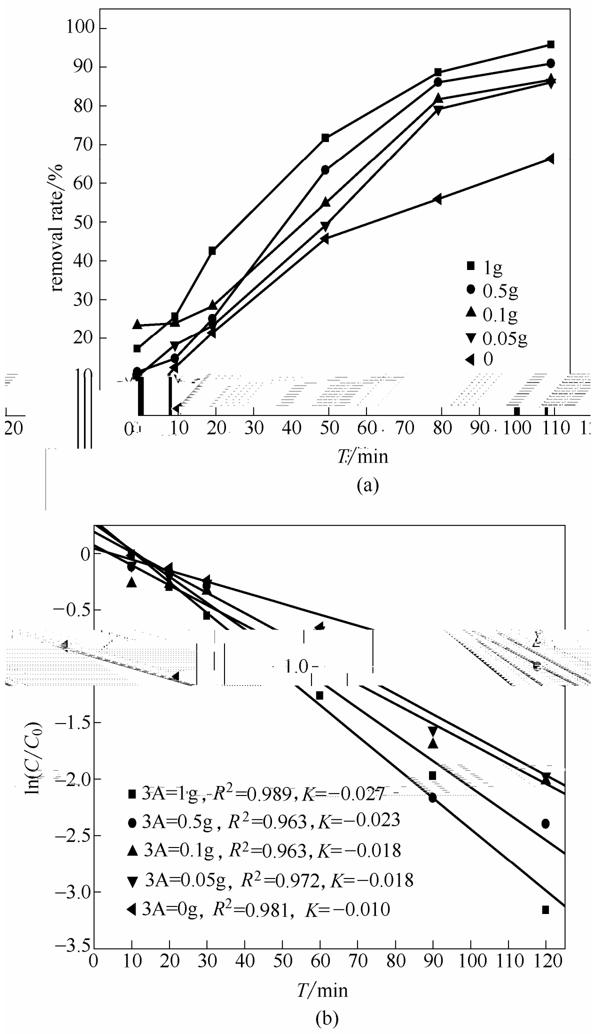
2.2.3 3A-Fe

. ѣ H_2O_2 Fenton

H_2O_2 ѵ ч 1/5 th pH ч 10 3A-Fe

. 500 ml ч 100 mg · L^{-1}

6 Â



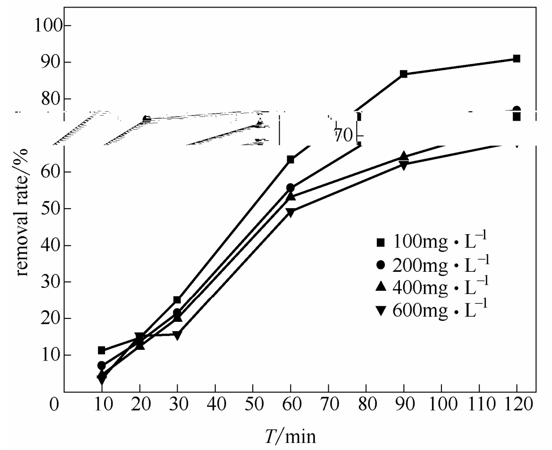
6 3A-Fe ϑ

Fig.6 Effects of 3A-Fe dosage on degradation of nitrobenzene

ƅ ϑ . ҹ 66.3%' . ҹ 0.05 ã 0.1 ã 0.5 ã 1 g ҹ 86.1% ã86.7% ã90.9% ã95.8% ҹ 0.018 0.027 mol · (L · s)$^{-1}$. ϑ Â Arends [24] [25] Fenton H_2O_2 ѽ . Ư H_2O_2 Fe^{3+} . Ӥ HO · HO · . ɩ . Â3A-Fe ҹ H_2O_2 . . ϑ 3A-Fe ↕˜ ϑ β β ῒ ƅ H_2O_2 ɩ ˆ HO ·˜ [23] Â

2.2.4

pH ҹ 10 . ϑ ҹ 0.5 g H_2O_2 ҹ 0.12 mL · L^{-1} Ӥ 100 600 mg · L^{-1} , 7 Â ƅ Fenton Ӥ 100 600 mg ·L^{-1} ῒ 100 mg · L^{-1} Â ϑ ɩ 91% Ӥ 68.3% Â ҹ H_2O_2 ϑ ҹ ῒ · OH [14] ῒ Â ↕ ῒ Â

