The Development of a Mountable Isotope Enrichment Device for the Re-usage of Isotope Generators

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1. Introduction

The radioactive concentration of ^{99m}Tc and ^{188}Re from their generators are dependent on the specific activity of their mother nuclides, ^{99}Mo and ^{188}W. After a lapse of time, the eluted isotope concentration is reduced and cannot satisfy the need for clinical application. The purpose of this study is to develop an isotope enrichment device of compact size that can extend the period of use as well as conveniently concentrate the isotopes. We designed the concentration module by including 2-different check valves which do not require a manual on-off process. In the concentrating process, cation exchange resin embedded with Ag and anion exchange resin were used. After completing the concentrating step, the recovering yield was identified to be more than 88%.

2. Methods and Results

2.1 Research Background

The extracted solvent used to produce ^{99m}Tc is a 5~10ml saline solution. The longer the generator is used, the amount of the desired radioisotope exponentially decreases due to the half life. For this reason, in a generator that has been used for a long time, the amount of radioactivity decreases for every unit volume when producing radioactive medicine. When this is used for diagnosis, its effects on the body and the low quality of the imaging are some examples of the problems that are encountered. For a ^{99m}Tc generator, the permissible period of application is two weeks but owing to the above problems, the actual period of application is less than a week. When a company collected generators that had been in use for two weeks and extracted Tc, there was 10~30mCi of radioisotopes. On the other hand, the amount of Tc produced after one week contains 50~100mCi and is thought to have recyclable potential.

^{188}Re and ^{99m}Tc are clinically used beta-ray emitters that have similar chemical properties. They have the advantage of being used on labeled compounds created for the sake of ^{99m}Tc labeling. ^{188}Re (20,000,000 won/500mCi) is a more expensive nuclide than ^{99m}Tc and when used in diagnostic medicine, it is required to be more enriched in order to extend the permissible period of application. Although ^{188}Re is now currently in the research phase of being developed as radioactive medicine, if it becomes a drug in the future, an enhancing device will be required.

2.2 . Technological principle

The technological principle behind concentrating ^{99m}Tc extracted from 5ml of saline solution and ^{188}Re is as follows (Fig. 1). Firstly, by passing 5ml of saline solution containing radioisotopes through a cation exchange resin containing Ag, the salt within the solution was removed. At this point, the radioisotope was dissolved in distilled water. When this was passed through an anion exchange resin, the radioisotope attached to the anion exchange resin since there were no other interfering ions. Then, by dripping 0.5~1ml of saline solution only on the anion exchange resin, the ion intensity in the NaCl solution caused just the radioisotopes of technetium and rhenium to flow out. Using the above method allowed the volume to be reduced from 5~10ml to 0.5~1ml. This principle was used to develop a compact-sized enhancing system.

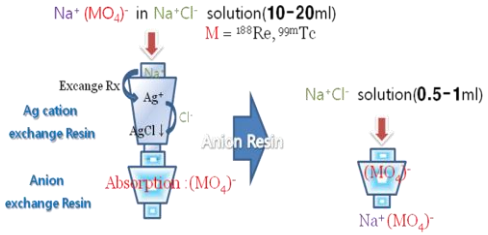
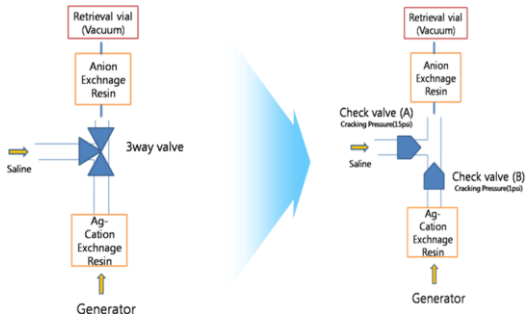


Fig.1

2.3. Experiments and Research results

- Mountable enhancing system



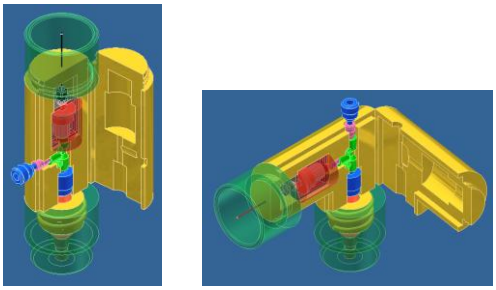


Fig. 2. The blueprint of the mountable enhancing system

The rough outline of the enhancing system of radioisotopes is as follows (Fig. 2). A key characteristic is that instead of using a 3-way valve, two separate check valves with different opening pressures were used. When using the former type of valve, the valve's opening and closing must be done manually, but the following enhancing system does not require such manual activity, making it more convenient to use.

- Evaluation of the concentration efficiency

An enhancement of a collected ^{99m}Tc generator was performed using the aforementioned method. The inserted amount was 5ml and the amount of saline solution used for collection was 1ml; a 5-fold concentrated amount. As Table 1 shows, for ^{99m}Tc concentrated through the developed enhancing device, the yield resulting from the average of concentration was 87.5%.

Table 1. Results showing ^{99m}Tc concentration

	1st	2nd	3rd	4th	5th	6th	7th	8th
^{99m}Tc (mCi/5ml)	15.5	23	17.8	10	4.74	23.7	20.4	11.27
Concentration (mCi/1ml)	13.2	20.0	15.6	8.6	4.3	20.6	17.63	10.24
Concentration yield (%)	85.2	86.9	87.6	86.0	90.1	86.9	86.4	90.9

With the same method as above, ^{188}Re was also enhanced and the average yield was 92.5%.

- Analysis of quality

With the enhanced ^{99m}Tc and ^{188}Re, TLC, toxicity tests and metal content examinations (ICP-AES) were performed. The results of the tests all attained appropriate levels according to the standards of radioactive medicine and methodology. The figure below shows TLC data expanded using technetium attained through the experiment and 75% methanol. The graph shows a single peak over 98%.

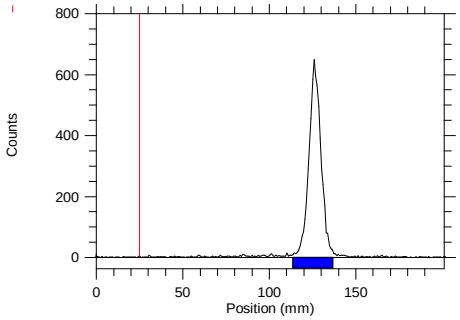


Fig. 3 Radiochromatogram of concentrated 99mTc

Spoting point : 25mm, Solvent front : 175mm, $99mTcO_4^-$: 126.5mm, Rf = 0.677

4. Conclusion

In summary, we designed concentration module including 2-different check valve which don't need manual on-off process. In concentration process, cation exchange resin embedded Ag and anion exchange resin are used. After completing concentration step, the recovering yield is identified with more than 88%.

In conclusion, The developed isotope enhancing system can partially resolve the international problem of radioactive isotope supply and demand through the recycling of isotopes. In addition, it can aid in providing hospital care during emergency times when isotope supply is low. More detailed information will be given in the journal once supplementary experiments are completed.

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