Supporting Information

The performance of three typical single and two coupled electrochemical processes for drilling wastewater treatment: comparison and implication

Fan-xin Kong[a]*, Yu-kun Wang[a], Jia-Mei Cao[a], Wen-Peng Wang[a], Jin-fu Chen[a],

[a] State Key Laboratory of Heavy Oil Processing, Beijing Key Laboratory of Oil & Gas Pollution Control, China University of Petroleum, Beijing 102249, China

Submitted to

Environmental Science: Water Science and Technology

June 2021

* Corresponding author: Dr. Fan-xin Kong, Tel.: +86-10-8973 3637;

Email: kfx11@cup.edu.cn

S1. Characteristics of the prepared electrode

Surface morphology of prepared TiO_2-NTs/SnO_2-Sb electrode and the carbon-PTFE electrode differed substantially as observed by SEM (Fig. 2). Obvious spherical shape can be observed on the surface of TiO_2-NTs/SnO_2-Sb electrode, while porous structure can be observed on surface of carbon-PTFE electrode. The high surface roughness of the two electrodes was expected to enhance the electrode activity (Chai et al. 2011).

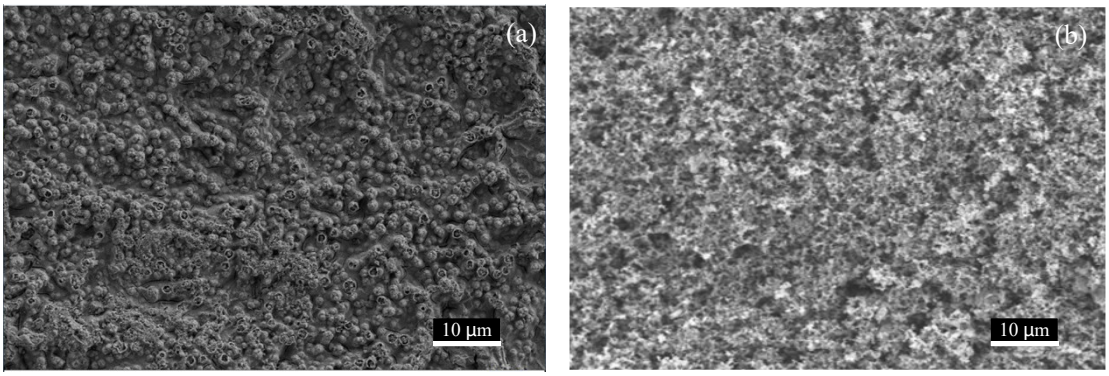


Fig. S1. SEM images of the prepared (a) TiO_2-NTs/SnO_2-Sb, (b) carbon-PTFE

TiO_2-NTs/SnO_2-Sb electrode as a high-efficiency anode material can generate strong oxidizing •OH for organic pollutant removal during ECO process, which can oxidize and decompose organic pollutants more thoroughly (Wang et al., 2019), while carbon-PTFE gas diffusion cathode can produce H_2O_2 through O_2 reduction by two electron pathways. The yield of •OH produced by TiO_2-NTs/SnO_2-Sb anode and H_2O_2 produced by carbon-PTFE cathode were measured to evaluate the •OH and H_2O_2 production mass under current density of 20 mA cm^{-2}, respectively. Previous study (Wang et al., 2021) indicated that peroxone reaction of electro-generated H_2O_2 with O_3 can produce •OH. The linear increase for both •OH and H_2O_2 production with time indicated that excellent performance of electrode and the electrodes was well prepared.

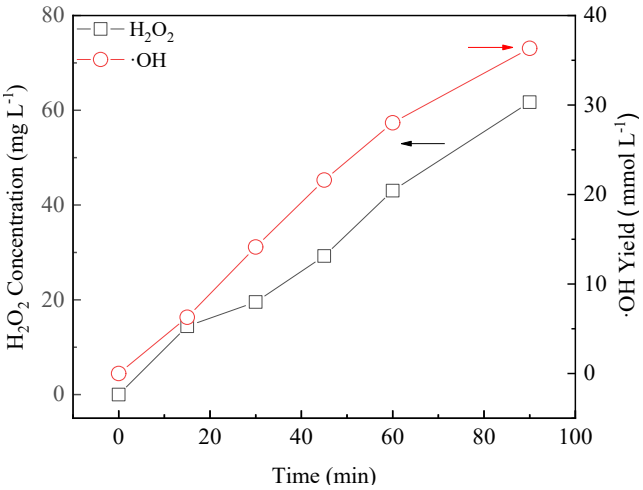


Fig. S2. •OH concentration in situ produced by TiO_2-NTs/SnO_2-Sb anode and H_2O_2 produced by carbon-PTFE cathode under current density of 20 mA cm^{-2}

