Treatment of wastewater from petrochemical industry by a solar-powered electrocoagulation process: Optimization of crucial operating parameters using response surface methodology

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Text S1. Laboratory SPEC experimental setup

In pursuit of enhanced economic and environmental sustainability, this study contemplates the integration of electrocoagulation with renewable energy sources, such as solar power, to forge a sustainable and energy-efficient solution. Electrodes for the electrocoagulation process were fabricated from aluminum plates measuring 10.00 cm × 5.00 cm × 0.12 cm and 150-mesh 304 stainless steel mesh measuring 10.00 cm × 5.00 cm × 0.02 cm, serving as the anode and cathode materials, respectively. These electrodes were vertically oriented and positioned within the reactor, connected to a circuit via copper wires. The electrocoagulation reactor was constructed from acrylic, organic glass with dimensions of 10 cm in length, 10 cm in width, and 16 cm in depth, yielding a practical volume of 1600 mL, with an operational reaction volume of 1000 mL for the experiments. Energy storage was facilitated by a rechargeable battery (Jackery 200 plus, JE-2000C, Shenzhen Hello Technology Energy Co., Ltd., Shenzhen, China), which was subsequently connected to a direct current power supply (MOS, QJ6005E, 0-60 V/0-10 A) to initiate the SPEC (Sustainable Power Electrocoagulation) experiments. The experimental setup for the electrocoagulation treatment of petrochemical wastewater is depicted in Fig. S1.

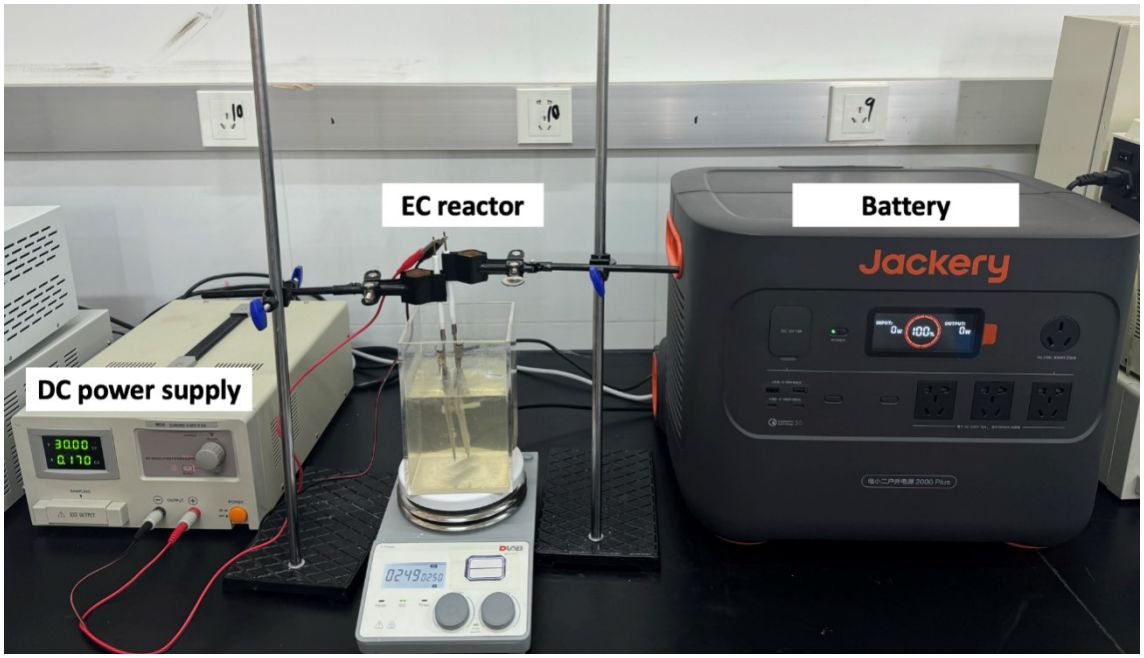

Fig. S1. Real image of the SPEC experimental setup.

Table S1. Elements composition of SPEC sludge.

Elements	Atomic number	Weight %	Atomic %
O	8	58.88	67.10
Al	13	34.21	23.11
C	6	6.10	9.26
Cl	17	0.43	0.22
Na	11	0.38	0.30
Total	-	100	100

Text S2. X-ray photoelectron spectroscopy of SPEC sludge

The XPS characterization results of the sludge obtained from treating petrochemical wastewater using the Al plate-SSM electrode combination in the SPEC process are shown in Fig. S2. The full spectrum of the XPS analysis further confirmed the existence of Al in the flocs following the SPEC process (Fig. S2A). The Al 2p spectra of aluminum flocs (Fig. S2B) revealed two prominent peaks with binding energies of 74.0 and 74.9 eV, which can be assigned to $Al(OH)_3$ and Al_2O_3, respectively. During the SPEC process, the oxidation of the anodic Al plate leads to the formation of Al^{3+} ions, which react with OH^- to form flocs of $Al(OH)_3$. These flocs can adsorb organic matter.

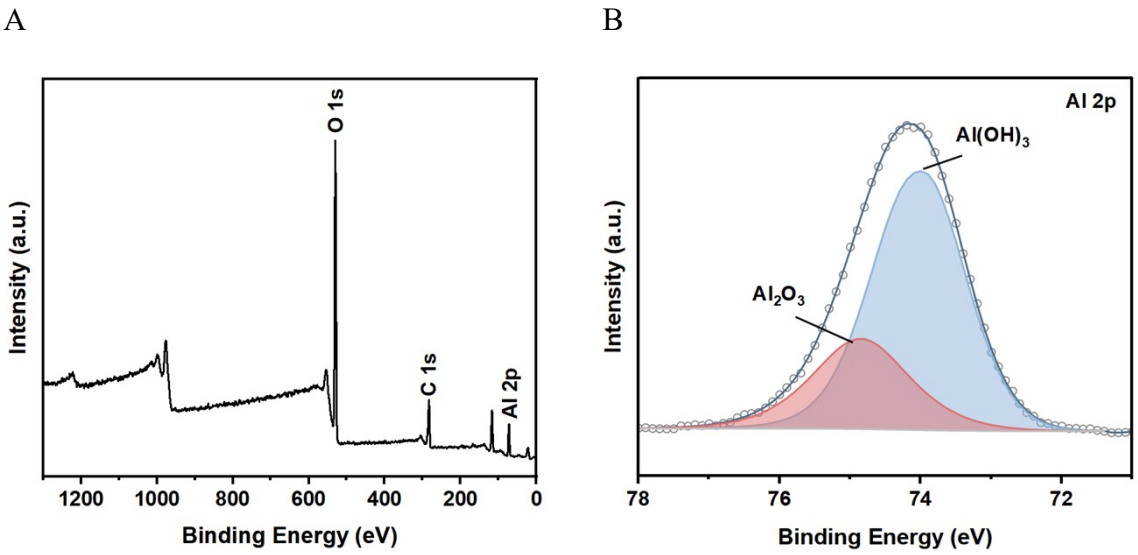

Fig. S2. X-ray photoelectron spectroscopy of SPEC sludge (A: Full spectrum; B: Fractions peak fitting spectrum of Al element).