Metals: From Speciation in the Aqueous Phases to the Liquid–Liquid Extraction Mechanism

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Since the Manhattan Project in the early 1940s, the separation and recovery of metals from solution by solvent extraction has gained a lot of attention and it is nowadays, together with precipitation and ion exchange, one of the three main separation techniques for metals recovery, largely used in mining, nuclear and metallurgical industries as well as in waste water treatment.

For years, in the solvent extraction field, the primary objective was to find the “good” solvent-extractant couple in order to develop an efficient separation system for a given metal. This was mainly driven by the fact that the metal resources were rather stable (mainly the richer ores of more or less defined composition). Once this couple was identified, the optimum extraction parameters were searched for. Tremendous efforts have been successfully applied in the adjustment of the extracting phase characteristics, mainly based on the extracting agent/diluent couple, possibly complemented by a phase modifier to avoid third phase formation, a synergist, etc. Considering the rather limited number of suitable organic solvents, most of the work has dealt with fine-tuning of the extracting agent’s chemical structure. Based on the latter consideration, solvent extraction systems are traditionally divided into cation exchangers, anion exchangers and neutral extractants. This is related to the extraction mechanism that thus seems mainly, if not entirely, governed by the extracting phase composition.

Our world is a changing one and the increase in demand for metals has induced interest in a broader variety of starting materials, where waste electronic equipment (WEE) or ores of poorer grade are now considered as possible starting materials for metal extraction, separation and recovery. Furthermore, environmental regulations have strengthened,

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leading to an increased need for waste management, among which is wastewater treatment. All these new metal sources broaden the range of chemical compositions of the starting material from which metal recovery is foreseen. Obviously, extraction is also influenced by the parameters related to the initial aqueous solution: type of metal, its oxidation state and speciation, its concentration, pH, ionic strength of the solution, etc. In our opinion, there is a lack of attention paid to the metal speciation prior to the extraction process, although this is in our eyes the key to comprehension of the extraction process. This has motivated us to launch this special issue and the Journal of Solution Chemistry is obviously the right journal to publish it.

This special issue is a nice demonstration of the important lever-arm that aqueous speciation can be. Papers presented here cover a wide range, from metals of interest to the nuclear fuel cycle (Np, U, Am, Eu) to strategic ones for our technological word (Pd, Pt, Rh, Ir, lanthanides), extracted from various acidic aqueous media (HCl, HNO₃, HClO₄). Industrial problems related to high ionic strength are not forgotten. Another lesson to be drawn from this issue is that the complexity of such systems must be tackled by the use of several different techniques in conjunction (NMR, Raman, EXAFS, luminescence, etc.) in order to understand and describe correctly these systems.

We would like to thank all the authors for their participation in this special issue and the journal editors for this wonderful opportunity to bring together all this nice research work.