Enhancement of the Extraction of the Uranium from Seawater

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ABSTRACT

Although uranium is only present in ppb-range concentrations in seawater, its recovery from the ocean has been under serious consideration for several decades with a view to enhancing uranium reserves and avoiding the environmental impacts of uranium mining. Extensive studies of the adsorption of uranium from seawater have been conducted, almost all them by Japanese groups. Current adsorbents studied for this application consist of polyethylene fiber fabrics onto which amidoxime groups are attached by means of radiation-induced grafting. However, the capacities of such polymeric adsorbents for recovery of uranium from seawater is still low and the adsorption kinetics is slow due to a combination of factors including non-optimal reactivity of amidoxime with uranium in the relevant pH range, competition by other dissolved metals, non-optimized densities of amidoxime groups and lengths of the polymeric chains, and limited durability and regeneration capacity of the polyethylene-based fibers upon prolonged use. In order to enhance the performance of adsorbents for large-scale of uranium from seawater and aqueous media in general, this proposal is aimed at the exploration of new monomers, such as acrylamido phosphonates, that could be grafted onto the polymeric fibers to enhance adsorption rates and increase the uptake of uranium due to higher reactivity for both uranium tricarbonate and uranyl ions, as well as to enhance the selectivity of the polymeric adsorbents with respect to uranium. In addition, the proposal is intended to explore improvements in adsorbent technology based on the use of winged fibers with very large reactive area, utilization of polymers with superior stability, mechanical properties and environmental durability such as nylon, polyimide, polyurethane and polypropylene. In addition, the density of the adsorbent groups on the polymer will be maximized through performing the radiation-induced grafting at low dose rates to minimize radical recombination, in the absence of oxygen, and at low temperatures to keep the radicals stable until they are reacted with the active adsorbent molecule to be grafted onto the polymer.

The proposed project will be performed through cooperation between the University of Maryland and collaborators at Notre Dame University and The Catholic University of America. Together, the investigators at the three collaborating universities have extensive experience in radiation science and engineering, polymer science, and separation chemistry. The three collabo=rating groups have all the equipment necessary for successful implementation of the research plan, including extensive radiation facilities as well as state-of-the art equipment for characterizing the chemical and mechanical properties of the resulting polymeric adsorbents and their performance in recovery of uranium from seawater.