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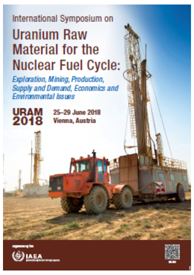

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THE EXTRACTION OF URANIUM FROM SALT LAKES IN CHINA

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INTRODUCTION

Uranium is one of the primary fuel sources for nuclear power generation, making it an element with considerable technological importance. The available energy of 1 kg uranium is equivalent to that of 2050 tons coal. Along with environmental concerns will undoubtedly increase, nuclear energy is prior to be chosen for development because of its cleanliness and high-efficiency. The terrestrial uranium resources are finite and odds and a few countries have major resource mostly in the world. It is reported that the uranium reserves was about 5 million tons when the exploitation cost was under 130 dollars per kilogram. The economical uranium reserves will be exhausted in the next several decades according to current consumption and development.

Uranium resources are broadly classified as either conventional or nonconventional resources. Nonconventional resources are very low-grade resources and those from which uranium is only recoverable as a minor by-product. Uranium is therefore a secondary product and its recovery is not subjected to most of extraction costs. The exploitation of nonconventional resources is an inevitable choice for long-term development. The high-salt and low-uranium aqua-systems such as seawater or salt lake are one of the important nonconventional resources. The total amount of uranium in seawater is about 4.5 billion tons, one thousand times of the amount of uranium in terrestrial ores. We planed to uranium extraction from seawater taking the extraction of uranium from salt lakes as cut-in point. The technical deposit will be accumulated which promoting extraction uranium from seawater forward.

DESCRIPTION

1. Uranium Resource of Salt Lakes in China

There are many salt lakes in the west provinces of China such as Qinghai, Tibet, Inner-Mongolia, Sinkiang, and so on. Some of the salt lakes are uranous. The uranium bearing salt lakes distribute in five regions which are Tibet region, Qinghai region, Sinkiang region, Inner-Mongolia region, and east halite region from southwest to northeast. The boundary of different regions are mountain chains which starting from Himalayas and Kunlun mountains, to Altun-Qilian-Liupan mountains and to northeast Helan and Taihang mountains, ending at Greater Khingan mountains[1].

Uranium resources of salt lakes were estimated by volume measure. Based on the quantity and the known uranium gross of salt lakes, the potential uranium resource was calculated about 80 thousand tons. In view of unknown uranium gross of salt lakes, the total uranium resource of salt lakes is abundant.

1. Certain Uranium Bearing Salt Lake in Tibet

Certain uranium bearing salt lake lies in the north of Tibet province where the climate is low precipitation, high evaporation and drought area. The water of the salt lake is achromatous, salty and little basified and the location is on the northwest of Gandise tectonic belt. The surface altitude of the lake is 4500 m, and the area is 252 km2. The best depth of the lake is 36m, and pH value of the water is 9.52, whose mineralization degree of is 20.35 g/L[2].

Uranium concentrations of the salt lake are around 260˜324 μg/L and the average value is 289 μg/L. Uranium concentrations near the shores are higher than that of being river supplies and the deep higher than the upper. Uranium concentrations on the surface of the lake are diverse in the range of 264˜324 μg/L because of river supplies and wind powers and the average value is 285 μg/L.

1. Synthesis of Functional Materials for Uranium Extraction from Salt Lakes

The different methods such as solvent extraction, ion exchange, flotation, biomass collection, adsorption, and precipitation and so on can be used to extract uranium from seawater or salt lake, among which the adsorption is studied more and more feasible way to develop in application. To choose which kind of material is the key to adsorption method. It is important to prepare favorable materials for uranium extraction from salt lakes.

According to the literature[3], the salophen(SLP) was immobilized on the surface of silica gel particles and used as the solid phase receptor for quantitatively analyzing uranium. Under optimal conditions, the linear range for the detection of uranium is 0.5˜30.0 ng/mL with a detection limit of 0.2 ng/mL. It is obvious that SLP is selective interaction with uranium to form complex in the very dilute solution. Hereby, the route was designed and actualized, which SLP was grafted to styrene- divinylbenzene(ST-DVB) copolymer microspheres.

Characterization. The infrared spectra of SLP functional material and amic microsphere were recorded with KBr pellet method. The element analyses of SLP functional material and amic microsphere were recorded by EL-2 type instrument.

Uranium capacity. In the experiment, 1.0 g of SLP functional material was added into 100 L simulative salt lake solution which multi-ion solution containing uranyl ion as well as competingions(U 0.34 mg/L, K^+ 0.55 g/L, Na^+ 7.98 g/L, Mg^{2+} 0.13 g/L, Ca^{2+} 3.40 mg/L, Cl^- 1.26 g/L, SO_4^{2-} 6.28 g/L, CO_3^{2-} 5.03 g/L, HCO_3^- 1.02 g/L, pH=9.5). After 30d, the uranium capacity of material was calculated, 1.17 mgU/g, by the way of cineration and lixiviation.

1. Spot Uranium Sorption Experiments of Materials

Spot uranium sorption experiments of materials were located at above-mentioned salt lake in Tibet. The materials were tied underwater onto the simple equipment which was set in the centre of the lake. After 3 months, the equipment was fished out. A thick yellow matter was found on the equipment except for little mud.

