Research Activities on the Development of Alternative ^{99m}Tc Generator

Seung Rag Choi, Jun Sig Lee, Kang-Hyuk Choi, Ul-Jae Park, Kwang Jae Son, Young-Don Hong
Korea Atomic Energy Research Institute, P. O. Box 105, Yusung, Daejeon 305-600, Korea
**Corresponding author: jlee15@kaeri.re.kr*

1. Introduction

As an alternative technology of the currently available ^{99m}Tc generator, a generator is developed by using an activated ^{99}Mo as the mother source of ^{99m}Tc. In the period of 2008 ~ 2009, the world was suffered by the short supply of ^{99m}Tc for medical diagnosis because of the aging of the production plants in the world and no availability of an immediate solution. In this regard, it is expected to secure the supply of ^{99m}Tc at least certain portion of the total demand for ^{99m}Tc by developing an alternative technology such as producing ^{99m}Tc by activated ^{99}Mo, cyclotron technology, etc. This research aims the development of a new ^{99m}Tc generator to relief suffer from the short supply of the generator produced by using Fission Moly. The developed generator will act as the emergency ^{99m}Tc resource until the ultimate solution becomes realistic. In this paper, the research progress from the basic study that has been performed during the last years will be presented.

2. Experiments

2.1 Column Matrix

The adsorbent for this generator is a sulfated alumina produced by a sol-gel method reported in earlier works [1 - 3]. The adsorbent acts as anionic exchanger when reacts with molybdates in the aqueous solution as shown in Figure 1. After the exchange reaction between molybdates and sulfates, the adsorbent is just a conventional alumina which adsorbed molybdates from the aqueous solutions. Among the adsorbed molybdates, ^{99}Mo decays to ^{99m}Tc, and then ^{99m}Tc is available for the elution. The elution of ^{99m}Tc is conducted by certain amount of the saline solution just like that from the conventional generators produced with fission ^{99}Mo.

2.2 Generator Performance

For the performance test of the generators, either natural or enriched ^{98}Mo (98% or higher) in the form of MoO_3 powder is irradiated at HANARO. The performance of the generator is tested for ^{99}Mo loading, ^{99m}Tc elution, presence of impurity in eluted solution, and labeling efficiency of ^{99m}Tc. The loaded radioactivity of ^{99}Mo per generator is up to 65mCi in this study. Each generator column contains 4g of the synthesized adsorbent. Loading of ^{99}Mo is performed by using a peristaltic pump. Elution of ^{99m}Tc is performed by using a vacuum vial and 10ml of saline. Impurity tests in the ^{99m}Tc solution are performed by using a multi-channel analyzer, an alumina testing kit, thin-layered chromatography, and an inductive-coupled plasma spectrometer.

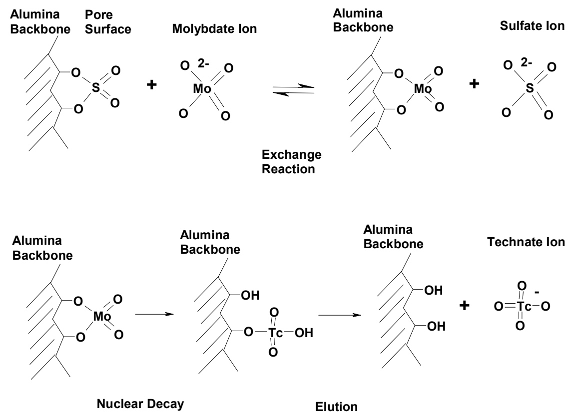

Figure 1. Schematics of Adsorption and Desorption Mechanisms of ^{99}Mo and ^{99m}Tc on the Adsorbent

3. Results and Discussion

3.1 Performance Test

Four grams of the developed ALSUL was packed in a column, which has 20 mm inner diameter and 20 mm effective length (total length of column: 48 mm). By introducing (n,γ)^{99}Mo at the concentration of 45,000 mg Mo/ml with the volume of 20 ml, the adsorption capacity of a column is about 90%. The elution efficiency of ^{99m}Tc after 24 hours from the loading process is in the range of 90 ~ 97% as shown in Figure 2. It is noticed from these experiments that the adsorption column functions perfect for the loading of Mo and elution of ^{99m}Tc, there is leaching of Mo from the column at an unacceptable level. Hence, a secondary column in which a small amount of acid alumina (i.e. 0.2 ~ 0.4g) is packed is installed at the end of the loaded column to remove the trace quantity of Mo from the eluting solution. By the addition of the secondary column (tandem column), the amount of ^{99}Mo is significantly reduced to a quantity (Mo/Tc < 10 ppm) much less than the required criteria of the pharmacopeia. It can be understand that the leaching of Mo from the main column on which extreme amount of Mo is adsorbed is inherent because of the adsorption and desorption equilibrium. Hence, the addition of a secondary column to remove Mo from the elution solution is inevitable.

