Sustainable tin-based biochar nanocomposite for hexavalent chromium removal from drinking water

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In this work we prepared an inorganic/biobased nanocomposite adsorbent for the efficient uptake of hexavalent chromium from drinking water in compliance to the new concentration levels described by European Union legislation as safe (25 μg/L). The main parts of the nanocomposites are the Sn(II) oxy-hydroxides acting as a reductant of Cr(VI) to Cr(III) which is incorporated onto the biochar, derived by residual hemp stem, providing a porous surface and with numerous sites. All synthesis steps were designed according to the principles of sustainable chemistry for low cost and minimum toxicity of reagents, reuse of residuals and low energy consumption. Biochar's sufficient specific surface area was with minimum thermal energy consumption while the Sn oxy-hydroxide prepared by the aqueous precipitation of a non-toxic tin salt precursor under acidic conditions followed by the separation of solid to recover used acids in the next batch. The amorphous biochar network decorated by nanostructured Sn oxy-hydroxide identified as $Sn_6O_4(OH)_4$ resulted after the partial decomposition of $Sn_{21}Cl_{16}(OH)_{14}O_6$ which takes place during wet blending. Adsorption performance demonstrated that the nanocomposite loaded with 20 %wt. of Sn oxy-hydroxide succeeds an increase of the obtained adsorption capacity, referring to residual concentration 25 μg/L, by three times (21.6 mg/g_{Sn}) in comparison to the pure Sn oxy-hydroxide adsorbent with respect to the Sn active phase content (6.9 mg/g_{Sn}). This approach aims to provide a new way to produce low cost Cr(VI) adsorbents contributing to the exploitation of biomass residuals towards added-value products but also to the significant decrease of required inorganic active adsorbent quantities and corresponding reagents to achieve the same adsorption capacity.

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