Measurement of Specific Activity of ^{177}Lu Produced in HANARO

*Hwa Yong Lee, Ul Jae Park, Sung Soo Nam, Hyun Soo Han
Korea Atomic Energy Research Institute
150 Dukjin-dong, Yuseong-gu, Daejeon, Korea 305-353
*hylee13@kaeri.re.kr

1. Introduction

^{177}Lu is one of the most useful nuclides for the radiotherapy as it has suitable decay characteristics. ^{177}Lu decays with a half-life of 6.71d and emits maximum 497 keV(78.6%) of β^- particles. It is also emits gamma photons of 113 keV(6.4%) and 208 keV(11%). The emission of such gamma photons makes it useful for imaging with a gamma camera.[1]

^{177}Lu is usually produced by the reaction of ^{176}Lu(n, γ)^{177}Lu through the thermal neutron irradiation of the natural Lu_2O_3(^{176}Lu, 2.6%) or an enriched Lu_2O_3(^{176}Lu, 60.6%) in a reactor. Alternatively, ^{177}Lu can be produced by the reaction of ^{176}Yb(n, γ, β^-)^{177}Lu followed by a radiochemical separation from the resulting product. However, the production of ^{177}Lu by the latter case is not easy because of the difficulty in radionuclide separations.

In this study, ^{177}Lu is produced by the irradiation of the enriched ^{176}Lu through the reaction of ^{176}Lu (n, γ)^{177}Lu at HANARO. Radiochemical purity and specific activity of the produced ^{177}Lu was measured by using HPGe detector coupled with MCA system.

2.1 Method and Results

2.1 Production of ^{177}Lu

^{177}Lu is produced by the irradiation of the natural or enriched Lu_2O_3 target in a reactor through the reaction of ^{176}Lu(n, γ)^{177}Lu. Approximately 108 Ci/g and 3000 Ci/g of ^{177}Lu can be produced by the irradiation of the natural Lu_2O_3 (2.6%) and an enriched Lu_2O_3 (60.6%), respectively, at a flux of 3×10^{13} n/cm^2·s for 7 days.[1]

In this study, the enriched Lu_2O_3 (^{176}Lu, 65.8±0.7 %) is used as the target to produce a high specific activity. One milligram of the enriched Lu_2O_3 powder was sealed in a quartz ampoule and then it was introduced in an aluminum target capsule, which is welded by the standard procedure at KAERI. The target was irradiated for 3.5 days at IP-15 hole of HANARO in which the neutron flux is 9.42×10^{13} n/cm^2·s. The treated target was treated in a 50% mixture solution of 6M HCl and H_2O_2 (32%). To dissolve the target completely, the solution was set under IR lamp (40 ℃) for 2 hours. After then the solution was dried by using IR lamp (about 80~90 ℃). To this treated target, 1.0 ml of 0.1M HCl was added, filtered by using a membrane filter, and transferred to a vial to make a ^{177}Lu solution.

2.2 Measurerment

Analysis of the specific activity and radionuclidic purity were performed because precise activity is important to prescribe exact doses in radionuclide therapy. Hence, the specific activity of ^{177}Lu produced at HANARO was measured by using an ion-chamber (CRC 15 R, Capintec Co.) and HPGe detector (relative efficiency 10%, knee point 150keV) coupled with a 3.1K multi-channel analyzer (MCA) system.

Also, radionuclidic purity of the produced ^{177}Lu was determined by the analysis of the gamma ray spectrum. An ^{152}Eu reference source (Isotope Products Laboratories., USA) was used for both energy and efficiency calibration of the detector.

2.3 Results

Approximately 1.08 mCi/ml of ^{177}Lu (after 51days from EOB), which was measured by using the ion chamber was produced by the irradiation of 1mg of Lu_2O_3 (^{176}Lu, 65.8±0.7%) at IP-15 of HANARO for 3.5 days. The value estimated from the MCA measurement was the same as that was measured by the ion chamber. It was observed from the gamma ray spectrum (Figure 1) that the activity of ^{177m}Lu was approximately 0.00934 mCi/ml, which was about 0.87% with respect to ^{177}Lu. There was no other radionuclidic impurities was observed.

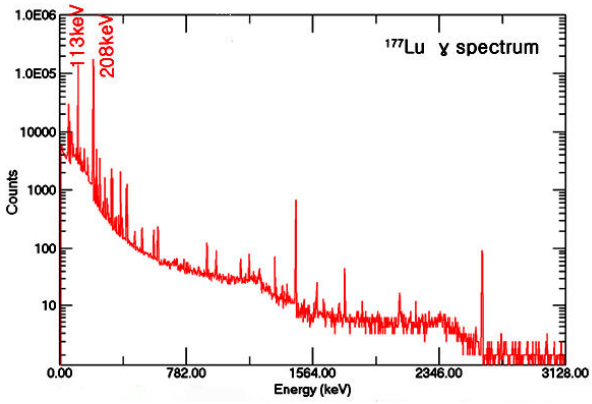

Figure 1. Gamma spectra of ^{177}Lu produced at HANARO (Peaks at 1460 keV and 2614 keV were from the background)

3. Conclusion

^{177}Lu was produced by using the enriched target, Lu_2O_3 (^{176}Lu, 65.8±0.7 %), through the reaction of ^{176}Lu (n, γ). The analysis of specific activity and radionuclidic purity of ^{177}Lu, which was produced from HANARO were performed to setup a standard protocol of the quality control for the regular production in the future. The measured specific activities by using the ion chamber and the MCA system were compared. From this comparison, the values from the two instruments were agreed well.

Further research will be performed to study the relationships among the ratio of ^{177}Lu and ^{177m}Lu, the irradiation time, and the neutron flux.

Reference

[1] M.R.A. Pillai, S. Chakraborty, T. Das, M. Venkatesh and N. Ramamoorthy, Production logistics of ^{177}Lu for radio, Appl. Radiat. Isot., 59, 109-118, 2003