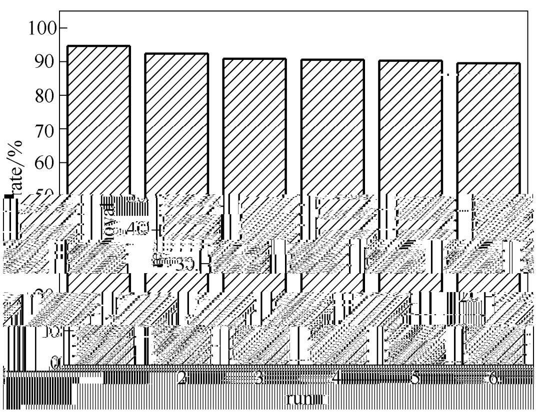


7

Fig.7 Effects of initial concentration on degradation of nitrobenzene

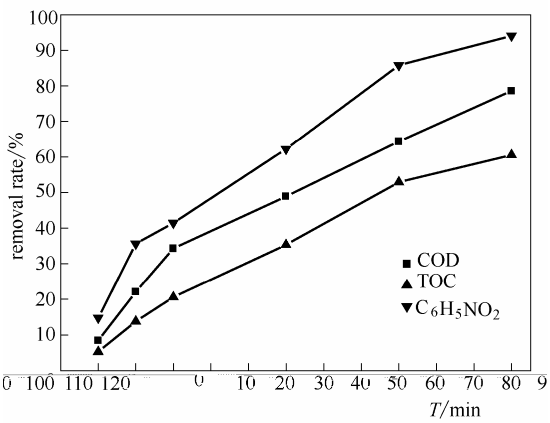
2.2.5 pH ҹ 10 ãH_2O_2 ҹ 1/5 th . ϑ ҹ 0.5 g Ӥ 500 ml ҹ 100 mg · L^{-1} . Â 120 min Ư . Ư ƅ Ӥ 8 Â ɩ ˜ ƅ 6 Ư . Ӥ ˜ 90% Â ѽ ˆ ɣ 0.03 mg · L^{-1}˜ Fe 3A 3A-Fe . ˜ Â

2.2.6 COD_{Cr} TOC 500 ml ҹ 100 mg ·L^{-1} pH ҹ 10 ã H_2O_2 ҹ 1/5 th . ϑ ҹ 0.5 g Ӥ



8 .

Fig.8 Efficiency of 3A-Fe after recycling



9 COD_{Cr} TOC

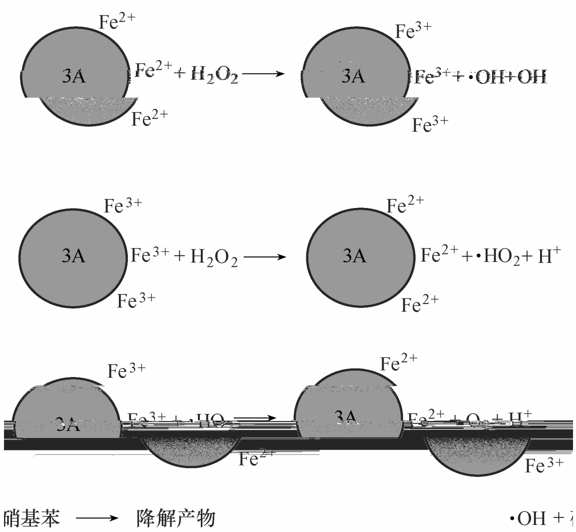
Fig.9 Comparison of COD_{Cr} and TOC removal efficiency

3A-Fe . COD_{Cr} TOC 9 Â TOC . Fenton Ь . . . ч CO_2 H_2O Â COD_{Cr} COD_{Cr} TOC . ч CO_2 . ч ỉ à Â

2.3

Fenton ч Fenton . Й Fe[2+] Fenton Fenton . H_2O_2 U Fenton . . ɾ [23,26] Â [27] Chou [28] ч 0.07 mmol · L^{-1} ⲙ 3.92 mg · L^{-1} Fenton ч h Â ῳ

^ γ 0.03 mg · L^{-1} Â ч 3A-Fe . . Ь Fenton Fenton Â 3A Fe(ň) Fe ʼn Ь H_2O_2 · OH · HO_2 · HO_2 . ·OH [29] . ч Fenton . h · OH Â 3A-Fe Fenton . . Й



3

^ 1˜ 3A-Fe ч . Fenton pH 2 10 ỉ Fenton pH Â ^ 2˜ 3A-Fe . .

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