UDC 546.36

EFFICIENT ADSORBENT FOR REMOVAL OF RADIOACTIVE CESIUM FROM WATER

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Radioactive isotopes of cesium are among the most hazardous contaminants that can be released into the environment at nuclear disasters (e.g. the Fukushima accident) or small incidents, which may occur during fissile materials processing. The objective of this work is the synthesis of a mesoporous material containing embedded phosphotungstic acid (PTA) and its study in the selective adsorption of cesium. The material (PTA/SiO_2) was synthesized by sol-gel co-condensation of tetraethoxysilane with PTA in acidic media. The obtained product had high BET surface area and pore volume. A characteristic band of the Keggin structure of PTA was present in its FT-IR spectrum while its XRD patterns were absent. This proved the embedding of PTA on a sub-molecular level. PTA/SiO_2 demonstrated high adsorption capacity on cesium. Kinetic studies showed that the adsorption data correlates strongly with the pseudo-second order model. The adsorbent surface had two types of adsorption sites: heteropolyacid anions and silanol groups. However, adsorption on silanol groups was very sensitive to the temperature. At the increased temperature, the nature of adsorption fit the Langmuir model extremely well. For improvement of the mechanical characteristics of the adsorbent, PTA/SiO_2 was formulated with binders. The bound materials contained active adsorbent and binders: γ-Al_2O_3, kaolin, or charcoal. Among all materials, the formulation with Al_2O_3 demonstrated the highest porosity and effectiveness in adsorption. The material was stable up to 540 °C. The adsorption capacity of all materials depended on the concentration of cesium in the solutions. Maximum adsorption was achieved after one hour. The adsorption of cesium is controlled by intraparticle diffusion while its rate can be described by the pseudo-second-order model. The obtained results can be used in the development of an effective adsorber for clean-up of water contaminated by radioactive ^{137}Cs and ^{134}Cs.