Supporting Information

A Rational Strategy for Substantially Enhanced Solar Utilization Efficiency and Organic Pollutant Degradation Rate Via Mediated Central Processing Unit Filling

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Supplementary experimental section

Chemicals

Phenol (C_6H_6O, AR, Shanghai Aladdin), sodium sulfate (Na_2SO_4, AR, Tianjin Damao Chemical), quartz sand (Neutral, AR, Shanghai Macklin), alumina (Neutral, Al_2O_3, AR, Shanghai Yuanjiang Chemical), sulfuric acid (H_2SO_4, AR, Shenyang Chemical), sodium hydroxide (NaOH, AR, Shenyang Chemical), potassium dichromate ($K_2Cr_2O_7$, AR, Shenyang Chemical), ferrous sulfate ($FeSO_4 \cdot 7H_2O$, AR, Shanghai Macklin), O-phenanthroline ($C_{12}H_8N_2 \cdot H_2O$, AR, Shanghai Aladdin), silver

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sulfate (Ag_2SO_4, AR, Tianjin Damao Chemical), ammonium ferrous sulfate ($(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$, AR, Shanghai Macklin).

All aqueous solutions were prepared with deionized water. 200 ppm of phenol and 15,000 ppm of Na_2SO_4 electrolyte were contained in the simulated wastewater.

Electrodes

The DSA [1-2], Pt, Fe and Ni electrodes were tested at the beginning of experiments, separately. The brown intermediate products were generated and the fillings were easily contaminated when Pt was employed. Fe sheets were corroded more severely, even with corrosion holes clearly visible on the surface. The phenomena above mentioned were none occurred as Ni and DSA were applied. The degradation rates of both Ni and DSA on the target pollutants were similar as well as the ability to decrease the value of COD. But the Ni flakes are nearly only 2% of the cost of commercial DSA electrodes for the same area. Consequently, Ni was considered as the most suitable material for electrodes in continuous system.

Central processing unit

The interface between the crucible and the stainless-steel frame was sealed with PTFE ring to ensure gas tightness. The inlet and outlet tubes were attached to the cover with heat-resistant black rubber. The PTFE tape and black rubber were used between the electrode wire and the insulation sleeve to prevent gas escaping from here. A check valve was installed between the inlet pipe and the reactor, likewise between the outlet pipe and the condensing unit.

Solar collector

Parabolic solar concentrator was used to focus the sun's rays to supply the high-heat required for chemical reaction. Diameter of the solar collector is about150 cm and the maximum temperature can reach 500 ℃ at the focus. The reflector is able to concentrate the sunrays into a light spot of ~ 5 cm in diameter [3]. The orientation of the reflector can be set to face the sun by means of the manual control device and it can be adjusted to the changing angle of the solar radiation in order to make sure that the continuous reactor is in the central focus [4].

Solar panels

The lithium battery box18650 was used to store and release electricity. The battery was charged by photovoltaic panels with an effective area of 60 cm^2 for the indoor experiments, however, the charging process might take 2-4 days. The maximum output voltage of the USB side of the battery box is 5 V and the current is 2100 mA. The output voltage can be adjusted to a range between 0.5 V and 30 V by connecting the micro-regulator to the socket. The input voltage of the micro-regulator is 5-12 V.

Solid media

The solid fillings were cleaned prior to use, including steps such as soaking, washing and drying. Moreover, the solid fillings were dried at 120 °C for 2 h before each experiment. The comparison experiment was set up to identify the presence of excess water in the medium which may affect experiments.

The adsorption capacity of Al_2O_3 on pollutants was tested to eliminate potential interference for wastewater treatment. The appropriate amount of simulated wastewater and the same amount of alumina media as the experiments were placed in hermetic

vessel. Samples were collected at different time intervals (1 h) after constant stirring and scanned with the UV spectrometer to determine concentration of phenol. The solid media (Al_2O_3) after high-temp reactions was tested accordingly. Al_2O_3 were placed into the sealed bottle containing deionized water. Next, sonication for 0.5 h and stirring for 3 h were carried out, respectively. After soaking overnight, the supernatant was analyzed by the UV spectrometer. The same sonication and immersion operations were performed on the corundum crucible after every experiment, but except the stirring process.

