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The effect of zirconia doping into hydroxyapatite-based nanocomposites in defluorination of water

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Elevated levels of fluoride in ground water are identified in many parts of the world and long-term consumption of water with fluorides above the permissible levels has resulted in adverse health effects. As far as the defluorination methods are concerned, adsorption is considered as one of the best methods. Hydroxyapatite (HAP) based nanocomposites are considered promising adsorbents due to their nontoxicity and biocompatibility. As per the literature, the incorporation of HAP with organic polymers such as chitosan (HAP-CTS) and montmorillonite (HAP-MMT) could improve fluoride adsorption. The major objective of the present work was to identify the effect of incorporating zirconium (Zr) into these nanocomposites to enhance fluoride adsorption. Here the zirconium was selected due to its nontoxicity and high affinity of zirconia towards fluorides. Zr was incorporated into HAP-CTS and HAP-MMT via an *in-situ* precipitation method in different ratios of Ca:Zr. Comparative adsorption studies of these nanocomposites indicated that HAP-CTS with Ca:Zr ratio 8:2 (Z-HAP-CTS 8:2) as the most promising material while Zr-HAP-CTS 6:4 gave the second-best improved sorption properties. These nanocomposites were characterized by scanning electron microscopy (SEM), Fourier transform infrared (FT-IR) spectroscopy (as well as by X-ray diffraction and subjected to detailed adsorption studies. Adsorption data were fitted into Langmuir, Freundlich and Temkin models and the Freundlich isotherm was found to be the best model for the Zr-HAP-CTS 8:2 nanocomposite. This indicates the muli layer adsorption and the maximum adsorption capacity was 20 mg/g. To study the applicability of the synthesized materials in real world applications, gravity filtration studies were carried out using actual water samples contaminated with 2.5 ppm initial fluoride concentration. From the study, a breakthrough capacity of 4000 ml/g was obtained by considering the breakthrough concentration as 0.5 ppm when the water sample was passed through a gravity column with a 1 cm diameter at a flow rate of 10 ml/min.

Keywords: Hydroxyapatite, zirconium, chitosan, adsorption, fluoride

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