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In-situ synthesis of calcium/magnesium phosphate system for water de-fluoridation: Clay ceramic materials

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Abstract

Clay ceramic water filters impregnated with silver colloids have been used to purify water in many parts of East Africa disregarding the removal of fluoride, which is a health-threatening ion in water supplies. This paper presents a synthesis of clay ceramic materials containing in-situ generated calcium/magnesium phosphate system as an adsorbent for water de-fluoridation. The materials were prepared in varied ratios of clay (K) to heat-pretreated dolostone (R) (K:R = 0:100, 90:10, 85:15, 75:25 and 100:0), sintered at temperatures between 500 °C and 900 °C, and characterized using XRF, AAS, CHNS–O analyzer and X-ray PDF analysis. The materials improved in de-fluoridation performance with increase in sintering temperature at 500–700 °C, before exhibiting a sharp drop at 800 °C. The adsorption performance of K:R = 75:25 was higher than that of K:R = 0:100, signifying the effect of clay. The adsorption data obeyed Freundlich isotherm model, suggesting multi-layer adsorption. Fluoride uptake follows pseudo-second-order and intra-particle diffusion models, which suggests a chemisorption process involving rate-limiting intra-particle diffusion.

Keywords

Clay ceramics; Calcium phosphate system; Water de-fluoridation; Adsorption kinetics; Adsorption isotherms