Al_2O_3 media after reusing were packed into the high borosilicate glass bottle and 1M NaOH was poured. The solid fillings were separated by centrifuge after sonicating, washing and acidifying. After above steps, the media were dried at 200 °C under N_2, and stored in the desiccation vial.

Detection and analysis methods

UV spectrophotometer was used to detect the concentration of phenol (the characteristic absorption peak appears at 270 nm). The correlation fitting curve between concentration and absorbance value with a relevance rate of 99.99% was firstly established, then the concentration of phenol in solution could be calculated by the standard equation.

The COD value of solution was determined by the standard potassium dichromate titration method. The titration procedures should be repeated three to five times for the same water sample in order to lessen experimental error.

Morphology of the filling media before and after reactions were analyzed by

scanning electron microscope (SEM). Crystal lattice structure of solid filler was investigated by X-Ray Diffraction (XRD).

Supplementary figures

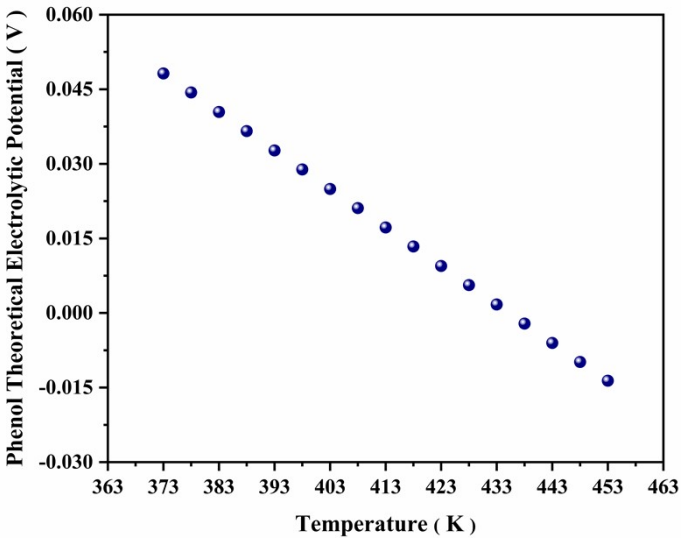

Fig.S1 Electrolytic potential with various temperature

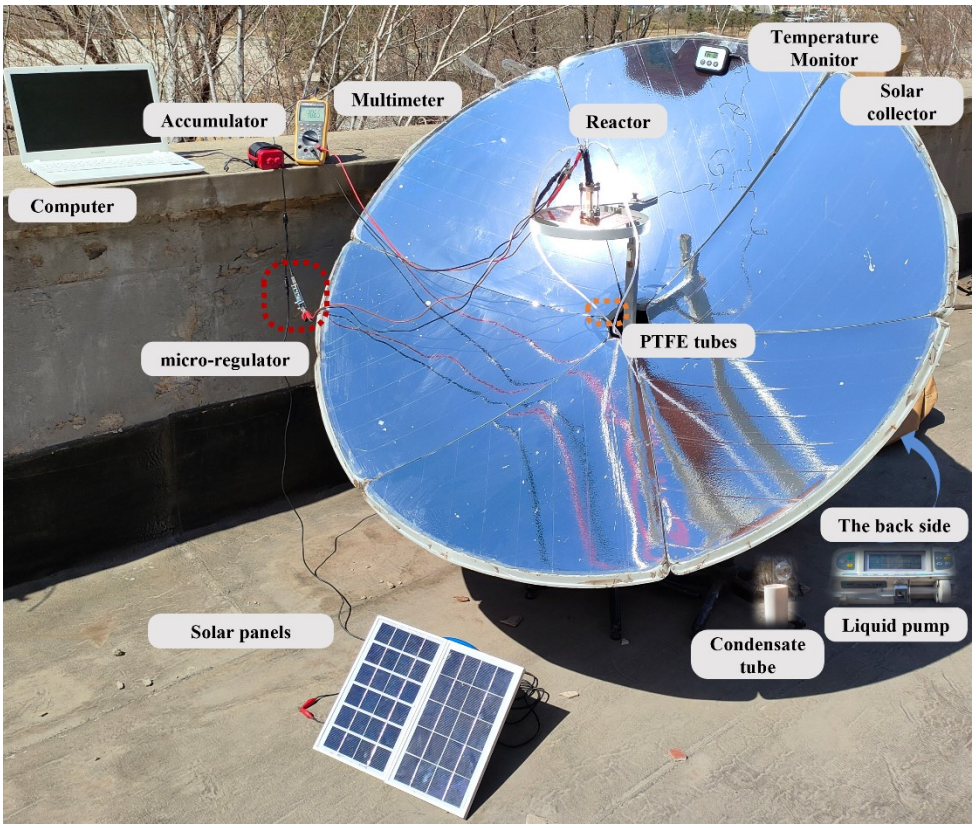

Fig. S2 Outdoor experimental device

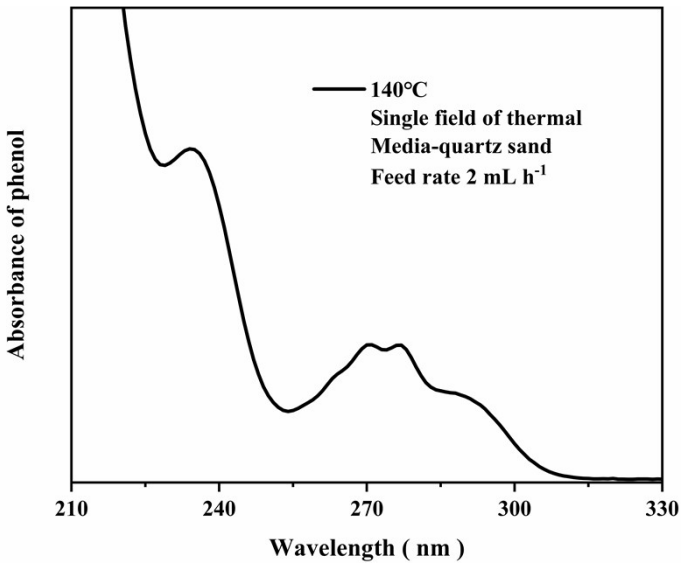

Fig.S3 UV spectrum of phenol under the single field of thermal at 140 ℃

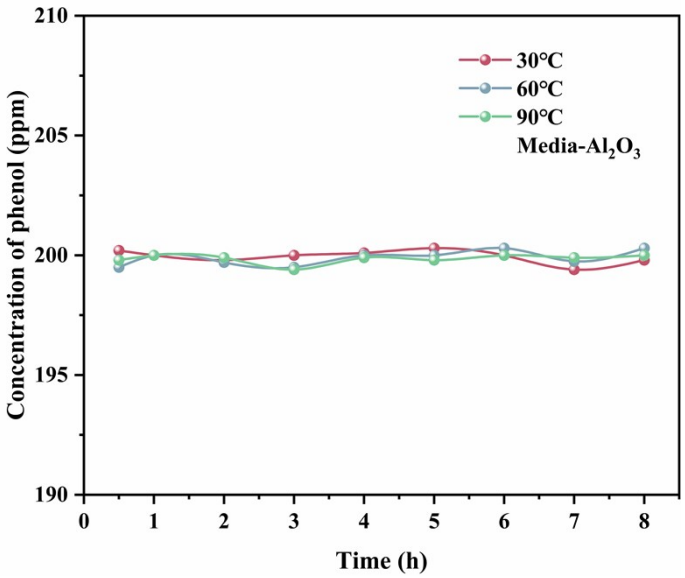

Fig.S4 Concentration of phenol with adsorption time at different temperatures

Reference

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