Studies on ion exchange membranes having permselectivity for specific ions (in connection with membrane structure)

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Summary

Three trials to prepare ion exchange membranes with specific properties were made : 1) preparation of composite membranes composed of ion exchange membranes and conducting polymers (polypyrrole, polyaniline), 2) surface modification of anion exchange membranes by anionic polyelectrolytes and 3) preparation of anion exchange membranes having various anion exchange groups.

1) The composite membrane prepared from anion exchange membrane and polypyrrole shows interesting properties in electrodialysis : high acid retention in electrodialysis of hydrochloric acid solution and anti-organic fouling properties in the presence of anionic surface active agents. Especially, when anion exchange membranes of which pyrrole had been impregnated were immersed in an aqueous ferric chloride solution, current efficiency of hydrochloric acid increased markedly without increase in electric resistance of the membrane. This is due to formation of rigid and weakly basic anion exchangable layers on the anion exchange membrane.

The composite membrane prepared from Fe^{3+} form cation exchange membrane and pyrrole gives conducting film with high mechanical strength. When a Fe^{3+} form cation exchange membrane and the composite membrane was clamped between two platinum plates, Fe^{2+} - Fe^{3+} coupling redox battery was formed.

2) It is well known that surface-modified-anion exchange membrane with anionic polyelectrolytes permeates chloride ions against sulfate ions selectively in electrodialysis. It is confirmed that this membrane also shows improved permselectivity for nitrate ions, fluoride ions and bromide ions against chloride ions compared with corresponding membrane. The layer provides properties of selective permeation of ions with larger hydrated ionic diameter to the membrane.

3) Anion exchange membranes having various anion exchange groups, trimethylbenzyl, triethylbenzyl, tri-n-propylbenzyl and tri-n-butylbenzyl, were prepared. Though electric resistance of the membranes increases with increasing alkyl chain length bonded to ammonium groups, nitrate ions permeate selectively to chloride ions with increasing chain length. Permselectivity of sulfate ions to chloride ions decreased with increasing the chain length.

New functions can be imparted to ion exchange membranes by making the membrane to the composite with conducting polymers, by modification of membrane surface and changing anion exchange groups, etc.