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THE SEPARATION OF ^{65}Zn FROM ^{113}Sn AND ^{207}Bi RADIOISOTOPES BY AMALGAM EXCHANGE AND ELECTRO-ANALYTICAL METHODS

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ABSTRACT

In this study, by using amalgam-exchange and electro-analytical methods, the separation of ^{65}Zn radioisotope from a solution containing either one or both of the ^{113}Sn and ^{207}Bi radioisotopes were investigated. The radioisotopes were drawn into Zn-amalgam from the solution at first, and then ^{65}Zn was recovered from the amalgam through back-electrolysis. No detectable contamination was observed and the recovery efficiency was found to be around 75 %.

ÖZET

Bu çalışmada ^{113}Sn ve ^{207}Bi radyoizotoplarından birinin ya da her ikisinin içerildiği çözeltilerden, amalgam değişimi ve elektroanalitik yöntemlerin uygulanması ile ^{65}Zn radyoizotopunun ayrılması incelendi. İlk basamakta, radyoizotoplar çözeltiden çinko amalgamına çekildiler. İkinci basamakta, ^{65}Zn geri elektrolizle amalgamdan geri kazanılarak diğer radyoizotoplardan ayrıldı. Herhangi bir bulaşma gözlenmedi. ^{65}Zn için geri kazanma verimi % 75 dolayında bulundu.

INTRODUCTION

The separation methods used for separating radioisotopes in liquid phase are mainly, precipitation, solvent extraction, ion-exchange, isotope-exchange, electrolytic storage and amalgam-exchange.

For a successful separation the technique used is expected to be highly efficient and reproducible. A good purification and quick separation are the other desired qualities. The aim of this study was to separate the radioactive species in solution using the

amalgam-exchange and electro-analytical methods together, to eliminate the disadvantages of these methods when used individually, and to purify the desired radioactive species effectively and recover them with a high efficiency.

The amalgam-exchange technique is a process where the atoms of a metal in its amalgam are displaced with its ions in the aqueous solution. Amalgam-exchange method has been used extensively to separate certain species from a mixture of radioisotopes /1-6/.

EXPERIMENTAL

Powdered zinc metal was first rinsed with 2 N HNO_3 then with distilled water and dried. Purified mercury was washed with 0.1 N HNO_3. A certain amount of mercury was mixed with the necessary amount of zinc to prepare a zinc-amalgam of 1.5 % by weight. 5.0 ml 10^{-4} M $Zn(NO_3)_2$ in 1.0 N HCl solution, 1.0 ml ^{65}Zn stock solution and 0.5 ml amalgam were placed into a glass vial, stoppered with a rubber stop-cock and sealed with an aluminum cap. The vial was placed in a shaker and shaken for 10 minutes. A 1.0 ml sample solution was taken out from the vial and counted in a multi-channel analyser. After the radioactivated amalgam was washed with distilled water, it was taken into a polarographic cell containing 10.0 ml 0.1 N HCl.

The polarographic cell was connected to a potentiostat. The solution and the amalgam were subjected to back-electrolysis at -0.70 V for two hours while keeping the mixture stirred in a magnetic stirrer. After the electrolysis, 1.0 ml samples were taken from the solution and compared with 1.0 ml stock solution samples by counting. During the separation of ^{65}Zn using the combined technique, the possibility of any contamination by ^{113}Sn and ^{207}Bi was also investigated and it was found these radioisotopes caused no contamination whatsoever. Experiments were conducted to separate ^{65}Zn from solutions containing ^{65}Zn and ^{113}Sn; ^{65}Zn and ^{207}Bi; ^{65}Zn and ^{113}Sn and ^{207}Bi by the technique mentioned above.

RESULTS AND DISCUSSION

The following results were obtained in the case where ^{65}Zn the only component in aqueous medium:

^{65}Zn remaining in the solution	10.05%
^{65}Zn drawn into the amalgam	89.95%
^{65}Zn recovered	76.84%

The results obtained from the experiments in which, by the absence of ^{65}Zn, the contamination by ^{113}Sn and ^{207}Bi was investigated are shown below:

^{113}Sn remaining in the solution	34.66%
^{113}Sn drawn into the amalgam	65.34%
^{113}Sn going into the final solution	-
^{207}Bi remaining in the solution	2.32%
^{207}Bi drawn into the amalgam	97.68%
^{207}Bi going into the final solution	-

As it can readily be seen, ^{113}Sn and ^{207}Bi cause high contamination at the amalgam-exchange step. However at the back-electrolysis step no contamination takes place. Therefore it was concluded that in the presence of these radioisotopes, ^{65}Zn can be separated without any contamination.

According to these results the following findings were obtained in the experiments.

^{65}Zn remaining in the solution	10.42%
^{65}Zn drawn into the amalgam	89.58%
^{65}Zn recovered	72.30%
^{113}Sn going into the final solution	-
^{65}Zn remaining in the solution	9.63%
^{65}Zn drawn into the amalgam	90.37%
^{65}Zn recovered	70.69%
^{207}Bi going into the final solution	-
^{65}Zn remaining in the solution	10.02%
^{65}Zn drawn into the amalgam	89.98%
^{65}Zn recovered	70.47%
^{113}Sn going into the final solution	-
^{207}Bi going into the final solution	-

The percent yield can be increased even further by extending the time allowed for the back-electrolysis. However, in order not to make the time spent for the whole experiment too long, the time for the back-electrolysis kept fixed at two hours. The yield was found to be higher for ^{65}Zn when it is the only component in solution than when it was mixed with other contaminants. Two factors seem to affect the yield. The first one is that the presence of other radioisotopes influence the exchange rates thus causing a decrease in the yield, and the second one being the different periods of time between the preparation and the use of the amalgam in the two cases mentioned above.

The total separation efficiency of the polarographic methods is rather low /7/. However, the amalgam-exchange method is simple, the reaction is fast, it requires no special equipment, and the yield efficiency is high. On the other hand, where the amalgam-exchange method is used by itself, in the last step, the desired radioisotope is drawn back into a 1.0 N acidic solution containing too many inactive carrier atoms. Instead, it was considered to draw the radioisotope to be separated into a less acidic solution containing very few or no carrier atoms. This led us into the idea of combining the two methods mentioned above and the results obtained from the experiments using this combined technique seemed to be more satisfactory.

Although, this combined technique results in a little lower yield and takes a little longer time than the amalgam-exchange method, it provides some advantages such as obtaining the radioisotope with higher spesific activity in the last step and drawing it into a less acidic solutions, and also it seemed to be applicable a host of actual samples with little care.

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