S2. The pH variation of the main single and coupled process

Table S1 Final pH variation of different processes

	pH				
Process	200 mA	300 mA	400 mA	500 mA	600 mA
EC	8.74	8.86	9.04	9.09	9.15
ECO	6.91	6.74	6.57	5.82	5.67
E-peroxone	4.11	4.50	5.41	6.85	7.86
ECP	8.36	8.76	8.84	8.91	8.93

S3. Ozone oxidation process

Bench scale experiments of ozonation treatment of drilling wastewater was performed in a 150 mL air-tight organic glass electrolytic cell, using a DC power supply (KXN-305D, Zhaoqing, China), and a temperature-controlled magnetic stirrer. The experiment treated 150 mL of drilling wastewater with a magnetic stirring bar for 4 h, and used an ozone generator to continuously sparged the mixture of ozone and air into the reactor by a pure titanium microporous aerator at a flow rate of 0.6 L min^{-1} (8.25 mg L^{-1} O_3).

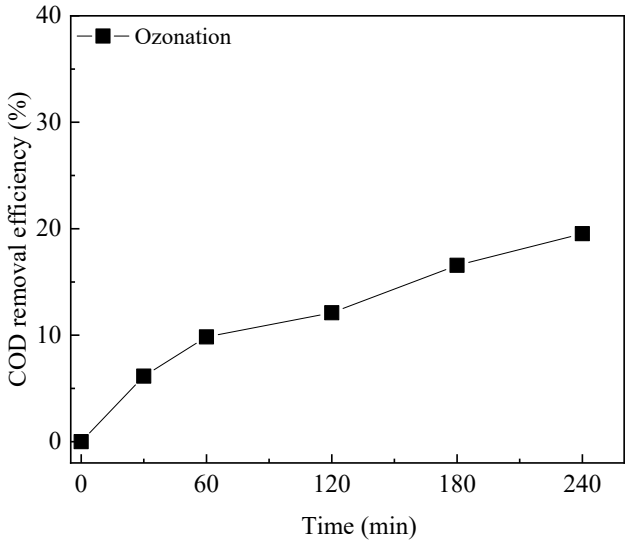


Figure. S3 COD removal efficiency by ozonation

S4. Kinetics modeling for different processes

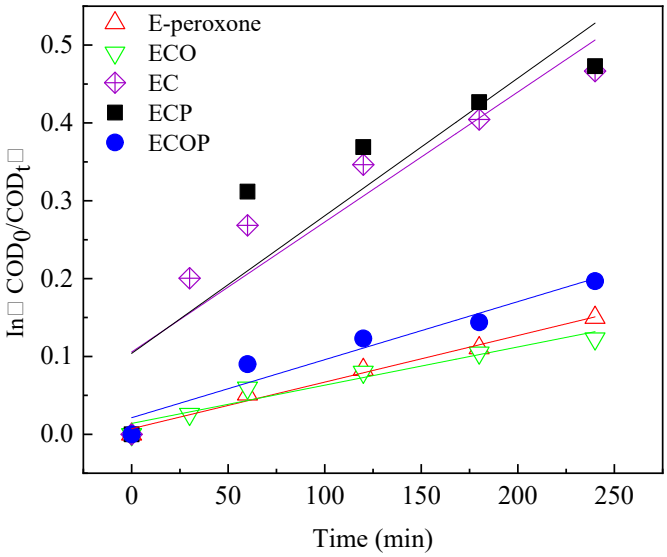
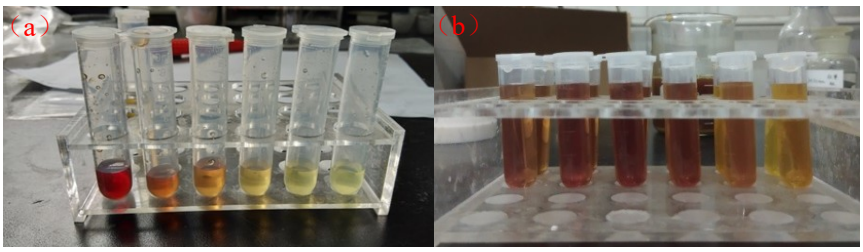