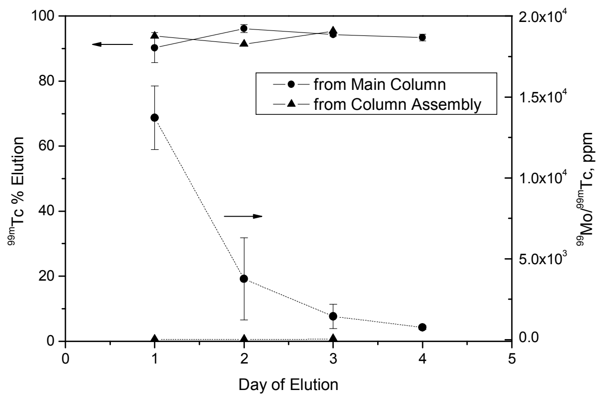

Figure 2. Elution Efficiency (Solid Lines) of ^{99m}Tc and ^{99}Mo impurity (Dotted Lines) in the Elution Solution from only the Main Column (diamond) and the Main Column and Tandem Column (triangle); Adsorbent in the main column = 4.0g, molybdenum loaded = 819 ± 22 mg (^{99m}Mo = 28.8mCi), molybdenum loading efficiency = 91%, Amount of Eluant = 10 and 20ml for the main and the column assembly, respectively.

3.2 Labeling Test for ^{99m}Tc

Tests for the labeling of the eluted ^{99m}Tc are performed with Mebrofenin. In this study, the labeling efficiencies of ^{99m}Tc from the developed generator and a conventionally available generator are compared as the results are shown in Figure 3. The results show that both labeling efficiencies with ^{99m}Tc from two generators are almost identical (both cases >99% labeling efficiency) and meet the guideline of the pharmacopeia.

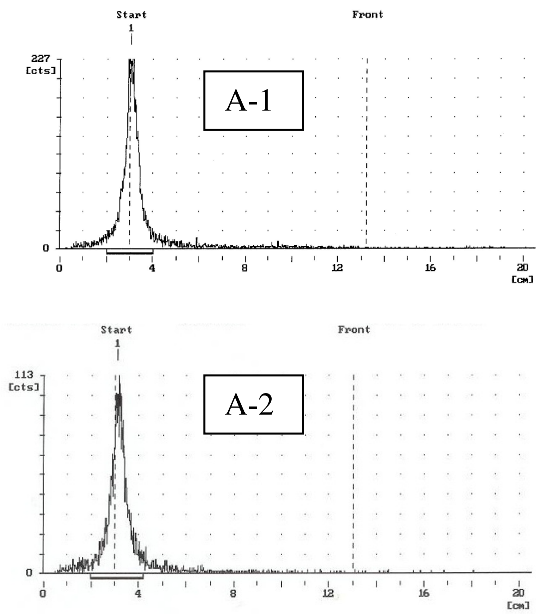

Figure 3. Thin Layered Chromatography of ^{99m}Tc Labeled Compounds, A-1: Mebrofenin with ^{99m}Tc from this study, A-2: Mebrofenin with ^{99m}Tc from a commercial generator (Developing conditions: Whatman #1 paper for stationary phase and MEK for mobile phase)

3. Conclusions

As discussed in this paper, the basic research work for the development of a ^{99m}Tc generator by using (n,γ)^{99}Mo has been completed. The quality of the eluted ^{99m}Tc from this generator is compatible with that from the conventionally available generator. Currently, research activities to perform trial production are undergoing. All components of the generator, a production system and protocols are ready for the trial production. Details of the research works will be published.

Acknowledgement

The financial support of Ministry of Education, Science and Technology (MEST) in the Republic of Korea through Mid and Long Term Nuclear R&D Program is gratefully acknowledged.

REFERENCES

[1] Jun Sig Lee et. Al., Absorbents for radioactive element and preparation method thereof, Korean Patent # 755933 (Aug. 30, 2007)

[2] Jun Sig Lee et. Al., Development of a High Performance ^{188}W/^{188}Re Generator by Using a Synthetic Alumina, Applied radiation and isotopes, 67, 1162-1166, 2009

[3] Jun Sig Lee et. Al., Currently Available Technologies Strategic Approach to Secure Supply of ^{99}Mo and ^{99}mTc, The 24th KAIF/KNS Annual Conference, 2009