

일반강연 II-15

## 폴리비닐알콜과 이온성고분자로 제조된 나노분리막

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## NANOFILTRATION MEMBRANES BASED ON POLY(VINYL ALCOHOL) AND IONIC POLYMERS

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### 1. INTRODUCTION

With good physical and chemical properties as a membrane material, poly(vinyl alcohol) (PVA) has been widely used for the preparation of several kinds of membranes for different applications.<sup>1-5</sup> Considering such good physical chemical properties, some people have tried to use it for the formation of reverse osmosis (RO) membranes with a good chemical stability as well as high flux and high rejection rate. However, unfortunately, the performance of the RO membranes based on PVA has not been satisfactory yet. The PVA RO membranes thermally crosslinked have shown very low flux and relatively low salt rejection.<sup>6</sup> In this experiment, ionic polymers such as sodium alginate and chitosan were used together with PVA to increase the nanofiltration performance of the PVA membranes.

### 2. EXPERIMENTAL

PVA and PVA/ionic polymer composite membranes were prepared by coating the respective polymer solutions on the microporous polysulfone support (UOP UF membrane). The coating layers were crosslinked using glutaraldehyde. The morphologies and the chemical structures of the membranes were characterized with X-ray diffractometry (model D/MAX III B Rigaku) and with FTIR (Bio-Rad, Digilab Division, model FTS-80, FTIR), respectively. Swelling indices of the membranes were measured to obtain relative degrees of crosslinking. The membranes were tested with different feed solutions (1000 ppm solutions of PEG 600, Na<sub>2</sub>SO<sub>4</sub>, MgCl<sub>2</sub>, and NaCl) at various operating pressures (100 - 600 psi) to observe their permselective performances as well. All the tests were carried out at room temperature.

The flux of the membrane was measured by weighing the permeate penetrated through the membrane per unit time (g/min) and solute rejection rates were obtained from the data from high performance liquid chromatography (HPLC) using the following equation;

$$\text{Rejection (\%)} = 100 \times (A_f - A_p)/A_f$$

where  $A_f$  is the HPLC peak area of feed solution and  $A_p$  is the HPLC peak area of permeate.

### 3. RESULTS AND DISCUSSION

**FTIR:** The chemical structures of the crosslinked active layers of the composite membranes were characterized with FTIR. The FTIR spectrum of the crosslinked PVA layer showed characteristic peaks of acetal linkage as a strong C-O-C stretching at  $1110 \text{ cm}^{-1}$ . That acetal linkage was formed from the crosslinking reaction between the hydroxyl groups of PVA and glutaraldehyde.

**Swelling Test:** For the study on the relative crosslinking degrees of the membranes, swelling indices of the active layers crosslinked for different reaction time were measured. The swelling index was calculated by using the following equation; Swelling Index (%) =  $100 \times (W_s - W_d)/W_d$ , where  $W_s$  and  $W_d$  are weights of swollen samples and dried samples, respectively. The swelling indices of the prepared active layers decreased with increasing crosslinking reaction time as usual. On the other hand, the behavior of the swelling index as a function of reaction time of the active layers was dependent on their composition.

**X-ray Diffraction:** The microstructures of the PVA membranes crosslinked under different conditions were studied with X-ray diffractometry. In this study, dried samples and swollen samples with  $20 \mu\text{m}$  of thickness were used. All the dried PVA membranes showed very similar XRD patterns and appeared to be semicrystalline despite their different degrees of crosslinking. All the XRDs showed broad peaks at around  $10^\circ$  and relatively sharp semicrystalline peaks centered at around  $20^\circ$  of  $2\theta$ . From this result, one can find that average intermolecular distances of the PVA membranes are almost same in spite of the different degrees of crosslinking. This result suggests that the differences of the average intermolecular distances of the PVA membranes with different degrees of crosslinking are not large enough to be detected by the XRD

**Permeation Test:** The permeation tests of active layers and composite membranes were carried out separately in order to see the thier respective properties. In the case of the active layers of PVA, PVA/Sodium alginate(SA), and PVA/Chitosan(Ch), the blending of ionic polymers appeared to improve the organic solute rejection rates such as PEG 600 without decrease of their fluxes. When 5% of SA was blended with PVA, the permselective properties of the resulting active layer were as follows at 200 psi of operating pressure: 98% of rejection rate and  $0.18 \text{ m}^3/\text{m}^2\text{day}$  of flux.

For the case of the composite membranes, the effect of ionic polymers was little bit different from the case of the active layers. The blending of the ionic polymers increased the fluxes and kept rejection rates almost same. In this case, another major factor other than the ionomer blending affecting on the permselective properties of the membranes was crosslinking time. As the crosslinking time increased the fluxes decreased and rejection rate increased. The PVA/SA blend membranes crosslinked for 2 min. showed following performances at 200 psi with 1000 ppm PEG 600 solution: 95.9% of rejection rate and  $0.54 \text{ m}^3/\text{m}^2\text{day}$  of flux.

#### 4. REFERENCES

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