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Short Communication

Radioactive Isotopes for Uranium in Nuclear Resources

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DESCRIPTION

Nuclear power plays a significant role in addressing the energy shortage and mitigating environmental problems such as the climate change. Uranium, as critical radioactive element, has been widely used to produce nuclear power, which is increasing the necessity for uranium as an energy resource. However, uranium and its radioactive isotopes contribute to high-level of nuclear waste, which needs to be properly disposed. Therefore, the study of uranium ion doped in $RE_2Hf_2O_7$ serves as a prerequisite for their capability for nuclear waste immobilization and eventually safe nuclear energy and sustainable environment [1]. Moreover, the terrestrial deposits of uranium are predicted to become a shortage to the booming energy demand. Seawater also contains uranium at low concentrations. Although the concentration of uranium is extremely low, and the seawater represents an inexhaustible source of uranium which is estimated at approximately 4.5 billion tons nearly 1,000 times of the entire available terrestrial deposits of uranium. Development of highly efficient and selective adsorbents are capable of recovering uranium from seawater would be valuable to ensuring the availability of uranium resources.

On the other hand, vigorous exploitation of the nuclear power has potential harms to ecological environment and human health. Due to uranium mining and processing activities, nuclear accidents and improper nuclear waste treatment, a large amounts of the uranium species have released into water system [2]. The use of uranium in aqueous solutions mainly exists as soluble uranyl ions which are highly toxic and easily migrate. The exposure to excess of uranium can result in DNA damage and dangerous health issues such as liver disease and lung cancer. Thus, it is important to remove and recycle uranium from aqueous solutions for environmental conservation, human health, and sustainable development of nuclear energy.

In the last few decades, various treatment techniques including biological treatments, membrane, adsorption, advance oxidation processes, chemical precipitation processes, ion exchange, and electrochemical method has been developed to uptake uranium from aqueous solutions [3]. However, most of the methods have various drawbacks. For example, chemical precipitation is comparably simple and cost-effective; they have difficulty in reducing metal ion concentrations below legally limited levels and often produce large amounts of sludge. Among these methods, adsorption is a promising and effective method because of its high adsorption efficiency, easy operation, low cost, re-usability and availability of massive adsorbents. Recent advances for nano-materials have provided sample opportunities to develop and employ more efficient radioactive wastewater treatment technologies. Graphene Oxide (GO)-based on nano-materials have attracted significant interests because of their unique physic-chemical properties such as high specific surface area, high chemical stability and abundant oxygen-containing functional groups [4]. These properties make GO-based nano-materials for adsorption of uranium.

It has been found that, adsorption mechanism includes surface complexation or coordination, chelation, electrostatic attraction, sorption, ion exchange, ion diffusion, precipitation, reduction reaction, etc. For example, functional groups, such as amino and carboxyl groups are introduced onto Graphene Oxide (GO), surface complexation or coordination should be the main adsorption mechanisms. If reductive substances, such as zero-valent iron or Fe–Ni galvanic cell, are introduced onto GO, reduction should play an important role in elimination of U(VI) [5].

Temperature is one of the most important environmental factors that affect the adsorption of uranium by Graphene Oxide (GO) based nano-materials. It has different effects on series of chemical-physical processes such as adsorption-desorption, precipitation-dissolution and oxidation-reduction of uranium. Therefore, the change of temperature can lead to variation of adsorption capacity for uranium [6]. In order to understand the thermodynamic behaviors, adsorption isotherm models have been extensively used to provide information about the amount of adsorbed uranium ions by certain nano-materials as the adsorbents.

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CONCLUSION

Different GO-based nano-materials have different adsorption mechanisms with uranium. Other chemical functional groups or composites introduced into Graphene Oxide (GO) by surface modifications can greatly affect the interaction mechanism. Graphene Oxide (GO) based on nano-materials exhibit different interactions with uranium due to the modifications of different functional groups or composites. Generally, the adsorption mechanisms are expounded from results of batch techniques, spectroscopic analysis, surface complexation modeling, and theoretical calculations.

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