Pretreatment of Rubber Additives Processing Wastewater by Aluminum–Carbon Micro-Electrolysis Process: Process Optimization and Mechanism Analysis

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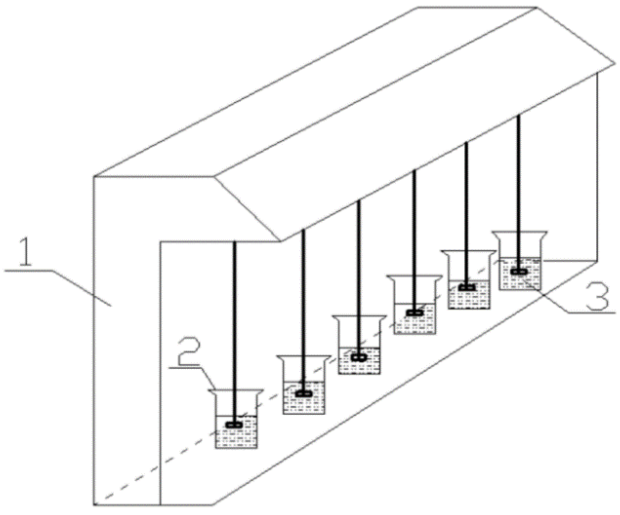
Table S1. Characteristics of environmental rubber peptizer wastewater.

Parameters	Unit	Range of value
pH	—	8.1~8.4
COD	mg L^{-1}	18500~22000
BOD_5	mg L^{-1}	42 0~500
BOD_5/COD	—	< 0.03
Chroma	color	800~1000
Turbidity	NTU	50~80
TN	mg L^{-1}	2000~2800
Cl^-	mg L^{-1}	40000~45000



1 six-unit electric agitator; 2 beaker; 3 Al chips and activated carbon

Figure S1. The schematic of Al/AC micro-electrolysis process.

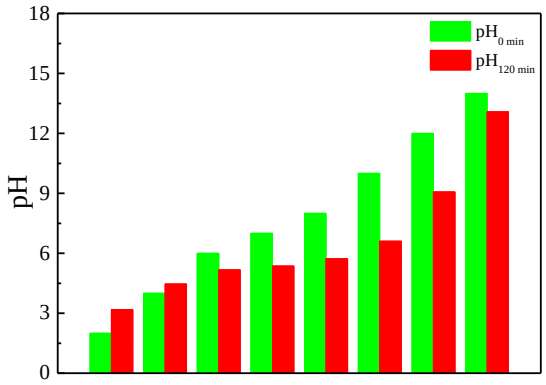


Figure S2. Comparison of initial and effluent pH of wastewater.

Results and discussion

Influence of reaction time

Reaction time is one of the key parameters in the Al/AC ME system. If the residence time is too short, the reaction process is inadequate, leading to incomplete degradation of organic pollutants in wastewater. However, with the increasing of organic pollutants degradation efficiency in the wastewater by prolonged reaction time, COD removal efficiency will not increase significantly. Measurements were performed to assess the effect of reaction time on wastewater treatment efficiency by this Al/AC ME system. Fig. S3 revealed the variations in COD and chroma removal efficiencies at different reaction time ranging from 0~250 min. It is apparent that the removal efficiencies of COD and chroma sharply increased with an increase of reaction time from 0 to 150 min. Their removal efficiency reached 40.8% and 86.7% at reaction time of 150 min, respectively. After that, with the prolonged reaction time, the changes in removal efficiencies of COD and chroma were insignificant. Therefore, a reaction time of 150 min would be encouraged for the wastewater

treatment by the Al/AC ME process.

