Enhancing Organic Dye Degradation of TiO_2/Fe_2O_3/Activated Carbon Composites: Synergistic Adsorption-Photocatalysis

Access to clean water is a key sustainable development goal, critical for global sustainability. A major source of organic contaminants in clean water is human activity, particularly from industrial processes. These pollutants are harmful, with some being persistent and needing to be removed or reduced according to the Stockholm Convention. Photocatalysis offers a promising solution for removing organic pollutants from industrial wastewater, utilizing photon energy to effectively decompose contaminants and harmful bacteria. TiO_2 is the most widely studied photocatalyst due to its strong oxidizing ability, chemical stability, non-toxicity, affordability, and availability. However, TiO_2's photocatalytic action is limited to the UV spectrum because of its wide bandgap (3.2 eV) and high carrier recombination rate. To overcome this, TiO_2/Fe_2O_3 heterostructures have been developed to shift the bandgap into the visible range, improving photocatalytic performance. The alignment of Fermi energy levels in TiO_2 and Fe_2O_3 allows for better separation of photogenerated electron-hole pairs, enhancing performance. Additionally, activated carbon (AC), with its large specific surface area, further boosts photocatalysis by improving charge transfer and reaction efficiency.