DETERMINATION OF ^{90}Sr FROM AQUEOUS SOLUTIONS USING SPE EXTRACTION

Dulanská S., Rajec P., Mátel Ľ.
Comenius University, Faculty of Science, Department of Nuclear Chemistry

Abstract

Solid Phase Extraction (SPE) is widely used technique for the isolation and concentration of analytes from liquid samples to achieve increased sensitivity in the analytical process. Three commercial sorbents produced by three different manufacturers were tested. 3M Empore™ Strontium Rad Disks , Sr resin and AnaLig Sr-01 were used to efficiently isolate strontium from aqueous samples.

1. Introduction

Numerous methods have been described for separation of strontium, which are based on precipitation, liquid-liquid extraction, ion exchange, chromatography. The most useful method is extraction chromatography. Beyond approved extraction column, 3M™ company has developed a new technology for selective detection and removal of dissolved radioactive materials from liquids. One of the commercial products is 3M Empore™ Rad Disk for separation of strontium, radium, technetium and cesium from water solution. IBC Advanced Technologies has developed a strontium-specific solid-phase extraction material available under the trade name Superlig 620 [1,2]. Solid Phase Extraction (SPE) is widely used technique for the isolation and concentration of analytes from liquid samples to achieve increased sensitivity in the analytical process. Empore solid phase extraction membranes offer an innovative solution to environmental and bioanalytical sample preparation problems. Empore extraction disks provide a sample preparation solution for large volume samples. The disk format provides a large surface area for sorbent/sample contact. Faster flow rates and higher through put are realized compared to liquid-liquid extraction or traditional packed column technology[1,2]. 3M Empore is material with Super Lig 644C bound into it. SuperLig is selective, ignoring competing ions. The Empore membrane is a mesh of polymer-based fibrous material that acts as a high-flow filter. The Empore SPE membranes applied as cartridges and plates offer fast sample flow rates (as the mass transfer kinetics of the tightly packed particles allow recoveries that are independent of sample flow rate); reduced solvent usage compared to liquid-liquid extraction and traditional packed particle SPE products; clean eluates (the PTFE fibrils minimize occurrence of fine particles, extending the column life) and potential elimination of solvent evaporation/reconstitution steps.[2,3] A variety of SPE materials called AnaLig have been developed using „molecular recognition" ligands on solid supports and commercialized by IBC Advanced Technologies[2]. These ligands are covalently bound to various polymetric or silica-gel supports. These materials have been developed and investigated mainly for water, wastewater or effluent cleanup processes. AnaLig materials selective for Sr, Ra, Tc were incorporated in Empore Rad disks marketed by 3M for use in analysis of water samples. Sr-Spec resin is a selective extraction chromatographic material produced by EIChroM Industries [5]. The Sr-resin is a cation exchange resin and consists of the crown ether 4,4′(5′)-bis(tert-butylcyclohexano)-18-crown-6 dissolved in 1-octanol and sorbed on an inert polymeric support.

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2. Experimental

Procedure for AnaLig Sr-01

The samples were traced with ^{85}Sr for gamma yield determination option and acidified with concentrated nitric acid to 2M HNO_3. The steps were as follows [2]:

1. Each AnaLig Sr-01 column was conditioned with 10 ml of 1 M HNO_3
2. Samples were transferred into the column, and 5 ml of 1M HNO_3 was added to rinse the beaker and transfer each solution into the AnaLig.
3. The time when the last rinse completely drains through each column was recorded as the start of yttrium ingrowth.
4. 15ml 0,04M Na_4EDTA was add to elute the strontium into the Cerenkov counting vial
5. For AnaLig column regeneration, 5 mL of 0,05M Na_4EDTA and then 5 mL of 1M HNO_3 were passed through the column
6. ^{85}Sr recoveries were measured with HPGE detector at 514 keV line
7. Samples were counted over a two week period to monitor the in-growth of ^{90}Y on TRI CARB LSC counter

Procedure for Empore™ Strontium rad disks

The 3M Empore™ Sr Rad disks is commercially sold for the quantitative determination of radio- strontium in aqueous solutions. The samples were spiked with ^{85}Sr (for gamma yield determination option) [1].

1. The Empore disk was preconditioned by 10 ml methanol and washed with 20ml of 2 M HNO_3 at a flow rate of 10ml/min
2. After entire sample has passed through the disk, the disk was rinsed with 20 ml of 2 M HNO_3. The end time of this rinse was recorded as the start of the ^{90}Y ingrowth.
3. Added 15ml 0,04M Na_4EDTA to elute the strontium into the Cerenkov counting vial
4. 10 mL of 0,05M Na_4EDTA was passed through the disk for EmporeSr rad disk regeneration

Procedure for Sr resin [5]

1. The Sr-resin column was washed with 10 mL of deionised water and pre-conditioned with 10 mL of 8M HNO_3
2. The solution was loaded onto the column, and resin was washed with 5ml 8M HNO_3
3. Sr was eluted with 15ml 0.05 M HNO_3 into a Cerenkov counting vial.
4. The elution solutions were measured using an HPGE detector for ^{85}Sr recoveries at 514 keV line and counted directly by Cerenkov counting over a two-week period for the in growth of ^{90}Y using TriCarb LSC counter.

3. Result

Three commercial sorbents produced by three different manufacturers were tested. Empore extraction disks marketed by 3M, Sr-Spec resin a selective extraction chromatographic material produced by EIChroM and AnaLig Sr-01 by IBC Advanced Technologies were compared. All materials are suitable for separation of ^{90}Sr; however, the radiochemical yield is the highest for AnaLig Sr-01 with average R=89 ± 4.6% followed by Empore extraction

disks R=88 ± 5.2% and Sr-Spec resin R=68 ± 2.2%. It seems that AnaLig Sr-01, as well as Empore extraction disks, are very suitable for quantitative and reliable strontium separation from aqueous solutions. It was experimentally determined that AnaLig Sr-01 as well as Empore extraction disks are very suitable for quantitative and reliable strontium separation from aqueous solutions.

4. Reference

[1.] http://solutions.3m.com/wps/portal/3M/en_US/Empore/extraction/

[2.] IBC Advanced Technologies AnaLig gel Data Sheet Strontium Column Series SR-01. IBC Advanced Technologies. Inc.

[3.] http://www.eichrom.com/products/info/sr_resin.cfm

[4.] C.W.Sill. Nucl.Chem.Waste Managem.7(1987)201

[5.] Eichrom Technologies. Inc. ACS07 Analytical Procedures Rev. 1.5 February. 2005