1. Melioration of Functional Materials

Identification of adhesion matter at spot. As shown above, a thick yellow matter was found on the equipment and materials, which blocks the adsorption pores on materials and debases uranium capabilities. What is the yellow matter? The yellow adhesion matter was identified by polar microscope. The monadic images were presented in the photographs, and diatom fronds were confirmed through investigation and contrast.
Isothiazolinone（MIT）compounds are germicides used widely, which can restrain the growths of bacteria, mildews and algae effectively. Hereby, the route was designed and actualized, which MIT was grafted to ST-DVB copolymer microspheres. The infrared spectra of SLP functional material and amic microsphere were recorded with KBr pellet method.

Uranium capacity. In the experiment, 1.0 g of MIT functional material was added into 100L simulative salt lake solution as above.

Anti-bioadhering ability of MIT functional material. The living surroundings of algae are similar to that of bacteria, which can grow and propagate in salt solutions. The anti-bioadhering ability of MIT functional material was tested with germcultures in indoor experimentation, and SLP functional material was used in contrast.

MIT and SLP functional materials were put into incubators at 30℃for germiculture(①The bacteria was thiobacillus ferrooxidans, and the substrate composition was including of 3.0 g $(NH_4)_2SO_4$, 0.5 g K_2HPO_4, 0.1 g KCl, 1.0 g $MgSO_4·7H_2O$, 44.4 g $FeSO_4·7H_2O$, 1000 mL deionized water, pH=2.0；②The bacteria was sulfate-reducing bacteria, and the substrate composition was including of 5mL sodium lactate, 1 mL yeast extract, 0.2 g $(NH_4)_2Fe(SO_4)_2·6H_2O$, 0.01 g KH_2PO_4, 0.2 g $MgSO_4·7H_2O$, 2.0 g NaCl, 7.2 g Na_2SO_4, 1000 mL deionized water, pH=7.0). After 7 d, the materials were taken out and observed by microscope.

DISCUSSION AND CONCLUSION

As a whole about uranium resource of salt lakes in China, the regions of higher uranium concentrations are near the shores in the directions of south and northwest, and the uranium concentration in the center of the lake is even. Uranium content of the surface below 18m either in the horizontal level or on the vertical section in the lake change little in the condition of wind powers possibly. Certain uranium bearing salt lake in Tibet is carbonate-type and the water gross is at least 5.0 billion cubes as calculated

In the part of characteristic and batch sorption experiments of SLP functional material, the IR spectrum of SLP functional materials shows that the new frequencies appearing at 1618cm-1 belong to C=N stretching vibration in SLP. The C, H, N contents of SLP functional material decrease, while O, Cl contents accordingly increase compared with that of amic microsphere. The result indicates SLP was grafted to ST-DVB copolymer successfully. The SLP functional content was 2.23 mmol/g calculated. The result suggests that the graft reaction was successful. While, the sorption amount increases drastically with the increase of pH values which indicates that SLP functional material has high capacities in alkaline solutions. The uranium desorption rate of SLP functional material≥98% when 20 g/L Na2CO3+60 g/L NaHCO3 was used as desorption agent.

In the spot uranium sorption experiments of SLP Materials, the materials were retrieved then washed by distilled water. The uranium adsorption capacities of materials were calculated by the way of cineration and lixiviation. SLP functional material is more selective adsorption of uranium, whose uranium capacity is up to 2.53 mgU/g. In addition, the uranium adsorption capacities of several materials in simulative solutions were higher than that in salt lake. The reason possibly is, on one hand, the simulative solutions are not balance states including kinetic and thermodynamic factors. On the other hand, the complexes of MgUO2(CO3)32- and Ca2UO2(CO3)3 interfere with adsorption courses of materials in solutions[4].

The bioadhering phenomena happened during spot experiments, the analogous instances for the uranium extraction from seawater at spot in Japan, America and China. It is a difficult problem to overcome bioadhering for the extraction of uranium from seawater or salt lake. The concept of anti-bioadhering materials for the extraction of uranium was presented firstly. Anti-bioadhering materials for the extraction of uranium is defined as, "a functional material can adsorb and enrich uranium selectively, which reduce or avoid bioadhering simultaneity in natural uranous water."

In the part of characteristic and batch sorption experiments of anti-bioadhering materials, the IR spectrum of MIT functional materials shows that the new frequencies appearing at 1646 cm-1 belong to C=N stretching vibration in MIT. The result suggests that the graft reaction was successful. After 30 d during spot uranium sorption experiments, the uranium capacity of material was calculated, 1.36 mgU/g, by the way of cineration and lixiviation, which was higher than that of SLP functional material. It was found that MIT functional material was of anti-bioadhering property remarkably.

Anti-bioadhering mechanism of MIT functional material was present. MIT functional groups interfere with the phosphorylation of adhesion kinases partially. Certain bond of the adhesion kinase is the most sensitive part, where cells begin to be stopped breathing. The microbes can not attach anything and breed consequently.

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Country or International Organization

China

Primary author: Prof. NIU, Yuqing (Beijing Research Institute of Chemical Engineering and Metallurgy, CNNC)

Co-author: Prof. CHEN, Shusen (Beijing Research Institutions of Chemical Engineering and Metallurgy, CNNC)

Presenter: Prof. NIU, Yuqing (Beijing Research Institute of Chemical Engineering and Metallurgy, CNNC)

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