Development of Functional Charged Membranes for Use in Separation and Concentration of Trace Heavy Metal Ions from Sea Water

Takashi Hayashita, Jun Nishimoto, and Masaaki Tabata
Faculty of Science and Engineering, Department of Chemistry
Saga University

Summary

Certain heavy metal cations such as Pb(II) and Cd(II) can be extracted into organic solvents as anionic metal halide complexes by liquid-anion exchangers. Similar ion-association sorption can be obtained by anion-exchange polymers. The potential of these phenomena for application in heavy metal ion separation by functional charged membranes has been explored. Selective separation of Pb(II) and Cd(II) chloride complexes was performed by both liquid membrane containing liquid anion-exchanger as a mobile carrier and solid polymeric membrane containing anion-exchange site as a fixed carrier. Donnan membrane equilibrium of the system allows Pb(II) and Cd(II) chloride complexes to be concentrated in the aqueous receiving phase. The initial flux equations for metal permeation through anion-exchange membrane were derived on the basis of 1:1 and 2:1 complex formation between the anion-exchange site and metal chloride complexes. A good correlation between the observed and the calculated fluxes was obtained.

To enhance permeation selectivity and efficiency, a novel polymeric plasticizer membrane, which is composed of cellulose triacetate polymer as a membrane support, o-nitrophenyl octyl ether as a membrane plasticizer and trioctylmethylammonium chloride as a mobile carrier, has been developed. This type of membrane exhibited a superior separation selectivity and efficiency to the conventional anion-exchange membranes.

The dialysis condition through the polymeric plasticizer membrane was investigated in detail. The permeation selectivity changed from Cd(II) selectivity in the dialysis cell of a small membrane area (0.8 cm^2) to Pb(II) selectivity in that of a large membrane area (15 cm^2), which is attributed to a difference in the retention of Cd(II) chloride complex in the membrane. To reduce the retention of Cd(II) in the membrane and enhance its permeability, the addition of EDTA in the receiving phase was found to be very effective. As a result, the permeation selectivity for Cd(II) and Pb(II) chloride complexes through the charged membrane was successfully controlled.