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Performance evaluation of polypyrrole–montmorillonite clay composite as a re-usable adsorbent for Cr(VI) remediation

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ABSTRACT:

A flexible composite adsorbent combination of polypyrrole and montmorillonite clay (PPy-MMT) has been prepared by in situ oxidative polymerization method. This well-achieved adsorbent has amphoteric characteristics and has been explored in many adsorption processes related to heavy metals removal, more especially Cr(VI) from the water phase. However, the progressive accumulation of Cr(VI) onto the adsorbent surface reduces its adsorption capacity before adsorbent depletion. This factor limits the application of the adsorbent due to high cost and environmental impact related to adsorbent disposal after use. Here, we report the feasibility of different regenerating agents to recover adsorbed Cr(VI) and activate the tunable surface charge of the adsorbent composite to restore its initial adsorption capacity until exhaustion. The recycled PPy-MMT adsorbents were characterized by FTIR, TGA and EDS analysis. At low solution pH, PPy-MMT is protonated resulting in high adsorption capacity for Cr(VI) through electrostatic attraction and ion exchange while simultaneously reducing Cr(VI) to less toxic Cr(III). The spent adsorbents were reversibly subjected to sequential adsorption–desorption cycles between adsorbent neutral state and the oxidized state using different concentrations of regenerating agents including NaOH, NH4OH, HCl, NH4Cl and HNO3, respectively. The results suggested that with 0.01 M NaOH and 0.5 M HCl, PPy-MMT could be used for over five cycles for Cr(VI) removal with more than 80% regeneration efficiency indicating potential applicability as a re-usable adsorbent for Cr(VI) removal.