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Demonstration Study of $^{188}W/^{188}Re$ Generator

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1. Introduction

A demonstration work for the production of $^{188}W/^{188}Re$ generator has been performed. For the demonstration work, a sol-gel derived adsorbent, which is developed to produce both (n,γ) $^{99}Mo/^{99m}Tc$ and $^{188}W/^{188}Re$ generators.

2. Experiments

2.1 Adsorbent Preparation

Detailed synthesis scheme for the adsorbent is described elsewhere [1]. In this study, adsorbent containing 3.4mmol/g sulfur is used.

2.2 Characterizations

To perform characterization experiments, a desired amount of tungsten oxide is dissolved in a 1.0N sodium hydroxide solution, and the solution pH is adjusted to 10. A trace amount of ^{188}W solution is added to make 2uCi/ml of the specific solution activity just before starting experiments.

Batch loading experiments are performed for 2 hours by shaking 0.5gram of the synthesized adsorbent in 25ml of 20,000mg/L tungstate solution at room temperature.

To demonstrate the application of the synthesized adsorbent for a high activity $^{188}W/^{188}Re$ generator, 1.0 Ci of ^{188}W solution was purchased from TENEX, Russia. A generator column is prepared by packing 0.7 g of the adsorbent on the top of 0.5 g of acidic alumina in a 1.0 cm ID column (see Figure 1). To this column, 4 ml of tungstate solution of 1.0Ci at pH 10 was introduced at the flow rate of 1.0 ml/min and washed with 10 ml of saline eight times. Elution of ^{188}Re is performed by passing 5 ml of saline solution every 4~7 days after ^{188}W is adsorbed. To measure the activity of ^{188}W included in the eluted solutions, known amount of the eluted solution is passed through an acid-formed Sep-Pak to concentrate ^{188}W. Thereafter sep-pak is washed by saline of 30ml to remove ^{188}Re. The activities of ^{188}W on the Sep-Pak are measured by a dose calibrator (Capintec, CRC-127R) and HPGe γ–ray detector.

3. Results and Discussion

From our previous studies, the sol-gel derived adsorbent has high potential for the $^{99}Mo/^{99m}Tc$ generator [1]. In this study, the adsorbent is employed to produce $^{188}W/^{188}Re$ because both generator systems are chemically similar. The main objective of this study is to demonstrate the applicability of the adsorbent for a high activity $^{188}W/^{188}Re$ generator.

Similarly to the $^{99}Mo/^{99m}Tc$ system, ^{188}W is adsorbed on the adsorbent by the ion exchange reaction shown in Figure 2. In the batch, the maximum uptake capacity of synthesized material for tungsten is approximately 520mg/g. Also, the uptake capacity on the column from an experiment that was performed similar to the demonstration experiment is 450mg/g, when a loading solution containing ^{188}W 7.56mCi/mg is introduced.

Hence it is theoretically possible to load (make a generator column) 3.5 Ci of ^{188}W on a gram of the adsorbent.

In the demonstration study, the amount of ^{188}W loaded on column in a hot cell is 1.0Ci. ^{188}Re is eluted with the efficiency of 69% at the first time, and then approximately 80% for the following six times of elution from the column as shown in Figure 3. The elution profile shows that most of ^{188}Re is eluted by the first 5 ml fraction (see Figure 4). Hence, the concentration of ^{188}Re is highly concentrated in a small amount of the solution.

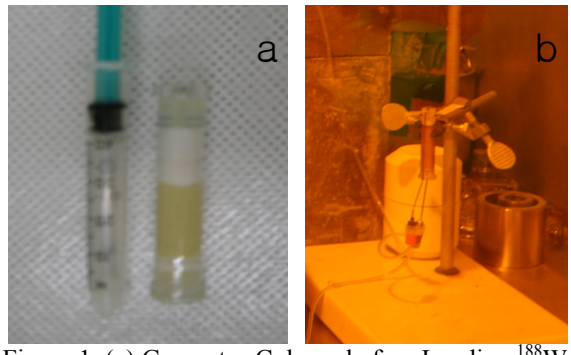

Figure 1. (a) Generator Column before Loading ^{188}W, Column Size: as small as 3 cc syringe, (b) ^{188}W-loaded Column, needle mounted, peristaltic operational

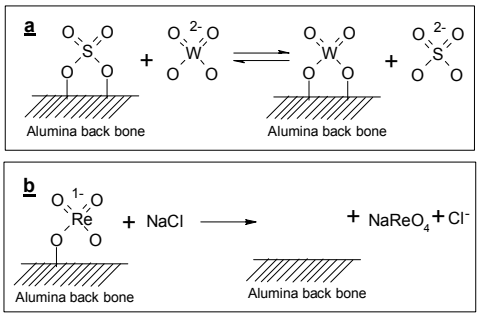

Figure 2. (a) Reaction between functional group and tungstate (b) extraction procedure of rhenium by saline

