RI and Target recovery system of Lanthanides

K. H. Choi *, U. J. Park , S. H. Jung, J. B. Kim, J. H. Moon, S. S. Nam, K. D. Jang
Korea Atomic Energy Research Institute, P. O. Box 105, Yusung, Daejeon 305-600, Korea
Corresponding author: khchoi@kaeri.re.kr

The reactor-produced radiolanthanides have been pivotal for development of therapeutic radiopharmaceuticals. Some radiolanthanides show excellent theranostic effects in that they have proper LET (Linear Energy Transfer) to induce apoptosis for cancer treatment and gamma ray to use as a tracer for cancer diagnosis. Generally, radiolanthanides can be produced by (n,ɣ) and (n,ɣ)β reaction. Among the two reactions, the (n,ɣ)β is more suitable for medical application because it can produce high purified chemical yields as well as high specific activities.

Most lanthanides are present as trivalent cation in aqueous solution, and exhibit similar chemical properties. Especially, after the (n,ɣ)β reaction, atomic number of daughter nuclide is only lower by one than that of mother nuclide, target nuclide. Therefore separation of adjacent lanthanides is complicated process to obtain pure target nuclide. Several papers have reported that the ionic character change of lanthanides with appropriate chelating agents can isolate the target lanthanides. These specific agents to the metal ion are called as 'complexing agents' including α-HIBA, tartaric acid, mandelic acid, lactic acid etc.

Radioisotope research division of KAERI has developed separating technique for target lanthanides, total 20mg scale, by using complexing agents and ion-pairing agents in cold state.

To handle radioactive materials, especially separation of (n,ɣ)β nuclide, proper shieling and automation to protect operators are required. Our division has developed an automated system for separating pure target radioisotopes, which is aimed to protect operators from harmful radiation as well as to reduce the separation time. In this presentation, we propose a new technique to separate (n,ɣ)β radiolanthanies and show a RI separation system.

2. Experiments

2.1 Materials and Instruments units

All reagents and materials were of analytical grade. To prepare separation system, Ultra High Pressure Constant Pressure Pump was purchased from Chrom Tech, Inc. Selection valve and Switching valve were purchased from Rheodyne. Syringe pump and 3-way valve were obtained from Hamilton and Burkert, respectively. Operating Program was designed by using LAbView from National Instruments.

2.2 Manual system for Lanthanide separation

To separate the RIs, especially adjacent lanthanides, durable column and pump are required to endure internal high pressure, since fine cation resin (about 9μm) having large theoretical plate is used. Manual system is simply consisted of high pressure pump, sample injection valve and fraction collector to obtain sample. First draft is shown as below.

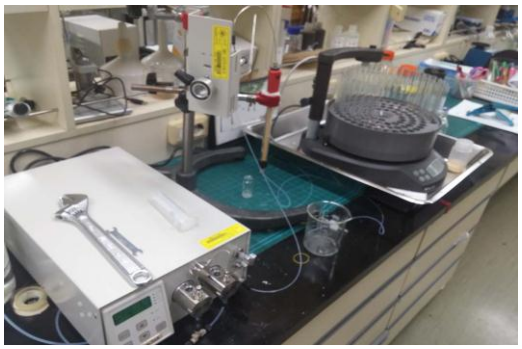
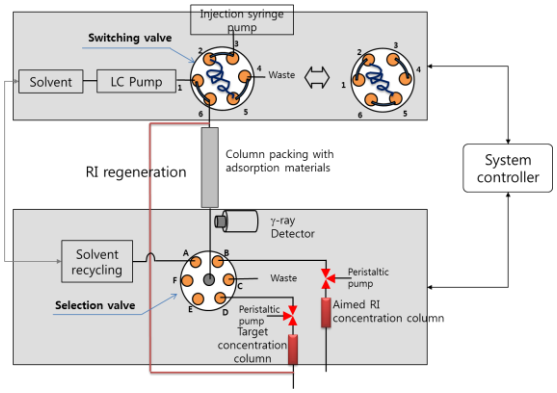


Figure 1 Manual system for Lanthanide separation

2.3 Manufacture of automated system

After neutron bombardment, dissolving and separation step of target nuclide should be done under shielding condition. In case of separation of (n,γ)β lanthanides, it takes 3~4 hours to get the aimed isotopes. To obtain target RIs, the mixed isotopes go through series of the following steps: injecting RIs to the column, adjusting flow rate, fractionalizing sample and then washing the each isotope. These complicated steps are illustrated by a flow diagram and automated RI separating system is shown as below (Figure 2).



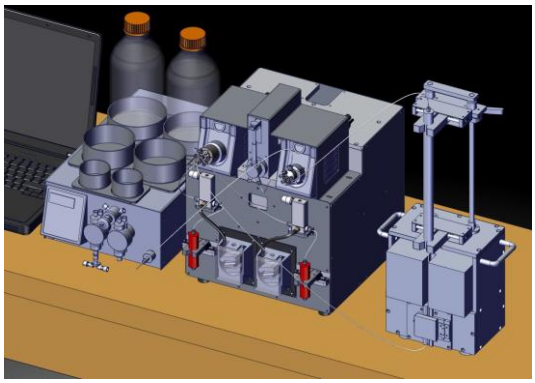
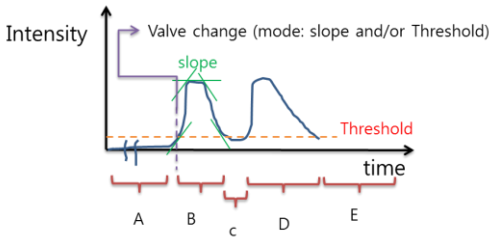


Figure 2 Automated system for (n,γ)β separation

2.4 Characteristics

This system is composed of four main parts: high pressure pump, switching/selection valve, RI detection, and controller. High pressure pump should endure internal pressure up to the 5000psi (300 atm). Switching/selection part controls the liquid flow of sample and eluents. All electronic units are attached to the backside of switching/selection part and covered with lead shield. RI detection part is composed of Cs/I detector and lead shield to minimize radiation effect. Controller can manipulate all parts of the system by a program using visual program language, LabView.

To control the RI separation, it should detect the separated RIs and change the channel for handling the flow direction. This system is equipped with the function according to peak threshold and peak slop.



3. Result and discussion

This system was designed for automated separation of the (n,γ) β reaction product. Especially, we are focused on getting the carrier free Ho-166 which is the first attempt at KAERI. Even though we have already developed to produce c.a Ho-166(carrier added form), we did not try to develop to produce carrier free Ho-166 since the separating process is difficult as well as production process follows double (n,γ) reaction. After HANARO is re-operated, we are schedule to produce n.c.a Ho by using this recovery system.

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