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# USE OF BIFUNCTIONAL COMPOUNDS N, P FOR URANIUM PURIFICATION FROM AQUEOUS SOLUTIONS OF NITRIC ACID

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The refining plants of natural uranium concentrates rely on a solvent extraction process to produce uranium at the so-called "nuclear" purity. Extraction of uranium (from yellow cake) is performed thanks to an organic phase containing a specific extractant, further washed to recover pure uranium in a new aqueous phase. The conventional extractant is tri-*n*-butyl phosphate (or TBP). However, even though the TBP works pretty well at industrial scale, it is still of research interest to find optimized and highly efficient systems. Research has therefore been undertaken to find alternatives to TBP ([1], [2], [3], [4], [5]).

It turns out that most of the tested extractants have a moderate affinity for uranium (VI) with little or no selectivity for this element toward the other metallic species. A new series of N, P bifunctional ligands showed excellent properties in a nitric medium in terms of affinity for uranium extraction[6]. Based on the know-how of the LTSM team in the field of bifunctional ligands synthesis and study and of the CEA / DMRC teams in the data acquisition on major actinides [7], [8], the objective of this study is to explore and study the capacity of new molecular architectures for uranium extraction, and to understand their extraction mechanisms. It is now established that the mechanisms underlying the liquid-liquid extraction processes are based not only on the complexing properties of the extracting molecules [9], but also on their capacity to form supramolecular aggregates because of their amphiphilic nature. This study concentrates therefore on both molecular and supramolecular mechanisms to understand and master both chelation and self-assembly properties of these molecules in order to optimize extraction processes.

The molecular structures of the complexes are probed using different techniques such as infrared spectrometry. The extraction of cations, acid and water by the new bifunctional ligands are characterized by ICP, coulometry and potentiometry. The organization of the ligands in supramolecular aggregates is characterized by X-ray and neutrons scattering measurements. Critical aggregation concentrations are measured in detail by surface tensiometry to relate them to aggregation energies. All these molecular and supramolecular aspects of the system are related to its extraction properties.

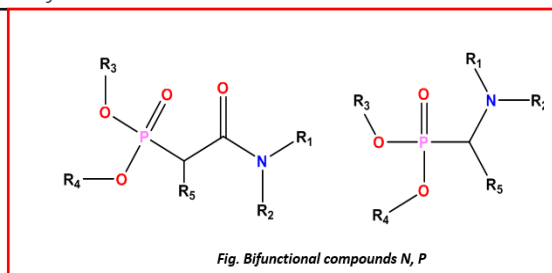


Fig. Bifunctional compounds N, P

[1] M. Miguiditchian et al., Procède d'extraction liquide - liquide pour la purification de l'uranium issu de la dissolution nitrique d'un concentré d'uranium naturel. PCT WO 2011/ 076739, 2010.

[2] S. Chaogong et al., *Journal of Radioanalytical and Nuclear Chemistry* 1994, 178(1), 91-98

[3] W. You-Shao et al., *Journal of Radioanalytical and Nuclear Chemistry* 1996, 214(1), 67-76

[4] Y. Xing-Cun et al., *Journal of Radio-analytical and Nuclear Chemistry* 1999, 241(1), 215-217

[5] M. Bouhoun Ali et al., *Journal of Applied Sciences* 2011, 11, 284-291

[6] G. Arrachart et al, Utilisation de composés bifonctionnels, à fonctions acide phosphonique/phosphonate et amine, pour extraire l'uranium(VI) de solutions aqueuses d'acide nitrique. FR 17 59993, 2017

[7] A. Leydier et al., Composés à fonctions oxyde de phosphine et amine, utiles comme ligands de l'uranium(VI), et leurs utilisations, notamment pour extraire l'uranium(VI) de solutions aqueuses d'acide sulfurique. FR 15 52886, 2015

[8] A. Leydier et al., Composés à fonctions oxyde de phosphine et amine, utiles comme ligands de l'uranium(VI), et leurs utilisations, notamment pour extraire l'uranium(VI) de solutions aqueuses d'acide sulfurique. FR 15 52888, 2015



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