ON THE REUSABILITY OF DIPHONIX RESIN AND SR RESIN FOR THE SEPARATION OF STRONTIUM FROM URINE

Michael D. Kaminski, Nuclear Engineering Division, Argonne National Laboratory

Kaminski@anl.gov

Mark Dietz and Cory Hawkins, University of Wisconsin-Milwaukee; Giselle Sandi, Rush University Medical Center; Anthony Park, Ilya Shkrob, and Carol J. Mertz, Argonne National Laboratory.

In the event of a large scale exposure of radioactive materials, triage centers will be overwhelmed with the need to screen potential exposure victims. The conventional method of testing urine for radioactive strontium-90 intake requires lengthy solution preparation steps totaling more than 12 hours. To avoid this, we have devised a process based on extraction chromatography that quickly conditions the raw urine to facilitate the removal of quenching and fouling agents and permits the reuse of resin for ^{90}Sr separations. We described a flowsheet using Diphonix resin column in tandem with the Sr Resin column.[1] These two resins exhibit opposite trends in the dependence of the corresponding distribution ratios for Sr^{2+} as a function of the acidity of the carrier phase. The high acidity that facilitates stripping of ^{90}Sr from the Diphonix resin column is optimum for loading strontium on the Sr Resin column. Aqueous methane sulfonic acid (MSA) solutions were chosen as the carrier phase for the Diphonix resin, as the presence of this acid (< 4 M) has no effect on ^{90}Sr uptake by Sr Resin, while for Diphonix resin only the overall proticity determines D_{Sr} (the same concentrations of the nitric and MSA have the same effect on ion retention). Since nitric acid tends to nitrate aromatic constituents in urine, resulting in strong coloration (even when these components are present at low concentration), the contact with strong nitric acid needs be delayed until the ^{90}Sr is pre-concentrated and most of the organic components are removed from the urine matrix using charcoal filters. Our approach uses the Diphonix resin to remove K^+ and Na^+ interferences to below 10 mM. With the alkali metals removed, competitive loading of the Sr Resin is avoided and its use to separate ^{90}Sr from ^{90}Y is possible. The entire system can be miniaturized to handle samples of any size.

Using a combination of standard urine and surrogates we completed 20 consecutive cycles of the flowsheet. We prepared the Diphonix column by loading a slurry of the resin into a graduated polypropylene tube to a bed volume of 2 mL and bed height of 3.5 cm. The Sr Resin was prepared in a smaller graduated polypropylene tube to a bed volume of 0.2 mL and bed height equal to 0.6 cm. Inert frit or glass wool sealed the ends. The solutions were passed through the Diphonix column by gravity and pumped through the Sr Resin columns using a peristaltic pump. We developed the elution curve using ^{85}Sr tracer and frequent sampling of the eluate (514 keV photon). We saw no reduction in the performance of the Diphonix or Sr Resin as measured by the recovery of ^{85}Sr. ^{85}Sr recovery was consistently >95% in the Diphonix resin strip solution and >95% after stripping the Sr Resin. The durability of the resin columns against this flow sheet suggests that it is possible to implement this in a semi-autonomous system. A scaled semi-autonomous system would allow the technique to be implemented in the triage setting to more quickly screen patients.

---

[1] C. Hawkins, et al., Analytica Chimica Acta 746 (2012) 114– 122.