Preparation of a Highly-Efficient Electro-Fenton Cathode Material for H₂O₂ Generation and Its Electrochemical Performance in COD Removal

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As a typical cathode material for electro-Fenton, the surface active compositions and pore structure of the polyacrylonitrile-based carbon fibers (PAN-CFs) are important to ensure the electrochemical activity of oxygen reduction reaction (ORR) and the corresponding electro-Fenton efficiency. In order to further improve the electro-generating efficiency of H₂O₂, PAN-based carbon nanofibers (PAN-CNFs) with high surface area, good conductivity and excellent electrochemical activity were prepared through the electrospinning, as well as the following graphitization and activation treatment. Results show that the as-prepared NH₃ modified PAN-CNFs (N-PAN-CNFs) have high selectivity and good electrochemical stability for the two-electron ORR in the acidic solution, and it is worth noting that the electro-generating efficiency of H₂O₂ is high up to 98%. In addition, the electrocatalytic oxidation of phenol solution with the concentration of 100 mg L⁻¹ is investigated with N-PAN-CNFs as the cathode material of electro-Fenton. It is found that the COD_{Cr} and average current efficiency after the electro-Fenton treatment for 3 h are high up to 85% and 80% respectively, while the corresponding energy consumption is just 25.6 kWh kg⁻¹ COD. The excellent electrochemical performance of N-PAN-CNFs might be ascribed to the reasonable pore structure, high surface area (89.7 m² g⁻¹), good conductivity (93.7 S cm⁻¹) and abundant graphitic-N and pyrrolic-N (high up to 62%). Therefore, N-PAN-CNFs are expected to be widely used as efficient cathode materials for the electro-Fenton in the sewage treatment.

Keywords: Electrospinning; Electro-Fenton; Oxygen reduction reaction; Pore structure; Nitrogen functional groups.

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