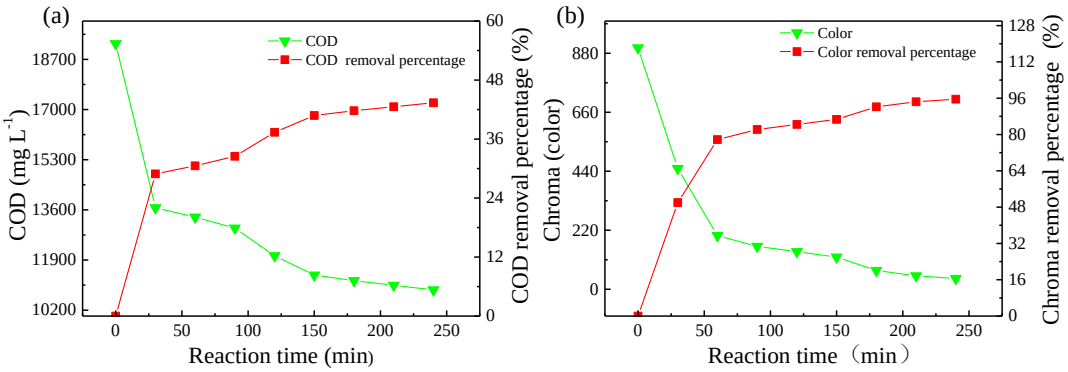


Figure S3. Influence of reaction time on (a) COD and (b) chroma removal. Reaction conditions: Al scrap dosage, 80 g L^{-1}; Al/AC mass ratio, 1:3; rotate speed, 150 r min^{-1}; pH value, 10.

Influence of stirring speed

Stirring speed is also crucial factor affecting the contact areas of electrode materials and wastewater in the ME process. The experiment was conducted at various stirring speed to achieve the optimal stirring speed. The profiles of COD and chroma removal efficiencies were showed in Fig. S4. As can be seen that the COD removal efficiency first increased and then decreased with the increasing of stirring speed from 50~400 r min^{-1}. The maximum removal efficiency of COD was obtained at stirring speed of 300 r min^{-1}. The possible explanation of this situation was that the friction between the stirrer and wastewater can effectively remove the passivation film of Al surface and the organic matter adsorbed on activated carbon surface, and restrain the aluminum-carbon hardening, which is beneficial to the adequate contact of aluminum-carbon electrode and thus improvement of wastewater treatment effect. In addition, high stirring speed will lead to the release of H_2 from [H] by

the excessive dissolved oxygen, deteriorating the treatment effect. Previous researches also studied the influence of stirring speed and similar results were achieved with the results of this work [1]. The similar variation trend in chroma removal was observed. Hence a stirring speed of 300 r $min^{-1}$was recommended.

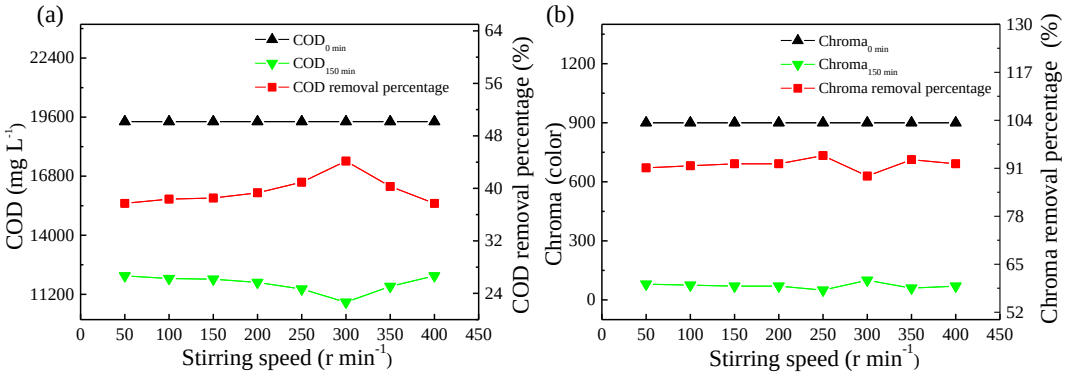


Figure S4 Influence of stirring speed on (a) COD and (b) chroma removal at 2.5 h. Reaction conditions: Dosage of Al chips, 80 g L^{-1}; Al/C mass ratio, 1:3; pH value, 10.

Table S2. Al/AC ME optimization validation experiment.

Process conditions	Influent pH=9.8; Al dosage=98.6 g L^{-1}; Al/C ratio=0.26; reaction time=176 min
Indicator	COD removal efficiency (%)
Response value	51.9
Experimental value	51.6
Error	-0.3

Reference

1. Bayar, S.; Yıldız, Y. Ş.; Yılmaz, A. E.; İrdemez, Ş., The effect of stirring speed and current density on removal efficiency of poultry slaughterhouse wastewater by electrocoagulation

method. *Desalination* **2011,** *280,* 103-107.