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Adsorption of selected fission products on titanate nanotubes

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Inorganic ion exchangers are widely used in the treatment of reactor coolant and aqueous nuclear wastes due to their high selectivity, radiation resistance, thermal and chemical stability. Among other inorganic sorbents, hydrous titanium dioxide was proposed as the prospective sorbent for the efficient separation of fission products such as 137Cs and 90Sr. Recently, new forms of nanometer-sized titanate with unique ion exchange properties were obtained. The physicochemical properties of nanostructured titanates are enhanced and the relation between properties and applications is extended.
The aim of our work was studies of ion exchange properties of titanate nanotubes in relation to 137Cs and 85Sr.
In the present work we synthesized titanate in nanotube form using hydrothermal procedure. Anatase was heated at the temperature of 140 ℃ in the 10 M NaOH solution for 24 h. The size and shape were characterized by SEM and TEM methods. The specific surface area was measured by BET technique and the pore size distribution by BJH method. The sorption kinetics studies on titanate nanotubes of 137Cs and 85Sr in form of chlorides were measured in 0.1 M NaNO3 solution. Additionally, the effect of sodium and potassium nitrate concentration and pH on 137Cs and 85Sr sorption were examined.
The structure of nanotubes was confirmed by XRD, SEM and TEM methods. The particles diameter was greater than 5 nm and length greater than 100 nm. The measured specific surface area was ca. 300 m2·g-1 and pore size distribution was equal 0.50 m3·g-1. Due to high porous structure ion exchange kinetics were relatively slow for Cs+ and Sr2+, but 60% of equilibrium was reached within 1 h. The increasing concentration of Na+ favoured 137Cs sorption than 85Sr. As expected, K+ cations influence on sorption was greater. An increase in Kd value with increasing pH was observed for 85Sr, while in the case of 137Cs the highest sorption was reached at pH 7-9, and at pH higher than 9 the Kd decreased.
The results suggest possible applications of titanate nanostructures as inorganic sorbents for the efficient separation of fission products from different liquid wastes, however further studies are necessary.
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Primary author: Ms FILIPOWICZ, Barbara (Institute of Nuclear Chemistry and Technology, Warsaw, Poland)

Co-authors: Prof. BILEWICZ, Aleksander (Institute of Nuclear Chemistry and Technology, Warsaw, Poland); Dr KRAJEWSKI, Seweryn (Institute of Nuclear Chemistry and Technology, Warsaw, Poland)

Presenter: Dr KRAJEWSKI, Seweryn (Institute of Nuclear Chemistry and Technology, Warsaw, Poland)

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