Hydrothermal synthesis of a hybrid adsorbent Ce:Mn-Carbon for fluoride removal from water

E. Vences-Alvarez[a], J. R. Rangel-Mendez[a]

[a] División de Ciencias Ambientales, Instituto Potosino de Investigación Científica y Tecnológica A.C. (IPICYT), Camino a la Presa San José 2055, Col. Lomas 4ª Sección, C.P. 78216, San Luis Potosí, SLP, México.

Abstract

Cerium-manganese nanoparticles (Ce:Mn) were synthesized and anchored on the surface of granular activated carbon (GAC) by hydrothermal microwave assisted synthesis to obtain a hybrid adsorbent (GAC-Ce:Mn) with high fluoride adsorption capacity. According to the modified carbons characterization, the presence of Mn^{2+} in the GAC-Ce:Mn sample was not significant. This suggests that Mn^{2+} could act mainly as a complexing agent, reducing the size of cerium oxyhydroxide nanoparticles to less than 20 nm on the activated carbon surface, which allows obtaining materials with high adsorption capacity. X-ray diffraction reveals the presence of CeO_2, but no crystalline manganese phases. Fluoride adsorption capacity on the GAC-Ce:Mn was 8.31 mg g^{-1}; however, the adsorption capacity of GAC-Ce was 11.03 mg g^{-1}, being higher than that obtained by the GAC-Ce:Mn. These results indicate that the presence of Mn^{2+} as a complexing agent to control the size of cerium oxyhydroxide particles anchored on the surface of GAC does not guarantee an increase in F^- adsorption capacity. On the other hand, the pH and the presence of arsenic do not have a significant effect on the fluoride adsorption capacity of GAC-Ce and GAC-Ce:Mn materials. Finally, functional groups such as carboxylic (-COOH) and phenolic (-OH), play an important role in the anchoring of Ce^{3+} on activated carbon, but not in the adsorption of fluoride ions because it is carried out by the displacement of OH^- from cerium oxyhydroxides.