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Separation of Lutetium from Ytterbium for medical n.c.a Lu-177 Production

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1. Introduction

The development of Lutathera and Pluvicto, radiophramaceuticals incorperating Lutetium-177(Lu-177). Lu-177 is a representative theranotics radionuclide, as simultaneously emits low-energy beta particles (E_{β},max = 0.5MeV) and gammar ray (E_{γ}=208 keV (11.0%) and 113 keV (6.4%))[1,2] ,which facilitates its utilization in both theraputic and dignostic application oncology.

Lu-177 utilized in medical applications is generated through 'indirect' process($^{176}Yb(n,\gamma)^{177}Yb \rightarrow ^{177}Lu$) and requires subsequent separation and purification process to achieve the necessary purity for therapeutic application[3]. Several techniques for separtion of Lu from Yb have developed. Sepecifically, ion chromatograpy is employed to effectivly separate Lu from substantial quantities of Yb[4,5], contributing to the development of standardized Lu-177 production technology.

Lu, separated throught ion chromatography, requires a purification process to remove eluent. The utilization of cation exchange resin and dilute HCl allows for effective purification of Lu from the eluent. Additionally, this method allows for the recovery and recycling of Yb targets.

At KAERI, technologies for the large-scale separation and purification of Lu-177 have been established. These technologies are employed sequentially to produce Lu-177. Furthermore, the atomation of these technologies has significantly improved the efficiency of Lu-177 production.

2. Methods and Results

In these study, non-radioactive stable isotopes(Lu_2O_3 and Yb_2O_3) were used, and the colorimetric reagent 4-(2-pyridylazo)resonocinol(PAR) was employed to identify presence and to investigate the separation conditions. PAR is yellow at pH9.8 and trasitions to red upon complextion with metal. Absorbance was measure at 510nm using a UV/vis spectrophtometer to present the results.

2.1 Separation

A cation exchange resin with sulfonly group was utilized as the stationary phase, and α-hydroxyisobutyric acid(α-HIBA) was used as the mobile phase for chromatographic sepration of Lu from Yb. The resin-packed column was saturated with HIBA by eluting the HIBA solution through the column using an HPLC pump.

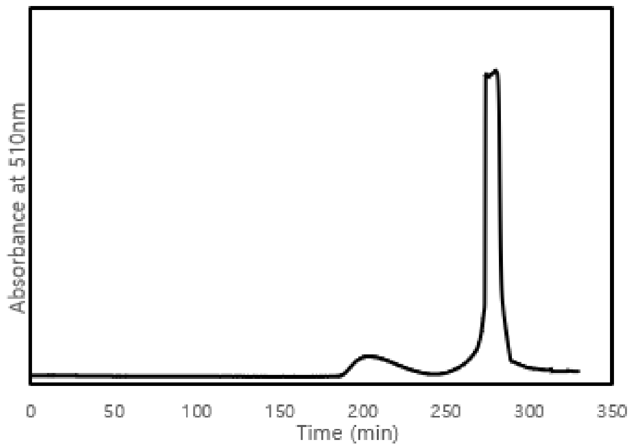

Fig. 1. 0.5g of Lu_2O_3 and 500mg of Yb_2O_3 were separated using 70g of resin and 0.07M α-HIBA at pH4.5(Flow rate = 6ml/min).

2.2 Purification

The separated Lu-HIBA was purifid of organic impurities without loss using 50W-X8 resin and dilute HCl. Lu-HIBA was loaded onto 50W-X8 reins and purified by 10ml of dilute(0.1, 0.5M) HCl through the resin using a peristaltic pump. The Lu concentration in the dilute HCl exting the resin was measured to determine the loss rate. Subsequently, the purified Lu was recovered with a 97% yield using 3M HCl.

	100-200mesh		200-400mesh	
HCl concentration	0.1M	0.5M	0.1M	0.5M
Loss rate	0.03	0.07	0.03	0.11

Tabel. 1 Lu loss rate by resin size during purification with 10ml dilute HCl

2.3 Atomataion

In the production process of Lu-177, the sepration and purification step are conducted consecutively. The separation status is monitored using a gamma-ray detector, and once the sepration of Lu-177 is complete, the process automatically transition to the purification step. This entire procedure is conducted remotly. The UI of general process is shown in Fig. 2.

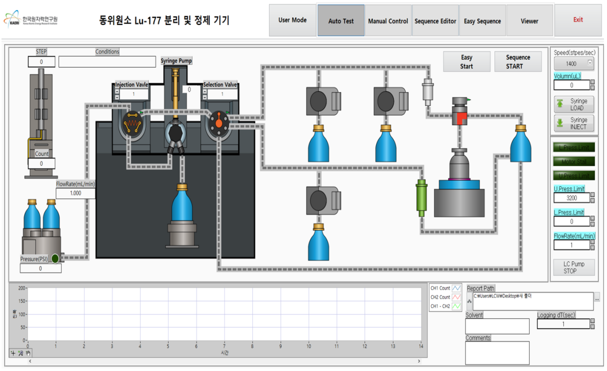

Fig. 2. User Interface of production system program

3. Conclusions

In this study, developed a technology for the separation of Lu from a large amount of Yb using ion-exchange chromatography. The Lu was purified without loss using cation exchange resin and dilute hydrochloric acid, and recovered with a 97% yield using 3 M hydrochloric acid. Additionally, an automated remote-controlled system for these two conditions has been developed, contributing to the standardization technology of Lu-177.

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