

Supplementary Material

A microwave-activated coal fly ash catalyst for oxidative elimination of
organic pollutants in Fenton-like process

Nannan Wang^{a,b,*}, Han Xu^a, Shuo Li^{c,**}

^a Department of Environmental Engineering, Beijing Institute of Petrochemical
Technology, Beijing 102617, PR China.

^b Beijing Key Laboratory of Pipeline Critical Technology and Equipment for
Deepwater Oil & Gas Development, Beijing 102617, PR China.

^c College of Chemistry and Chemical Engineering, Qiqihar University, Qiqihar,
161006, PR China.

Corresponding authors:

* Nannan Wang: E-mail: wnn_flying@163.com; Tel.: 0086-13704517275

** Shuo Li: E-mail: shuo_105@163.com

Table S1 Orthogonal test of the activation of CFA_R by MW irradiation

No.	Factor 1, i=1 Power of MW (W)	Factor 2, i=2 Irradiation time (min)	Factor 3, i=3 Mixing speed (rpm)	Factor 4, i=4 Loading of CFA _R (g L ⁻¹)	Removal rate of TOC (%)
1	100 _{j=1}	10 _{j=1}	0 _{j=1}	1 _{j=1}	21.3
2	100	20 _{j=2}	40 _{j=2}	5 _{j=2}	26.5
3	100	30 _{j=3}	80 _{j=3}	10 _{j=3}	30.7
4	100	40 _{j=4}	120 _{j=4}	20 _{j=4}	32.9
5	100	50 _{j=5}	160 _{j=5}	30 _{j=5}	32.1
6	300 _{j=2}	10	40	10	41.5
7	300	20	80	20	44.6
8	300	30	120	30	43.1
9	300	40	160	1	10.1
10	300	50	0	5	25.9
11	500 _{j=3}	10	80	30	33.8
12	500	20	120	1	15.5
13	500	30	160	5	16.8
14	500	40	0	10	17
15	500	50	40	20	46.8
16	700 _{j=4}	10	120	5	50.4
17	700	20	160	10	62.5
18	700	30	0	20	35.6
19	700	40	40	30	38.7
20	700	50	80	1	13.6
21	1000 _{j=5}	10	160	20	49.7
22	1000	20	0	30	35.9
23	1000	30	40	1	12.7
24	1000	40	80	5	39.7
25	1000	50	120	10	43.1
<i>I</i> ₁₁	28.7	39.3	27.1	14.6	
<i>I</i> ₁₂	33.0	37.0	33.2	31.9	
<i>I</i> ₁₃	26.0	27.8	32.5	39.0	
<i>I</i> ₁₄	40.2	27.7	37.0	41.9	
<i>I</i> ₁₅	36.2	32.3	34.2	36.7	
<i>R</i> _E	14.2	11.7	9.9	27.3	

Table S2 Significant oxide components in CFA_R and CFA_{MW} (wt%).

	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	Cr ₂ O ₃	MnO	NiO	CuO	Nb ₂ O ₅	CaO	K ₂ O	MgO	Na ₂ O
CFA _R	56.16	24.75	6.10	1.41	0.0200	0.0821	0.0066	0.0074	0.0021	4.81	2.53	0.706	0.261
CFA _{MW}	56.08	24.96	6.35	1.52	0.0225	0.0865	0.0068	0.0069	0.0022	4.68	2.67	0.559	0.244

Table S3 Performance comparison of Fenton-like catalysts prepared in different works

No.	Catalyst	Preparation conditions ^a	Run time / removal rate of index	Target pollutant	Ref.
1	CFA _{MW}	Single-step microwave irradiation	3 / >60% _{TOC}	polyacrylamide	herein
2	HpOFe-GAC	Multi-step preparation	5 / >78% _{color}	Acid Red 88	[1]
4	4%Fe/sulfonated-ZrO ₂	Multi-step preparation	4 / >55% _{TOC}	clofibric acid	[2]
5	Fe@MesoC	Multi-step preparation	3 / >18% _{TOC}	sulfamethoxazole	[3]
6	Fe ₃ O ₄ /ZrO ₂	Multi-step preparation	5 / >61% _{3,4-dichlorobenzotrifluoride}	3,4-dichlorobenzotrifluoride	[4]
7	PAC@Fe ^{II} Fe ₂ ^{III} O ₄	Multi-step preparation	5 / >70.4 _{aniline} and >99% _{benzotriazole}	aniline / benzotriazole	[5]

Note: ^a means detailed information is not given due to space limitation. Readers can obtain the specific preparation steps from the corresponding literature.

