

Concentration of Inorganic Ions through Ion Exchange Membranes by Active Transport

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Summary

For the purpose to concentrate ions by an active transport against concentration gradients of ions through ion exchange membranes, characteristics of active transport for alkaline metal ions through cation exchange membranes were studied under various conditions. Mechanism of the active transport for these ions was discussed, and a selective active transport for mixtures of alkaline metal ions also was investigated.

When one side of water-insoluble cation exchange membranes prepared by heat treating membranes (PSA/PVA) made of poly(styrenesulfonic acid) (PSA) and poly(vinyl alcohol) (PVA) was acidic and the other alkaline, alkaline metal ions were actively transported against their concentration gradients across the PSA/PVA membrane, this transport was significantly influenced by the initial H^+ ion concentration on the acidic side, and a transport fraction of alkaline metal ion in the active transport was increased with increasing H^+ ion concentration. The transport fraction also was dependent on the heat treatment period of the PSA/PVA membrane and a membrane with long heat treatment period showed high transport fraction.

The mechanism of the active transport for alkaline metal ions through the PSA/PVA membrane was discussed by viewpoints of an incorporation of ion into the cation exchange membrane on the alkaline side, ion exchange reaction in the membrane by the H^+ ion diffused due to a proton-jump mechanism from the acidic side, Donnan exclusion of Cl^- ion on the acidic side, and release of alkaline metal ion from the membrane on the acidic side.

On the other hand, in K^+-Na^+ , Li^+-Na^+ , K^+-Li^+ binary systems also, alkaline metal ions were actively transported. The selectivities in the transport of these ions were $K^+/Na^+ > 1$, $K^+/Li^+ > 1$, and $Li^+/Na^+ < 1$. The selectivity for these alkaline metal ions was explained by both a diffusive transport depended on the size of their hydrated ions and affinity between the alkaline metal ions and the carrier fixed to the PSA/PVA membrane, sulfonic acid group. Consequently, it was found the selectivity of active transport for alkaline metal ions through the PSA/PVA membrane was given by the following order: $K^+ > Na^+ > Li^+$.