# Separation of Heavy Metal Ions across Novel Mosaic Membrane

-part2-

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# 하전모자이크 막을 사용하여 중금속이온의 분리

-part2-

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## ABSTRACT

A theory for the material transports through ion exchange membrane has been developed on the basis of nonequilibrium thermodynamics by removing the assumption of solvent flow in the previous paper and applied to a detailed study of the ionic transport properties of new charged mosaic membrane(CMM) system. The CMM having two different fixed charges in the polymer membrane indicated unique selective transport behavior then ion-exchange membrane.

The separation behavior of ion transport across the CMM with a parallel array of positive and negative functional charges were investigated. It was well-known the analysis of the volume flux and solute flux based on nonequilibrium thermodynamics. Our suggests preferential salt transport across the charged mosaic membranes. Transport properties of heavy metal ions, $Mg^{2+}$, $Mn^{2+}$ and sucrose system across the charged mosaic membrane were estimated. As a result, we were known metal salts transport depended largely on the CMM. The reflection coefficient indicated the negative value that suggested preferential material transport and was independent of charged mosaic membrane thickness.

Key words: Charged mosaic membrane(CMM),Heavy metal ion, nonequilibrium thermodynamics, Volume flux, Solute flux, Cross coefficients, reflection coefficients

## INTRODUCTION

Generally an ion exchange membrane can not permeate mostly cation or anion without applied current, while so-called charged mosaic membrane having two different fixed charges in membrane matrix can permeate both cation and anion in concentration gradient. In previous studies[1~5], we reported the transport behavior of solvent and solute across the charged mosaic membrane and indicated the unique characteristics in the charged mosaic membrane, such as the preferential solute transport. This means that one of the membrane parameters, estimated from flux measurements indicates the negative value and the separation between solute and solvent or between electrolyte and non-electrolyte will be realized[6,7]. The composite charged mosaic membrane was investigated from simultaneous transport such as solute and solvent flux. On the other hand, the reflection coefficient and salt flux coefficient were estimated by taking account of the cross constants of the phenomenological equation. In previous studies, we reported transport coefficients of solvent and solute with mono-mono valent electrolyte solution across charged mosaic membrane. In this results, we are reported the divalent electrolyte solutions as $MgSO_4$ across CMM.

## EXPERIMENTS

The charged mosaic membrane were made two different ion exchange groups and the ion groups, cation and anion exchange groups were arranged parallel with each other inside membrane and the array of charge groups links continuously from one membrane to the other membrane[9]. The membrane characteristics are given the Table 1 and Fig.1.is the experiments apparatus.

Table 1. The structure characteristics of charged mosaic membrane

| | |
|---|---|
| Membrane thickness | 50um |
| Cation exchange group | $-C_5H_5{}^+CH_3$ |
| Microsphere content (wt%) | 23.4~26.1 |
| Anion exchange group | $-C_6H_5SO_3{}^-$ |

The flux measurements were carried out by a set of two glass cells. The membranes were tightly inserted between two cells by using silicon rubbers

in oder to avoid leak of water from the contact surfaces. The experiments temperature were kept at 25°C by the circulating constant water surround the cells during experiment.

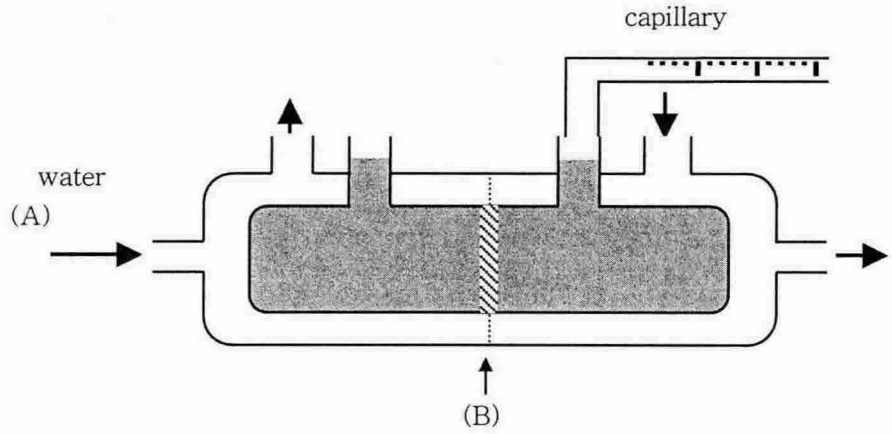


Fig. 1. The schematic of membrane experimental apparatus:
(A) Circulating water for supported constant temperature at 25°C,
(B) charged mosaic membrane(CMM), glass cell content is 25ml, respectively.