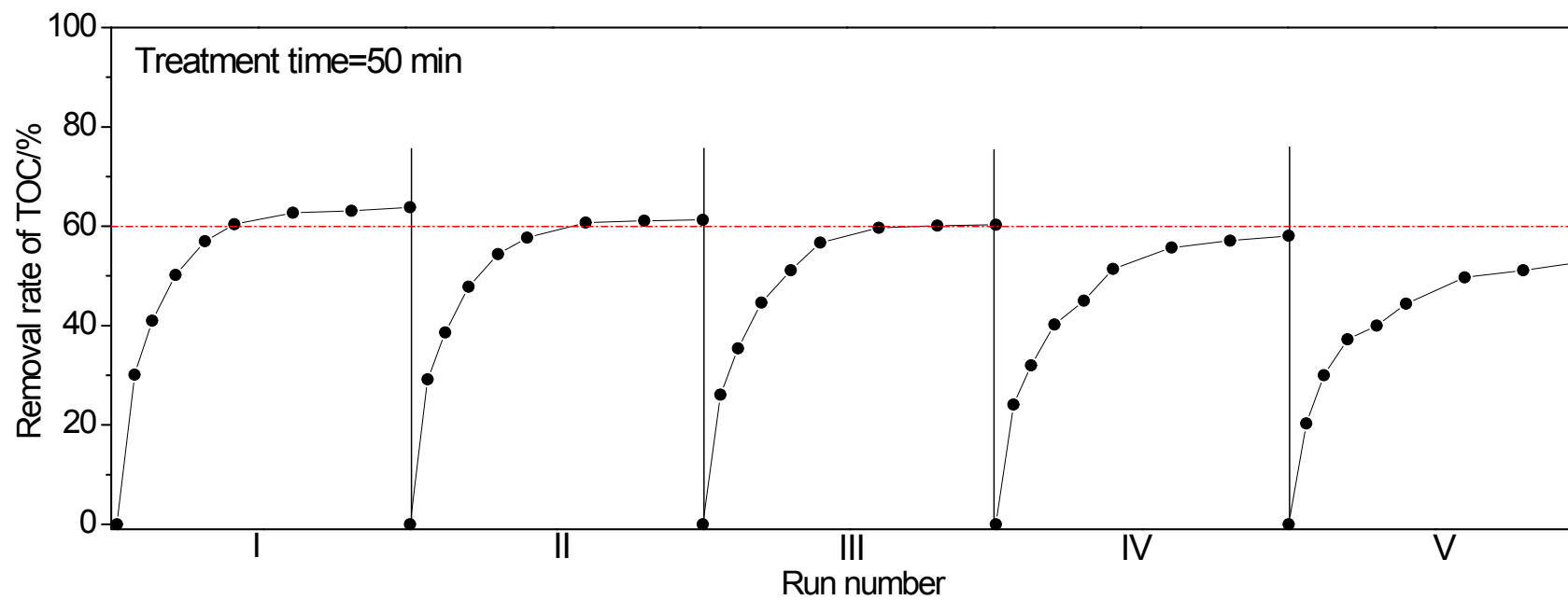


Fig. S1 Stability of CFA_{MW} in the treatment of PAM wastewater.
(H₂O₂ dosage=12 mg L⁻¹, CFA_{MW} loading=10 g L⁻¹, [PAM]= 200 mg L⁻¹, T=303 K, pH=3)

References

- [1] Rijuta Ganesh Saratale, Silojah Sivapathan, Ganesh Dattatraya Saratale, J. Rajesh Banu, Dong-Su Kim. Hydroxamic acid mediated heterogeneous Fenton-like catalysts for the efficient removal of Acid Red 88, textile wastewater and their phytotoxicity studies. *Ecotoxicol. Environ. Saf.* 167 (2019) 385-395.
- [2] Shailesh S. Sable, Sri Chandana Panchangam, Shang-Lien Lo. Abatement of clofibric acid by Fenton-like process using iron oxide supported sulfonated-ZrO₂: Efficient heterogeneous catalysts. *J. Water Process Eng.* 26 (2018) 92-99.
- [3] Juntao Tang, Jianlong Wang. Fenton-like degradation of sulfamethoxazole using Fe-based magnetic nanoparticles embedded into mesoporous carbon hybrid as an efficient catalyst. *Chem. Eng. J.* 351 (2018) 1085-1094.
- [4] Hai Chen, Zhengnan Sun, Zhilin Yang, Zhonglei Zhang, Jianlong Wang, Mingbao Feng, Qi Yang. Degradation of 3,4-dichlorobenzotrifluoride by the Fenton-like process using zirconia-coated magnetite magnetic nanoparticles as an effective heterogeneous catalyst. *Environ. Sci. Pollut. Res.* 24 (2017) 18575-18584.
- [5] Mehdi Ahmadi, Babak Kakavandi, Sahand Jorfi, Minoos Azizi. Oxidative degradation of aniline and benzotriazole over PAC@Fe^{II}Fe₂^{III}O₄: A recyclable catalyst in a heterogeneous photo-Fenton-like system. *J. Photochem. Photobiol., A* 336 (2017) 42-53