Fluoride removal from water by Layered Double Hydroxides (LDHs)

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The usual consumption of drinking water with high fluoride (F^-) concentration, over the limit of 1.5 mg/L set by the World Health Organization (WHO 2011), causes dental and skeletal fluorosis and is a serious health issue that affects the rural areas of the East African Rift Valley.

This work contributes to the *Horizon*2020 FLOWERED project (*de-FLuoridation technologies for imprOving quality of WatEr and agRo-animal products along the East African Rift Valley in the context of aDaption to climate change*) for the development of a low-cost technology for the defluoridation of drinking water through sorption methods by using layered double hydroxides (LDHs), a group of minerals with a high potential for the treatment of contaminated water (Lv et al., 2006).

LDHs have general stoichiometry $M^{2+}_{1-x}M^{3+}_{x}(OH)_2(A^{n-})_{x/n}\cdot mH_2O$. Their structure consists of octahedral brucite-like layers positively charged as a consequence of the partial substitution of bivalent metals ($M^{2+}= Mg^{2+}$, Zn^{2+}, Ca^{2+}, etc…) with trivalent ones ($M^{3+}= Al^{3+}$, Fe^{3+}, etc…), alternating with negative interlayers containing anions ($A^{n-}= CO_3^{2-}$, SO_4^{2-}, Cl^-) and variable quantity of water (Cavani et al., 1991).

LDHs can remove dissolved anions from solutions through the anion exchange or by rehydration after calcination. In the first case, the anions dissolved in solution replace those present in the interlayer of untreated LDHs; instead, in the second case, the mixed oxides obtained from LDHs calcination, when immersed in solution, uptake anions in the interlayer during the rehydration and the reconstruction of the LDHs lamellar structure. Moreover, great advantage can derive from the use of LDHs for several cycles of regeneration.

LDHs with different cationic ($M^{2+}= Mg^{2+}$, Zn^{2+}; $M^{3+}= Al^{3+}$, Fe^{3+}) and anionic ($A^{n-}= CO_3^{2-}$, SO_4^{2-}, Cl^-) compositions have been synthesized, with a coprecipitation method at constant pH, and sorption tests have been carried out to assess the LDHs F^- removal capacity, the effect of coexistent anions in solution and the F^- removal capacity of regenerated LDHs.

Results show that calcined carbonate LDHs can remove up to 43 mg of F^- per g of sorbent and that, after four regeneration cycles, the removal capacity is still 80%. However, the F^- removal capacity can significantly decrease in the presence of high concentration of coexistent anions, especially carbonate species at the high pH values reached during the experiments. Next study will be addressed to obtain the best performance of LDHs for the F^- removal from natural water.

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