Fig. S4 Pseudo-first order curves of COD degradation by different processes under the current of 300 mA

S5. Color variation by different processes



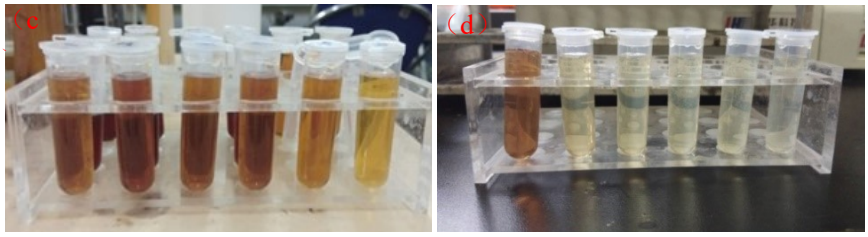


Fig. S5. Color variation by different processes

（a）EC（b）ECO（c）E-peroxone（d）ECP

S6. Kinetics modeling for the EC-E-peroxone porcess.

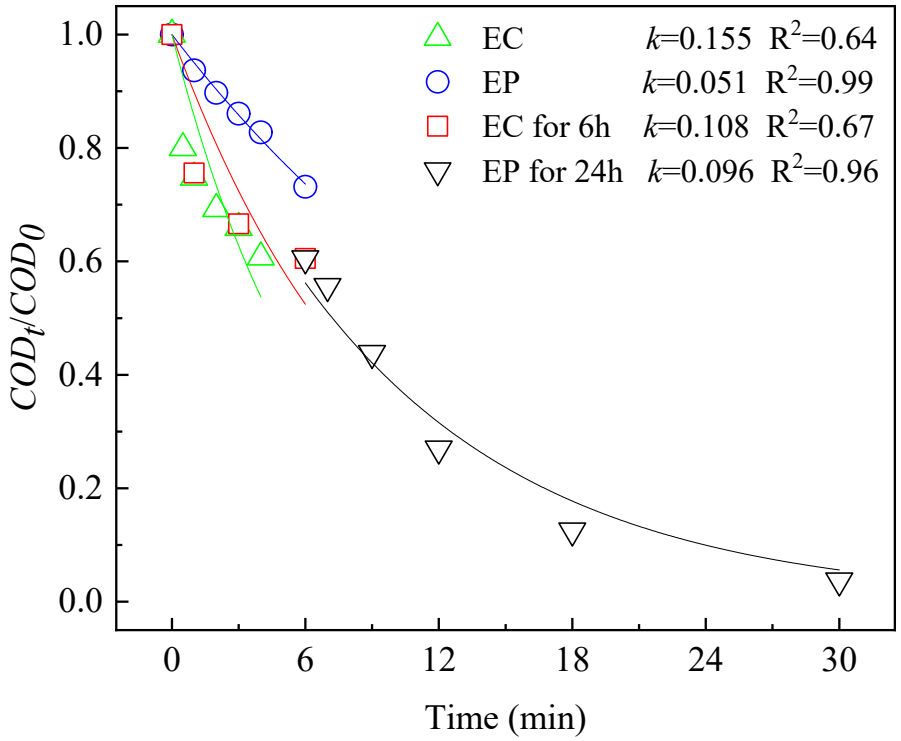


Fig. S6 Pseudo-first order curves by EP (6 h), EC (4 h) and EC-EP (EC process in the first 6 h and then EP process in 24h) process under the current of 400 mA.

References

Chai, S., Zhao, G., Li, P., Lei, Y., Zhang, Y.-n. and Li, D. (2011). Novel sieve-like SnO_2/TiO_2 nanotubes with integrated photoelectrocatalysis: Fabrication and application for efficient toxicity elimination of nitrophenol wastewater. The Journal of Physical Chemistry C 115(37), 18261-18269.

Kong, F.-x., Lin, X.-f., Sun, G.-d., Chen, J.-f., Guo, C.-m. and Xie, Y.F. (2019).

Enhanced organic removal for shale gas fracturing flowback water by electrocoagulation and simultaneous electro-peroxone process. Chemosphere, 218, 252-258.

Wang, Y.-k., Kong, F.-x., Yang, D.-m., Liu, Q., Lin, X.-f., Chen, J.-f. and Zhang, Y. (2021). The synergistic effect of electrocoagulation coupled with E-peroxone process for shale gas fracturing flowback water treatment. Chemosphere, 262.