Adsorption experiments of ^{88}Y and ^{143}Pm on in HNO_3

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Seventeen elements of Sc, Y, and 15 lanthanides are called as rare earth elements (REEs). REEs are used in a wide range of applications such as semiconductors, catalysis, lasers, magnets, and neutron absorbents.[1] It is difficult to purify them due to their very similar chemical properties. Therefore, simple and effective mutual separation methods are needed to obtain pure materials for the industry.

So far, many extractants have been developed, and some extractants are commercially available. However, the adsorption behavior of REEs on those resins were only reported for some elements in some inorganic solutions. A systematic study of the adsorption behavior of many elements will be useful for the development of separation and purification technology. In this work, to develop the separation methods of REEs, we studied the adsorption behavior of Y and Pm using 18 commercially available resins.

^{88}Y and ^{143}Pm were produced in the ^{nat}Sr$(d,xn)^{88}$Y and ^{nat}Pr$(\alpha,xn)^{143}$Pm reactions using the K70 AVF cyclotron at RIKEN and were separated from the target materials using LN resin. In the adsorption experiments, the resins (Actinide, CU, DGA (normal), DGA (branched), LN, LN2, Muromac 1 × 8, Muromac 50 W × 8, Pb, RE, Sr, TBP, TK 100, TK 101, TK 400, TRU, UTEVA, and ZR resins) were added in 1 mL of HNO_3 containing ^{88}Y or ^{143}Pm in a PP tube, and the mixture was shaken for 4 h using a mixer. After that, the resin was removed by centrifugation. Subsequently, the filtrate was pipetted into another tube and weighed and then subjected to γ-ray spectrometry using a Ge detector. Finally, the HNO_3 concentrations of the aqueous phases were determined by titration with a standardized NaOH solution. In all the adsorption experiments, control experiments without the resin were performed. The K_d values were determined from the following equation:

$$K_d = A_r V_s / A_s w_r = (A_c - A_s) V_s / A_s w_a \quad (1)$$

where A_r, A_s, and A_c are the radioactivities of the resin, the solution, and the control solution, respectively. V_s is the volume (mL) of the solution, and w_a is the mass (g) of the dry resin.

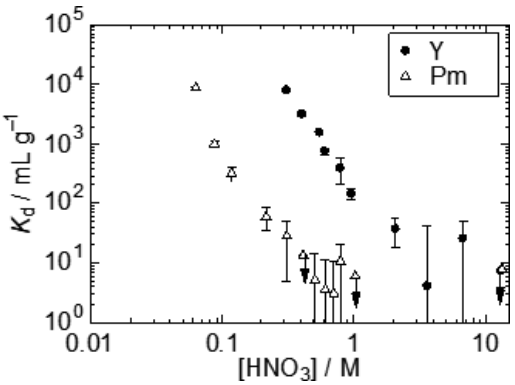

Fig. 1. The K_d values of Y and Pm with LN resin as a function of HNO_3 concentration.

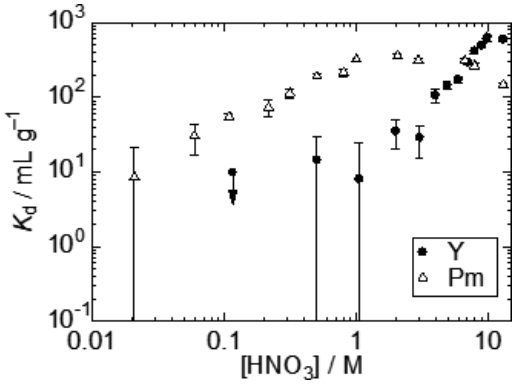

Fig. 2. The K_d values of Y and Pm with TRU resin as a function of HNO_3 concentration.

We investigated the K_d values of Y and Pm as functions of HNO_3 concentration. The K_d values of Y and Pm were low ($\leq$20 mL g^{-1}) and constant when we used CU, Muromac 1 × 8, Pb, Sr, TBP, TK 101, TK 400, UTEVA, and ZR resins in 0.1–13 M HNO_3. It was found that these resins are not suitable for the separation of Y and Pm in HNO_3.

Using DGA (branched) and Muromac 50 W × 8 resins, Y and Pm were adsorbed on the resins in some HNO_3 concentrations, and the K_d values of Y agreed with those of Pm. Therefore, these resins are not useful for the separation of Y and Pm from each other.

When Actinide and DGA (normal) resins were used, the K_d values of Y and Pm were $\geq 10^2$ mL g^{-1}, and the values were different from each other. Y and Pm can be separated using these resins. However, those K_d values were $\geq 10^2$ mL g^{-1} in 0.1–13 M HNO_3, and both Y and Pm were adsorbed on the resins. The Y and Pm species adsorbed on these resins can be stripped by using a large volume of eluents, and this separation method requires a long time. It is concluded that Actinide and DGA (normal) resins are not suitable for the separation of Y and Pm.

Figure 1 shows the dependences of the K_d values of Y and Pm on the HNO_3 concentration in the adsorption experiment using LN resin. When LN resin is used, the K_d values of Y are higher than those of Pm in a high HNO_3 concentration range. The same behavior was observed using LN2 and TK 100 resins. Figure 2 shows the HNO_3 concentration dependences of the K_d values of Y and Pm on the TRU resin. The K_d values of Y are lower than those of Pm when TRU resin is used. The same behavior was obtained with RE resin. It is suggested that these resins are useful for the separation of Y and Pm.

In the future, we will perform adsorption experiments using other REE elements and discuss about good separation conditions for REEs.

Reference

1) B. Swain, E. O. Otu, Sep. Purif. Technol. **83**, 82 (2011).

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