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Natural radionuclide extraction from aqueous solutions by ionic liquids

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Abstract
Ionic liquids (ILs) are salts with a low melting point (below 100 ℃) and they are composed of completely dissociated ions. ILs have many advantages and they are of growing interest in the field of green chemistry. Most of the commonly used ILs are composed of large organic cations and the basic compounds consist of e.g. imidazolium, pyridinium, pyrrolidinium, ammonium and phosphonium(1).

Some of the unique properties of the most widely studied ILs include the large liquid temperature range, high thermal stability, electrical conductivity, and tunable physical properties. Especially the extraction of uranium by using ILs is of enduring interest in the literature as it may also be relevant to spent fuel reprocessing.(4,5)

The presented work is part of a project dealing with purification processes for drinking water. The aim of our work was the extraction of Uranium, Radium and Polonium from aqueous solutions with an IL as well as its back extraction (Pb-210 has not been taken into account here as it is removed together with stable lead). Especially the conventional anion exchange step for uranium separation from water (or other sample matrices) is very time consuming (pre-concentration and column chromatography), while the liquid-liquid extraction into an IL also takes its time, but can be done by automated systems. Investigations in our laboratory a few years ago demonstrated that extraction of uranium from water is possible with [A336][TS]2,3, tricaprylmethylammonium thiosalicylate. The ILs under investigation now are [A336][MTBA], tricaprylmethylammonium 2-(methylthio)benzoate, as well as [Mal][A336], [Thiom.][A336], [Mal][Cyphos], [Thiom.][Cyphos], [A336][Ant], [PR4][Ant], [A336][DBA], [PR4][DBA].

Investigations were performed with an artificial uranyl nitrate solution of a known amount of uranium (e.g. a few µg U in 10 ml diluted nitric acid) and mixed with the respective ILs. After centrifugation the phases were separated and the aqueous phase was analysed by liquid scintillation counting (LSC) to ensure that the uranium was removed. Afterwards acids of different molarity or EDTA solutions were used for back extraction of uranium from the organic phase.

For the investigation of the other nuclides, water samples with known amounts of Ra and Po were used (reference samples or mineral waters). For application in the field of drinking water purification we searched also for immobilisation of the ILs on a suitable backing material.

Our goal is to find a new method to shorten and simplify the chemical procedure for the determination of radionuclides (especially uranium) in natural (water) samples as well as to look for a new purification method for drinking water supplies.

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