Magnetic separation of Dy ions in aqueous solutions

Yokohama Nat'l Univ., °Kasumi Kimura, Kyohei Hagita, and Isao Yamamoto

E-mail: kimura-kasumi-vs@ynu.jp

Magnetic separation is a physical technique that separates mixed substances using a magnetic force. Permanent magnets were used in the initial stage, so they were used for ferromagnetic materials with large particles. However, recent studies have also targeted paramagnetic ions with small particle sizes [1, 2]. The magnetic force for an ion is expressed by Eq. (1).

$$F = \kappa_{ion} B \left(\frac{dB}{dz}\right). \quad (1)$$

In this study, the target of magnetic separation is rare earth ions. Rare earth metals are indispensable for producing high-tech products, but whose supply is expected to become tighter. The recycling of them is indispensable for a stable supply.

We researched about magnetic separation experiment of rare-earth ions in aqueous solution. A 0.26 wt.% aqueous solution of $Dy(NO_3)_3 \cdot 6H_2O$ (99.5 %, Wako Chemical) was soaked into a sample tube with 330 mm length and ϕ30 mm ID, and set at a high gradient position in a horizontal superconducting magnet. After the fixed migration time, for example 12 h, small amount of liquid was sampled from the different position. Dy ion concentration was measured by using an inductively coupled plasma mass spectrometry system (Agilent, G3281A) for sample liquid diluted 100 times and the original concentration was evaluated. Fig. 1 shows the position dependence of the Dy ion concentration. At x = 266 mm, which position corresponds to magnetic force field of BdB/dx = 82 T^2/m, Dy ions were migrated and concentrated toward the center of the magnet boor. The change in the concentration of 0.01 wt.% is significant compared with the initial concentration of 0.267 ± 0.005 wt.%. The time dependence of the magnetic concentration of Dy ions is discussed.

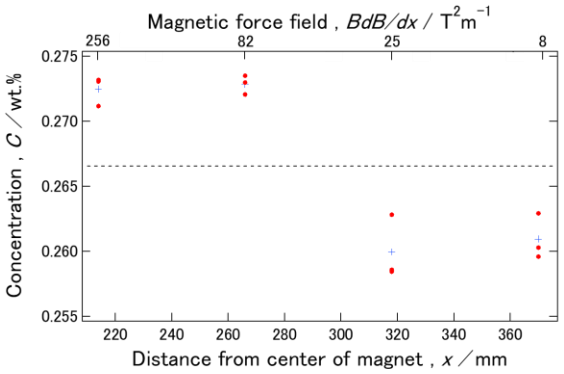

Fig. 1 The concentration distribution of Dy ion for magnetic migration for 12 h.

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References: [1] A. Franczak *et al*., Phys. Chem. Chem. Phys. 18 (2016) 27342.

[2] H. Kyohei *et al*., The 66th JSAP Spring Meeting (2019), 10p-M113-2.