Selective Separation of Rare-earth Elements from their EDTA complex by use of Electrodialysis Accompanied with Metal-Substitution Reactions of different rates

Hiroshi TAKAHASHI
Department of Materials Engineering and Applied Chemistry,
Mining College, Akita University

Summary

A novel electrodialysis has been proposed for the separation of rare-earth element. The electrodialyzer used for experiment consists five compartments, divided with cation-exchange membrane, C(SELEMION CMV), and anion-exchange membrane, A(SELEMION AMV). The compartments are set in the order, Anode, Feed, Reaction, Strip, and Cathode compartments, which are devided with the A, C, C and A membranes, respectively. The Feed solution, the Reaction solution, and the Strip solution contains $CuCl_2$, rare earth-EDTA complex and HCl, respectively. When such a electrodialysis system is applied a voltage, Cu^{2+} is expected to permeate from Feed compartment to the Reaction compartment and to be substituted for $(Rare\ metal)^{3+}$ in their EDTA complex. The resultant free(uncomplexed)-ions of rare-earths are transferred to the Strip compartment. The rare-earth ions may be selectively recovered owing to the differences in membrane selectivity and in substitution reaction rates between rare-earth elements.

The experiments for proof of the idea mentioned above have revealed the following: In the experiment for lanthanum-EDTA system, Cu^{2+} from the Feed compartment was immediately substituted for lanthanum, and a part of the resultant La^{3+} was transferred to the Strip compartment. No permeation of Cu-EDTA and free Cu^{2+} was observed during dialysis. The flux of La^{3+} increased with increasing current density. In the systems of gadolinium-EDTA and yttrium-EDTA, permeation behaviors were almost the same as that of lanthanum-EDTA systems. In the lanthanum-yttrium-EDTA system, lanthanum was selectively separated from lanthanum-yttrium-EDTA mixture solution: at the first, lanthanum was transferred from the Reaction compartment to the Strip compartment, yttrium followed after a long induction period. In the system of lanthanum-gadolinium-yttrium-EDTA, lanthanum was separated at first, gadolinium and yttrium followed with induction periods.

The reaction rate for metal substitution was measured by stopped-flow spectroscopic analyzer. The reaction rates decreased in the order, lanthanum, gadolinium and yttrium. The decreasing order of the reaction rates corresponded to the increasing order of the induction periods for permeation mentioned above. This suggested that the selective separation of rare-earth elements in this method was mainly caused by the difference in metal-substitution reaction between rare-earth elements.