To examine the radionuclidic purity of ^{188}Re solution, a reported method [2], which uses an acidic Sep-Pak to separate a small quantity of ^{188}W from large quantity of ^{188}Re, is adopted. The ratio of ^{188}W per ^{188}Re must maintain less than 1.0 x 10^{-3}% for the therapeutic purpose. However, the experimental data as shown in Figure 5 shows that the content is maintained at approximately 2.2 x 10^{-3}% after three times of elution. This is due to the use of only 0.7g of adsorbent for the column and no use of a tandem column. In this regard, the performance of this column is still excellent. The breakthrough near the criteria is always problem of the (n,γ) ^{99}Mo/^{99m}Tc because of extremely high chemical quantity of the inactivated nuclides from the irradiation targets. It is expected that the installation of a small column of alumina such as the Sep-Pak that is used to catch ^{188}W for the analysis is enough to purify the ^{188}Re solution.

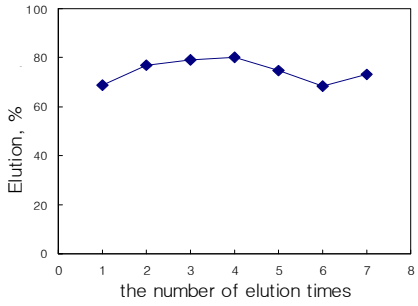

Figure 3. Elution Efficiency of ^{188}Re by Using 5 ml of Saline Solution (0.9% NaCl)

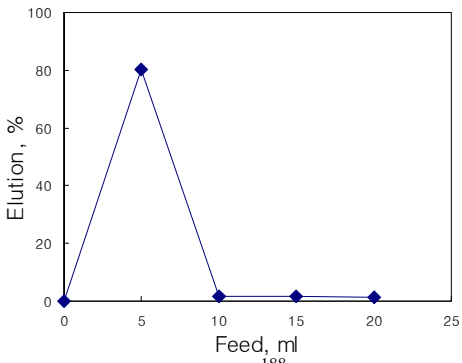

Figure 4. Elution Profile of ^{188}Re by Using Saline Solution (5ml Fractional Collection)

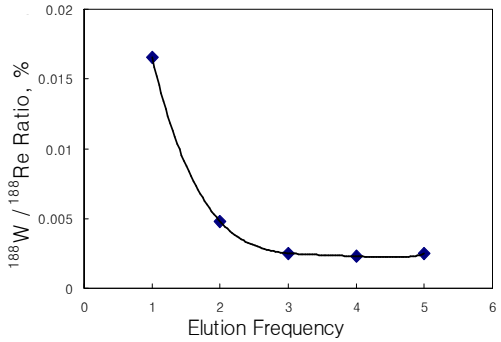

Figure 5. ^{188}W/^{188}Re ratio of eluted solution

3. Conclusion

As one of the tentative therapeutic radioisotopes, ^{188}Re can be produced from the decay of ^{188}W. The extraction of ^{188}Re can be achieved by the generator technology, which is similar to the ^{99}Mo/^{99m}Tc generator. In this study, the sol-gel derived adsorbent is applied to produce one Currie ^{188}W/^{188}Re generator. From batch and column experiments using a simulated tungsten solution, it is estimated that one gram of this adsorbent can be used to produce ^{188}W/^{188}Re generator with 3.5 Ci of activity. Regular extraction capacity of ^{188}Re from the demonstrating column is approximately 80%. The elution efficiency can be achieved with less than 5 ml of saline solution. The content of ^{188}W in the eluted ^{188}Re solution is 2.2 x 10^{-3}%, which is only 2.2 times higher than the therapeutic criteria. It is expected that the use of a small size tandem column can lower the content lower than the requirement.

Since this study is still on progress, installation of the tandem column will be attempted. Other results from characterization studies will be presented by other publications.

REFERENCES

[1] Jun Sig Lee, Jongsup Lee, et al. Absorbent for radioactive element and preparation method thereof, patent pending, Nov. 8, 2006, application No. 10-2006-0109983

[2] A.P. Callahan, D.E. Rice, D.W. McPherson, S. Mirzadeh, F.F. Knapp, The use of alumina "SepPaks®" as a simple method for the removal and determination of tungsten-188 breakthrough from tungsten-188/rhenium-188 generators, *43*, 801-804 (1992)