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Exfoliated polypyrrole-organically modified montmorillonite clay nanocomposite as a potential adsorbent for Cr(VI) removal

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Abstract

Exfoliated polypyrrole-organically modified montmorillonite clay nanocomposite (PPyOMMT NC), was prepared as a potential adsorbent, via in situ polymerization of pyrrole monomer for adsorption of toxic Cr(VI) from aqueous solution. The WAXD and SAXS results indicated that the clay sheets were exfoliated in the prepared nanocomposite. HRTEM results showed good dispersion of the clay into the polymer matrix. The presence of the PPy polymer in the nanocomposite and adsorption of Cr(VI) onto the nanocomposite were confirmed using ATR-FTIR. Using the BET method, an improved surface area was observed for the PPy-OMMT NC compared to native clay. Batch adsorption studies whereby the pH, initial Cr(VI) concentration, sorbent dosage and temperature were varied, revealed that Cr(VI) adsorption process was rapid, spontaneous in nature and favoured with increased temperature at pH 2. The kinetic data fitted well to the pseudo second order kinetic model while the equilibrium data was satisfactorily described by the Langmuir isotherm. The Langmuir maximum adsorption capacity of Cr(VI) onto PPy-OMMT NC at pH 2.0 was found to be 119.34, 176.2 and 209.6 mg/g at 298 K, 308 K and 318 K, respectively. The selective adsorption of Cr(VI) was demonstrated in binary adsorption systems with coexisting ions. Moreover, desorption experiments revealed that the nanocomposite can be reused effectively for two consecutive adsorption-desorption cycles without any loss of its original capacity. Groundwater test results showed that the nanocomposite is a potential adsorbent for Cr(VI) ion removal from contaminated water sources.