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Nanomaterials for sorption of critical radionuclides

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Any activity that produces or uses radioactive materials generates radioactive waste. Disposal of radioactive waste is a complex issue, not only because of the nature of the waste, but also because the need to solve the problem not to burden future generations. Retention processes of key important radionuclides were studied within this study.
Cesium is one of the most important nuclides. The reasons for this are following: the isotope 137Cs has high gamma radiation and half life 30.08 years. The isotope 135Cs has very long half life of about 2.3 million years. The isotope belongs to group of isotopes in nuclear waste that are present for the very long time scales and can be conveyed far from the containment. Another important radioisotope in nuclear waste is strontium. The isotope 90Sr belong to mid-lifed isotopes with the half life of 29 years. Europium is a typical member of the lanthanide series and can be utilized as a homologue for the prediction of other lanthanide behavior. Cesium is chemically very similar to potassium as strontium is similar to calcium. They both can then penetrate into the living organism and get it exposed to internal irradiation. Therefore it is necessary to prevent migration leaking of these radionuclides to the biosphere and develop progressive retention techniques.
In the presented work, new composite nanomaterials, based on graphene, graphene oxide and cellulose, are developed for the retention purpose. The nanomaterials (graphene and graphene oxide) used were prepared from natural graphite using high intensity cavitation field [1] in a pressurized (6 bar) batch-ultrasonic reactor (UIP1000hd, 20 kHz, 2000 W, Hielscher Ultrasonics GmbH).
The graphite was exfoliated with the effect of high intensity ultrasound and delaminated graphene nanosheets were used for graphene oxide [2] preparation improved by Hummers method [3]. Graphene oxide polystyrene composite was synthesized using direct emulsion polymerization of styrene in the presence of graphene oxide at 90 ℃. Hydrothermal conditions were maintained in stainless steel stirred autoclave. The metal Ni0 nanoparticles modified cellulose was prepared by reduction of nickel (II) nitrate with sodium borohydride at 25 ℃ or hydrazine hydrate under refluxing for 24 h.
The method used for evaluation of nanomaterial retention properties was batch sorption experiment, being based on contact of solid material with tracer solution under defined boundary conditions (solid/solution ratio, solution composition etc.). The experiment results were then evaluated, using sorption distribution coefficient (KD) and Cation Exchange Capacity (CEC).
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References:
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