Supplementary materials

Table S1. Characteristics of PVA.

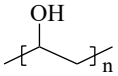
Chemical structure	Molecular formula	Relative molecular mass	Melting point	Degree of Polymerization
	$(C_2H_4O)_n$	95000 Da	230°C	1750±50

Table S2. Factors and coded levels of RSM

Factors	units	coded levels		
		-1	0	1
pH		6	7	8
current density	(mA/cm^2)	0.5	1	1.5
electrode type		1（Fe/Al）	2（Fe/Fe）	3（Al/Fe）

Table S3. Experimental design and response results of RSM.

Run	Initial pH	Current density(mA/cm^2)	Electrode type	Actual removal efficiency （%）
1	0	0	0	98.65
2	0	0	-1	37.87
3	1	0	0	94.81
4	0	1	0	99.49
5	0	0	-1	30.12
6	-1	1	1	25.07
7	0	-1	0	88.54
8	1	1	1	55.91
9	-1	1	-1	20.03
10	-1	-1	1	17.11
11	1	1	-1	30.01
12	-1	0	0	76.69
13	0	0	0	96.23
14	1	-1	1	30.78
15	-1	-1	-1	15.81
16	0	0	0	93.47
17	0	0	0	99.89
18	1	-1	-1	21.97
19	0	0	0	90.34
20	0	0	0	91.28

Table S4. ANOVA for the regression response surface model.

Source	Squares	df	Square	Value	Prob > F	
Model	22370.32	9	2485.59	226.59	< 0.0001	significant
A-initial pH	620.47	1	620.47	56.56	< 0.0001	significant
B-current density	316.97	1	316.97	28.9	0.0003	
C-electrode type	238.14	1	238.14	21.71	0.0009	
AB	55.07	1	55.07	5.02	0.0489	
AC	100.61	1	100.61	9.17	0.0127	
BC	54.24	1	54.24	4.94	0.0504	
A^2	177.5	1	177.5	16.18	0.0024	
B^2	0.15	1	0.15	0.013	0.9102	
C^2	9830.52	1	9830.52	896.18	< 0.0001	significant
Residual	109.69	10	10.97			
Lack of Fit	33.06	5	6.61	0.43	0.8113	not significant
Pure Error	76.64	5	15.33			
Cor Total	22480.01	19				

Table S5. Variation in PVA molecular weight with reaction time by GPC

Sample	Mn	Mw	Mp	Mz	Polydispersity
1(The initial PVA)	43630	84670	75833	136384	1.940623
2(10 min)	23470	48464	44488	77165	2.064892
3(30 min)	14791	19942	15951	26284	1.348275
4(60 min)	718	747	744	775	1.039961

Mw：weight-average molecular weight；Mn：number-average molecular weight；Mw/Mn：polymer dispersity index；Mz：z-average molecular weight；Mp：peak-position molecular weight；Mv：viscosity-average molecular weight. Sample 1，2，3，4：four samples with different molecular weight of PVA.

Methods	Conditions	Results	Reference
Photoelectrochemical oxidation	PVA: 50 mg/L; pH=3; 120 min;	PVA removal: 77.8% (Anode), 29.4% (Cathode); the specific energy consumption: 8.4 kWh/kg (Anode); 17.4kWh/kg (Cathode)	1
Catalytic ozonation (CMA/O_3)	PVA: 20 mg/L; pH=7; 15 min; pH=10; 10 min	PVA removal: 97.8% at pH=7; 99.3% at pH=10	2
Electrocoagulation (Fe/Al)	PVA:100 mg/L; pH=6.5; 120 min	PVA removal: 77%; The specific energy consumption :15.7 kWh/kg	3
Electrocoagulation (steel/ graphite rod)	PVA: 200 mg/L; pH=7; 60 min;	PVA removal: 93.94%; energy consumption: 2.27 kWh/m^3	4
Photocatalysis (P-25 TiO_2 and ZnO)	PVA: 20 mg/L; pH=5, 9; 150 min	PVA removal: 54% (P-25 TiO2) and 74% (ZnO) at pH=9	5
Ozone oxidation	PVA: 20 g/L; pH=9; 240 min;	PVA removal: 99%	6
APC-EC (Fe/Fe)	PVA: 150 mg/L; pH=7; 60 min;	PVA removal: 99.85%; energy consumption: 0.059 kWh/m^3; theoretical electrode consumption: 0.208 kg/m^3; electrode consumption: 0.105g	This work

Table S6. PVA removal methods in previous studies.

