Phosphoric Acid-Activated Carbon Derived from Algerian Date Stones as an Ecofriendly and High-capacity Adsorbent for Refinery Wastewater

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Abstract:

In response to the escalating water pollution caused by domestic, industrial, and agricultural effluents, wastewater treatment has become imperative. Among various methods, adsorption stands out as an effective, simple, and economical technique for removing contaminants. This study focuses on synthesizing activated carbon from date stones, a local agro-industrial waste, for application as an adsorbent in wastewater treatment. The date stones underwent a preparation process that included washing, drying, and grinding, followed by carbonization under an inert atmosphere. Subsequently, chemical activation was carried out using phosphoric acid to enhance porosity and surface functionality. Characterization of the activated carbon was performed using SEM, FTIR, and XRD analyses, which revealed an amorphous, porous, and functionalized structure optimal for adsorption processes. The adsorbent's performance was evaluated by measuring the reduction of chemical oxygen demand (COD) in refinery wastewater. Experimental parameters were optimized, including an adsorption contact time of 60 minutes, initial pollutant concentration of 160 mg/L, activated carbon dosage of 2 g/L, and agitation speed of 300 rpm, all maintained at pH 7 and 26°C. Under these conditions, a maximum removal efficiency of 97.63% was achieved. Adsorption equilibrium data fitted well to the non-linear Langmuir isotherm model, indicating a maximum adsorption capacity of 154.7 mg/g. The pseudo-second-order model, suggesting that chemisorption was the dominant mechanism involved, best described kinetic studies. These findings demonstrate the high potential of phosphoric acid-activated carbon derived from date stones as a sustainable and efficient adsorbent for refinery wastewater treatment.