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Magnetic arginine-functionalized polypyrrole with improved and selective chromium(VI) ions removal from water

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ABSTRACT:

Magnetic arginine-functionalized polypyrrole (Fe3O4@Arg-PPy) nanocomposite was fabricated by in-situ polymerisation of pyrrole (Py) monomer in the presence of arginine and Fe3O4 nanoparticles for toxic chromium (VI) ions removal from simulated and chromium ores leaching effluent. The nanocomposite adsorbent was characterised using a variety of techniques, including, Fourier transform infrared (FTIR) spectroscopy, X-ray diffraction (XRD), field emission scanning electron microscopy/energy dispersive X-ray spectroscopy (FE-SEM/EDS), high resolution-transmission electron microscopy (HR-TEM), vibration sample magnetometer (VSM), Braunauer-Emmett-Teller (BET) method and X-ray photoelectron spectroscopy (XPS). The adsorption kinetics study for the removal of Cr(VI) ions using Fe3O4@Arg-PPy demonstrated that the process followed a pseudosecond-order model. Isothermal investigation, on the other hand, revealed a monolayer adsorption behaviour following the Langmuir model with a maximum absorption capacity of 322.58mg/g at 25 °C and pH 2. The plausible Cr(VI) adsorption mechanisms were inferred taking into consideration the presence of amino functional groups within Fe3O4@Arg-PPy moiety, the fates of chromium valence state, and the solution pH variation. Reduction of Cr(VI) to Cr(III) by active electron rich nanocomposite was established using ion chromatography inductively coupled plasma-mass spectrometry (IC-ICP-MS) and XPS analyses. Cr(VI) removal took place via electrostatic attractions, reduction and chelation. Even in high salinity conditions, Fe3O4@Arg-PPy also retained its impressive adsorption efficiency towards Cr(VI) ions. Further, assessment for Cr(VI) ions removal in chromium ores leaching water samples demonstrated its potential practicability. The described adsorbent could equally be regenerated for four adsorption-desorption cycles, retaining up to 64% of its adsorption efficiency.