J Material Sci Eng 2018, Volume 7
DOI: 10.4172/2169-0022-C1-092

Novel mesoporous material for effective adsorption of radioactive cesium

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Statement of the Problem: In the past decades, the contamination of water by radioactive ^{137}Cs has become a major concern due to its effect on human and environmental health. However, effectiveness of existing technologies of Cs removal is insufficient while their cost is high. In this work, we report a novel efficient porous material for Cs adsorption.

Methodology & Theoretical Orientation: It is well known that heteropolyacids (HPA), e.g. phosphotungstic acid, form stable insoluble salts with cesium. However, HPAs are soluble in water and cannot serve as adsorbents. For the immobilization of phospotungstic acid, its co-condensation with tetraethoxysilane was conducted in the presence of Pluronic P123 as a pore-forming agent and HCl as a catalyst. Obtained water-stable material was bound with γ-Al_2O_3. Then it was studied in adsorption of Cs in batch and column tests. The kinetic data of adsorption were calculated.

Findings: The material was mesoporous with high surface area and surface concentration of adsorption sites. SEM imaging showed that the particles of HPA-containing silica gel occupied inter-particle space between larger γ-Al_2O_3 particles. The adsorbent demonstrated outstanding adsorption capacity on Cs. It was advantageous that the presence of K and Na ions did not make any notable impact on the adsorption. The material was successfully tested in the removal of radioactive ^{137}Cs from contaminated waters on Chernobyl nuclear station. Kinetic study showed that the adsorption proceeds in two steps: Fast adsorption on the particle surface and slower adsorption inside the pores. The adsorption mechanism is most adequately described by the pseudo-second order model.

Conclusion & Significance: High adsorption capacity and effectiveness of the HPA-containing porous adsorbent makes it a promising material for clean-up of contaminated water after incidents resulting in release of radioactive cesium.

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