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The Synthetization of Activated Carbon from Electrocoagulated Palm Oil Mill Effluent Sludge for Wastewater Treatment

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Abstract

Activated carbon (AC) as an adsorbent has been used widely to remove pollutants in wastewater. Many attempts have been made to produce economically accessible AC. This paper explores the idea of producing an AC, a value-added product from the by-product, sludge produced from the electrocoagulation process of palm oil mill effluents (POME) through chemical activation. AC has different applications after its discovery as a solid and reliable adsorbent. Its microporous structure, high surface reactivity, and surface area make it versatile and viable for removing pollutants from aqueous solutions. Electrocoagulation (EC) is a process whereby contaminants are removed by generating an electric current flow through the aqueous solution by using two electrodes made of iron and immersed into the solution. Aside from the wastewater treatment, the resulting by-product of the EC process known as sludge is recovered and converted into AC. POME sludge was utilized as a precursor of AC. The sludge is then carbonized and activated with an activating agent. The activating agents are phosphoric acid (H_3PO_4) and potassium hydroxide (KOH) solutions. The electrocoagulated sludge-based AC is characterized by its surface characteristics, elemental compositions, surface morphology, and available functional group. To validate the adsorption capacity of electrocoagulated sludge-based AC, textile dye wastewater treatment was carried out to test the efficiency of AC. The AC was used as an adsorbent to test the total suspended solids (TSS) and color removal of textile dye wastewater. The performance of this low-cost AC is comparable to that of many conventional adsorbents. Results indicate that TSS in textile dye wastewater decreased as the adsorbent dosage increased. The values of TSS removal by AC from H_3PO_4 activation decreased steadily compared to AC from KOH activation. Meanwhile, the color removal percentage decreased when the dye concentration increased. AC from H_3PO_4 activation has higher color removal percentage compared to AC from KOH activation. This shows that AC from H_3PO_4 activation has better adsorption due to its more extensive surface area. From BET analysis, AC by H_3PO_4 activation offers a higher surface area, 36.1017 m^3/g, compared to AC by KOH activation, which is 8.9460 m^3/g. A more extensive surface area has a higher tendency to adsorb contaminations. The findings of this work confirmed the potential use of electrocoagulated sludge-based AC as an alternative and economically adsorbent for effective dye pollution removal in wastewater.

Keywords: Activated carbon; Electrocoagulation; POME; Waste; Chemical activation; Wastewater treatment.