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Targeted Synthesis, characterization and exploration of dearsenification potential of β-Cyclodextrin functionalized hydrous Iron-Zirconium hybrid oxide

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β-cyclodextrin (β-CD) functionalized hydrous iron-zirconium hybrid oxide (CHIZO), a new class of tailored highly selective composites in organic-inorganic framework was synthesized aiming to apply for high arsenic laden water treatment which was characterized using various modern analytical tools like XRD, FE SEM –EDX, AFM, BET, FTIR, TGA, UV-Vis and cross polarized 1H and 13C solid state NMR (ssNMR) spectra for the conformation of the surface area, morphology, composition and the metal organic structural pattern. This material was explored for its efficacy on Arsenic(III) removal from aqueous solution. ssNMR clearly shows the high level of functionalization of the host oxide by the organic moiety suggesting the appreciable injection of the same into the pristine oxide. Highly pH dependent Arsenic(III) adsorption by CHIZO was decreased with increasing pH, and the pseudo-second order kinetics controlled the reaction. Langmuir isotherm was recognized to be the best fit model for describing adsorption equilibrium with significantly higher mono layer adsorption capacity of Arsenic(III) (32.012 mg g-1) than the host hydrous Fe-Zr oxide (7.21 mg g-1) at pH $\sim$7.0 and at 303 K. Thermodynamically spontaneous nature is due to endothermic nature of the reaction. Phosphate, sulphate and bicarbonate show adverse effect on Arsenic(III) adsorption. β-CD forms inclusion complexes by taking up Arsenic(III) from water into its central cavity and the driving forces associated with the complex formation include release of enthalpy-rich water molecules from the cavity, electrostatic interactions, hydrogen bonding and release of conformational strain. Privileged regeneration of spent adsorbent even by 1.0 M NaOH (above 80 %) is probably due to weak electrostatic interaction between Arsenic(III) and the adsorbent surface. The present study thus revealed that CHIZO could be an efficient adsorbent for Arsenic(III) because of its high adsorption capacity and economic viability.
Keywords: adsorption, β-cyclodextrin, composite, Arsenic (III), hydrous iron-zirconium hybrid oxide