1. K.Y. Huang, C.T. Wang, W.L. Chou and C.M. Shu, International Journal of Photoenergy, 2015, **2015**, 623492.
2. Z. Yan, J. Zhu, X. Hua, D. Liang, D. Dong, Z. Guo, N. Zheng and L. Zhang, Journal of Cleaner Production, 2020, **272**,122856.
3. W.L. Chou, C.T. Wang and K.Y. Huang, Desalination, 2010, **251**, 12-19.
4. Z. Wang, X. Teng, M. Xie, X. Cheng and J. Li, Journal, 2020, **31**, 2864-2870.
5. A. R. Nunes, A. O. Moura and A. G. S. Prado, J. Therm. Anal. Calorim., 2011, **106**, 445-452.
6. G. Zhu, F. Zhang, P. Jiang and M. Ge, Journal of the Textile Institute, 2021, **112**, 117-122.

Table S7. Two-kind EC method performance comparison analysis

Elements	DC-EC	APC-EC
Removal efficiency (%)	92.82%	99.73%
Energy consumption (kWh/m^3)	0.480	0.049
Theoretical electrode consumption (kg/m^3)	0.237	0.174
Actual electrode consumption (g)	0.190	0.105
Sludge weight (g)	0.1193	0.0674
Electrode stability (%)	83.27%	95.28%
Current efficiency (%)	62.37%	99.05%

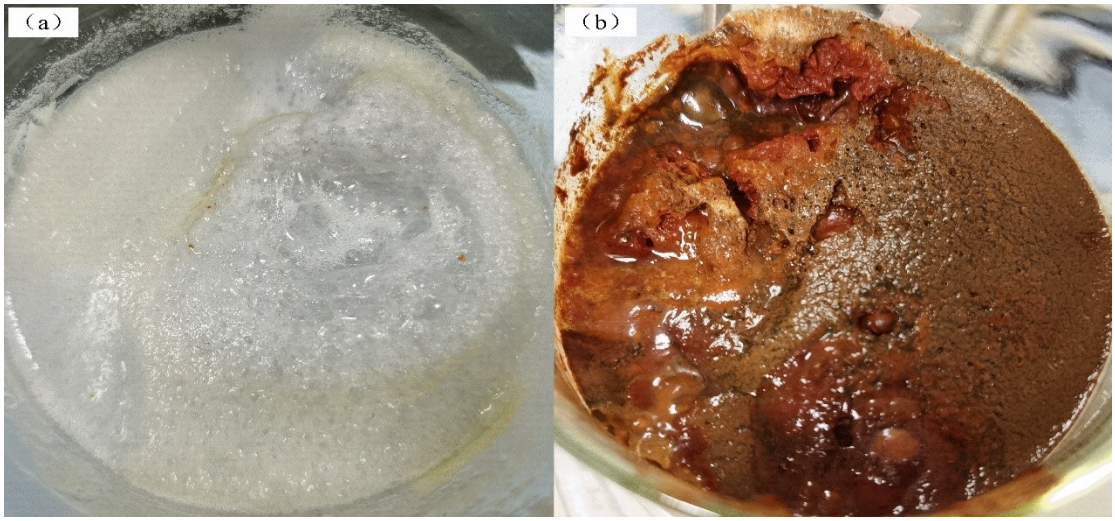


Fig. S1. The images of flocs after the EC process for (a) Al and (b) Fe electrodes.

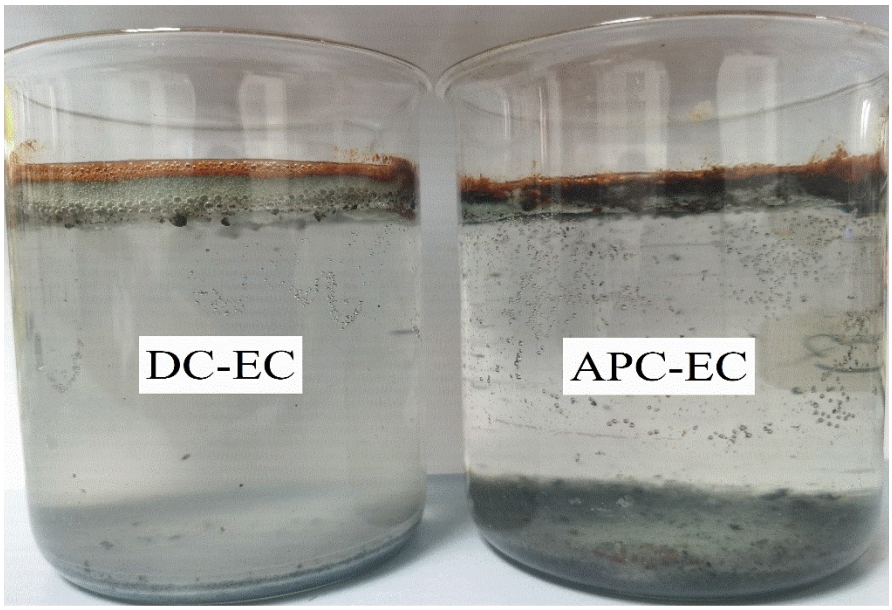


Fig. S2. The images of flocs after the DC-EC and APC-EC processes.