## RESULTS AND DISCUSSION

The volume change versus time in system was used sucrose as impermeable solute indicated linear relation (Fig. 2.). All the other relations with various added $MgSO_4$ concentration in system also indicated linearity. This means the systems are in steady state within examined time. Taking account of membrane area for the slopes of straight lines, one can obtain volume flux and solute flux. $Lp$ is filtration coefficient that means water permeability of water affinity with membrane [9,10]. $Lp$'s value were given against added $MgSO_4$ concentration and the result indicated the water affinity in membrane was not affected by existence of electrolytes in outer solutions.

### Phenomenological equation

In case of two flows about solute and solvent, practical phenomenological equations can be given as follows:

$$Jv = Lp\,(\Delta p - \sigma_s\,\Delta\Pi_s) \quad (1)$$

$$Js = C_s\,(1 - \sigma_s)\,Jv + \omega_s\,\Delta\Pi_s \quad (2)$$

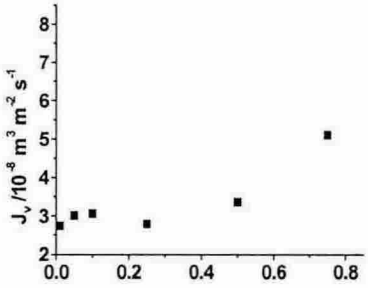


Fig.2

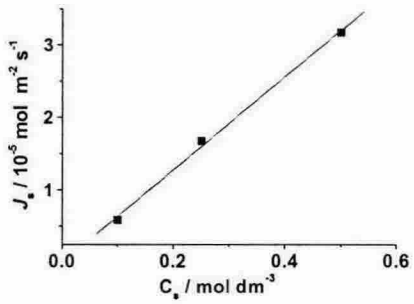


Fig.3

where Jv and Js are volume flux and solute flux which can be obtained from volume changes with time and concentration changes with time(figs.2and 3), respectively. $Lp$ is defined as the filtration coefficient (water permeability). The $\sigma$ is defined as reflection coefficient as fig.4. The $\omega$ is defined as permeability coefficient as fig.5. According to Kedem and Katchalsky, membrane parameters across charged mosaic membrane, $Lp$, $\sigma$ and $\omega$ in appropriate experimental conditions were given as follow equations,

$$Lp = -\left(\frac{Jv}{\Delta\Pi}\right)_{\Delta P=0} \tag{3}$$

$$\sigma = -\frac{1}{Lp}\left(\frac{Jv}{\Delta\Pi}\right)_{\Delta P=0} \tag{4}$$

$$\omega = \left(\frac{Js}{\Delta\Pi}\right)_{J_v=0,\Delta P=0} \tag{5}$$

The membrane parameters were estimated using Eqs.(3)-(5). As described above, the improved equation containing information about active layer thickness would be convenient to explain the discrepancy between present and previous results[11,12] .

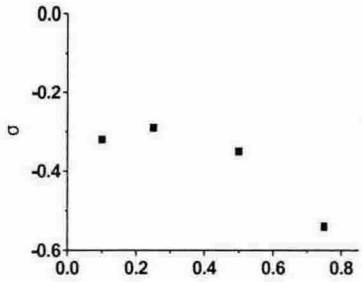


Fig. 4

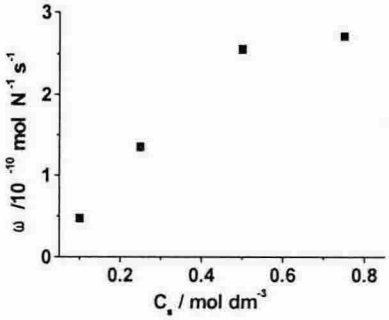


Fig.5

## CONCLUSION

In this work, $MgSO_4$ and water transports under the mixed $MgSO_4$ and sucrose solution system were investigated. Two kinds of measurements, volume flux and solute flux, were performed. Volume fluxes across charged mosaic membrane could be classified into osmotic flow of water due to $MgSO_4$ concentration difference, water flow dragged by $MgSO_4$ diffusion, and osmotic flow of water due to sucrose and they were found to be additive. In addition, it was elucidated that the presence of nonelectrolyte solution can easily change the direction and the magnitude of volume fluxes. From the results, it was suggested that efficient salt enrichment can be performed by controlling the direction of the solvent osmosis and one can expect negative salt rejection.

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