Solid Phase Extraction – Development of a Fast, Efficient, and Reliable Separation Technique for Pu (IV) in On-Line Irradiation Experiments

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Neutron-deficient plutonium isotopes can be identified by their decay signature, but our Pu-production experiments required removal of large amounts of interfering activities. Therefore, plutonium has to be separated either by a mass separator or by a fast and efficient chemical separation. Which method is preferred depends on the expected half-life of the isotopes investigated. To identify the shorter-lived ^{229,230}Pu, with expected half-lives of 10 – 60 s, Andreyev et al. [1] used the separator VASSILISSA. ^{231}Pu has an expected half-life of a few minutes [2] making chemical separations preferable.

Plutonium isotopes were produced in our experiments by irradiating ^{233}U targets with ^{3}He-ion beams [3] and transported to the chemistry laboratory with a He/KCl aerosol gas-jet system. The chemical separation is based on solid phase extraction using TEVA-resin® (EIChroM Ind.); a quaternary amine salt which is a strong anion exchanger. The chemical procedure is shown as a flow chart in Fig. 1. The reaction product bearing aerosols were taken up in 50 μL of 2 M nitric acid, and transferred to a 2-mm-i.d. and 2 cm long column with a free column volume (FCV) of 50 μL. The column was rinsed with 2.5 mL of 2 M nitric acid, and with 3 mL of 6 M HCl. The adsorbed Pu(IV) chloro-complex was eluted by reducing Pu to Pu(III) with 250 μL of a mixture of concentrated HCl and HI (v/v 9:1). The eluate was collected directly on a Pt-disk on a hot plate. The dried sample was flamed and α-counted. Purification and evaporation took each about 4 minutes; thus, a total of 8 minutes elapsed between end of collection and start of α-counting.

Fig. 2 shows the Pu-elution behavior, indicating that the major fraction is eluted in the first 5 FCV. Tracer studies showed, 68 ± 7 % of initial activity is eluted in the first 5 FCV, while 80 ± 8 % is contained in the first 12 FCV.

Separation factors from Th, Np and U were determined in tracer studies. Separations left only ~0.1, ~1 and ~0.4 % of these activities, resp., in the Pu-fraction.

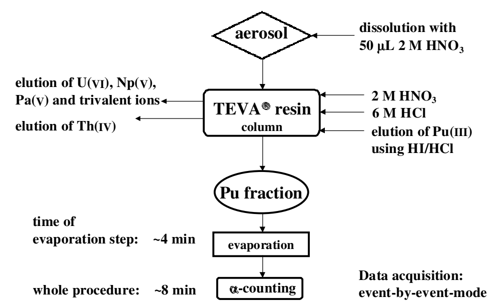

Fig. 1: Flow chart of separation procedure for Pu (IV) from neighboring elements.

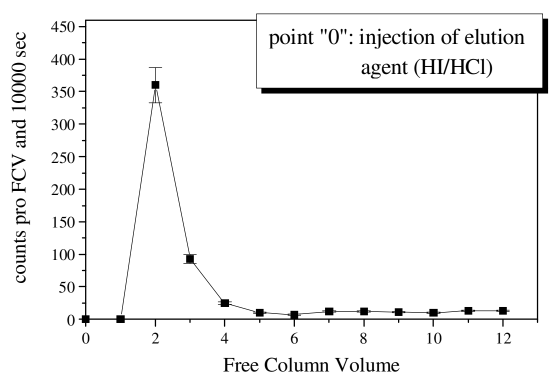

Fig. 2: Elution curve of plutonium from the TEVA-resin® using HI/HCl.

Footnotes and References

[1] A.N. Andreyev et al., Z.Phys. **A 337**, 231 (1990), A.N. Andreyev et al., Z.Phys. **A347**, 225 (1994).

[2] Y. Hatsukawa, H. Nakahara and D. C. Hoffman, Phys. Rev. C **42**, 674 (1990).

[3] C. A. Laue et al., contribution to this report.