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Effect of Mg²⁺-, Sr²⁺-, and Fe³⁺-substitution on Sr-85 and Co-60 adsorption on amorphous calcium phosphates: Adsorption performance, selectivity, and mechanism

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Аннотация

Hydroxyapatite Ca-10(OH)(2)(PO4)(6) is a well-known efficient adsorbent of dyes, heavy metal ions, and radionuclides. Its adsorption efficacy strongly depends on crystalline/amorphous structure, defectiveness, texture characteristics, and morphology. Herein, we synthesized Mg²⁺-, Sr²⁺-, and Fe³⁺-substituted (5 mol%) amorphous calcium phosphates as an effective Sr-85 and Co-60 radionuclides adsorbents. The introduction of Mg²⁺-, Sr²⁺-, and Fe³⁺ ions led to the formation of amorphous calcium phosphates with particles size in the nanoscale range of approximately 10-50 nm. The features of the adsorption behavior of amorphous calcium phosphates were determined depending on the variation of the pH of aqueous, NaCl and CaCl₂ solutions. Fe³⁺-substituted samples demonstrated the superior adsorption efficiency to Sr-85 (K-d 7.77 x 10⁽³⁾ cm⁽³⁾/g) and Co-60 (K-d 6.84 x 10⁽⁴⁾ cm⁽³⁾/g) radionuclides at pH of 10.0 and 4.0, respectively. The adsorption performance of obtained adsorbents slowly decreased at 0.1 M NaCl backgrounds

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and K-d Sr-85 and Co-60 reached $1.67 \times 10(3)$ and $2.78 \times 10(4)$ cm³/g for non-substituted calcium phosphate. The dramatic decrease of calcium phosphates adsorbents efficiency to Sr-85 (K-d <150 cm³/g) and Co-60 (K-d < $1.34 \times 10(3)$ cm³/g) for 0.05 M CaCl₂ model solution was established. The adsorption mechanism of dissolution-precipitation (for Sr-85) and chemisorption (for Co-60) was proposed. Fe³⁺-substituted calcium phosphate showed the competitive affinity and selectivity to Sr-85 and Co-60 comparing with described inorganic adsorbents and to be considered as prospective adsorbent for wastewater treatment in nuclear industry.

Ключевые слова

Ключевые слова автора: Amorphous calcium phosphate; Metal-substituted calcium phosphate; Sr-85 and Co-60 adsorbents; Liquid radioactive waste; Dissolution-precipitation mechanism

Keywords Plus: HYDROXYAPATITE; STRONTIUM; ION; REMOVAL; IMMOBILIZATION; SEPARATION; NANOTUBES; BEHAVIOR; CESIUM

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