Optimizing the separation of nuclear fission products using an Isotachophoretic method

Romain ROLLET

Introduction

Nowadays, the CEA (Commissariat à l'Energie Atomique) does the analysis of nuclear fission products in water using an HPLC method. This method exposes workers to high radiations and generate a lot of nuclear waste.
Using an Isotachophoretic (ITP) method allows the exposition of ionizing rays to be considerably reduced for the manipulator, and needs smaller volumes of sample, which produces less nuclear waste. In order to reach the same efficiency than the HPLC method in terms of separation quality, it is necessary to optimize the ITP method.
This paper presents the influence of the internal diameter (i.d.) of detection capillaries.

Experimental conditions

A mixture of 6 Lanthanide compounds (La, Nd, Sm, Eu, Gd, Er) was analyzed with an ITP method at ten different concentration rates (from 132.5 ng to 16.6 ng per Element).
The study was done under a constant intensity (3µA) at ambient temperature.
The leader electrolyte was a mixture of Ammonium Acetate and HMBA, with a concentration of 12.5 mmol/L and 14.0 mmol/L. The pH of this solution was adjusted to 4.5 by a concentrated ammoniac solution. The acetic acid played the role of the terminal electrolyte with a concentration of 15mmol/L.
The length of the capillary was fixed at 48cm, i.d. 75µm, with 6cm of injection length and 42cm for "real" separations. Only the i.d. of the detection capillary changed from 75µm to 20µm. A conductimetric detector was used and analyses were replicated 3 times.

Results and discussion

As shown in Figure 1, several curves were obtained for every different concentration. A plate corresponds to one element, and the length of one plate to the amount of this element. When the total amount decreases, the analysis is faster.
Figure 2 illustrates the resolution evolution of the 6 different compounds for 3 different i.d. of detection. The detection with a 20µm i.d. was not performed since no separation occurred.
The resolution with a 75/30 µm connection reached 0.9 which meant that 90 percent of elements were pure and could be collected.
Compared to an initial connection of 75/75µm, the resolution was multiplied by 2.

Figure 1: Separation of 6 Lanthanides at 4 different concentrations.

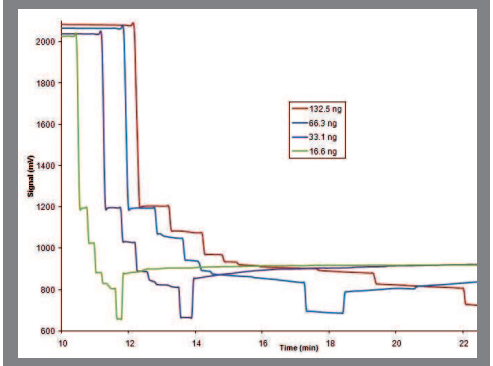
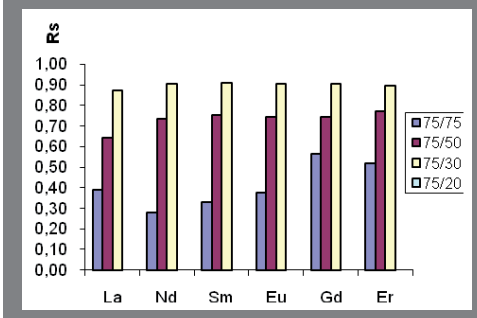


Figure 2: Resolution of 6 Lanthanides for 4 different i.d. of detection capillary.



Conclusion

This paper demonstrates that the internal diameter of the detection capillary has a major effect on the resolution of each plate. A high percentage of elements can now be collected. It is also important to study the length of separation which strongly and directly influences the analysis time.

Laboratoire des Sciences Analytiques
Master Analyse et Contrôle
Université Claude Bernard Lyon 1