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The effect of thermodynamic stability of casting solution on the membrane morphology and permeation properties in phase inversion process

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Most of synthetic polymeric membranes used in ultrafiltration, reverse osmosis and microfiltration processes are prepared by phase inversion(or phase separation) technique. In this technique, a homogeneous polymer solution is cast into thin film or hollow fiber shape and then immersed into a nonsolvent coagulant bath. The exchange of solvent and nonsolvent across the interface between casting solution and coagulant can make the casting solution phase-separate and form a membrane with a symmetric or asymmetric structure. Because of importance of this technique in membrane field, many investigations have been dedicated to elucidate the mechanism of membrane formation by phase inversion technique.[1-10] These investigation have suggested that the structure formation and permeation properties of phase inversion membrane depend on the variables such as the nature and content of casting solution and coagulant, temperature of casting solution and coagulant, and the diffusional exchange rate of solvent and nonsolvent etc. which can be related to the thermodynamic and kinetic properties of the casting system. The variables such as the nature and content of casting solution can also be the important factor affecting the structure formation and permeation property of the phase inversion membrane. But, fewer study have been done on the effect of nature and content of casting solution on the thermodynamic properties and their

relationship with the membrane performance in phase inversion process.[11-21].

In this paper, our aim is to elucidate the effect of PEG additive on the thermodynamic stability of casting solution and their relationship with the membrane morphology and permeation properties in phase inversion process. In order to perform this aim, PSf/NMP/PEG system and water were adopted as casting solution and nonsolvent, respectively. The thermodynamic stability of casting solution were changed by varying the molecular weight of PEG and the ratio of PEG #600 to NMP in casting solution, and were measured by means of the precipitation value(or nonsolvent tolerance) and viscosity. The structure and permeation property of the membrane were also investigated through SEM and UF test

In the preparation of phase inversion membrane from PSf/PEG/NMP solution using water as a precipitate, the morphology and permeation property of the membrane is highly dependent on the thermodynamic stability of the casting solution. The increasing the ratio of PEG #600 to NMP or addition of higher molecular weight of PEG causes casting solution more unstable and polymer segments aggregate to increase the viscosity of the solution. When the casting solution is more unstable, the pore size of the skin layer becomes bigger and the cross-section of the membrane changed from finger type to sponge type. Thus, the membrane prepared with more unstable casting solution yields lower selectivity and higher water flux. Especially, when the casting solution is highly unstable, the membrane had a co-continuous structure with porous skin layer and a macrovoid-free, sponge type of pores in cross-section. The co-continuous structure and fast precipitation observed in this study are thought to be enough evidences of the fact that membrane formation is governed by spinodal decomposition mechanism in the casting system with highly unstable casting solution and very powerful precipitate.