PREPARATION AND MODIFICATION OF POLYACRYLONITRILE MEMBRANES FOR THE FORMATION OF NANOFILTRATION COMPOSITE MEMBRANES

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INTRODUCTION

Polyamide (PA) composite membranes have been widely used for nanofiltration (NF) due to their high permeation performances. Most of them have been prepared by forming thin PA active layers on microporous supports prepared from engineering plastic polymers such as polysulfone (PSf) and polyetherimide (PEI). The supports prepared from such polymers usually have very good mechanical and chemical properties but do not have on their surfaces any functional groups which can form chemical bonds with the PA layers. Consequently, there is no such strong interaction as covalent or ionic bond between the active and the support layers for the conventional PA composite membranes.

Generally, the conventional PA composite membranes have been known to be stable in most applications. However, their chemical stability should be reconsidered in order to extend their applications into harsh conditions such as the solutions that contain chemicals enable to swell the support layer seriously. It will cause the active layer to be detached from the support layer and the membrane will be then in an undesirable condition.

In order to cope with this kind of problems, the introduction of strong interaction between active and support layers was considered in this study. One of the good strong interactions would be definitely covalent or ionic bond. In this study, polyacrylonitrile (PAN) was used as a support material, since the -CN groups of PAN on the surface of the support can be converted into -COOH groups by simple treatment with a NaOH solution at ambient temperature. The -COOH groups produced will be useful for the formation of ionic and covalent bonds with amine compounds. The

ionic bond formation between the two layers will act positively for the flux as well as for the chemical stability of the PA composite membrane.

For the realization of such kind of PA composite membranes, PAN supports useful for the formation of NF composite membranes were prepared from PAN solutions in N-methylpyrrolidone (NMP), using a phase inversion method. The compositions of the PAN/ NMP solutions used were as follows : 10/90, 15/85, and 20/80 (in wt%). The PAN supports were treated with various concentrations of NaOH aqueous solutions (0.1, 0.5, 1, and 2 mole) for certain periods of times (0.5, 1, 2, and 3 hrs) in order to modify their surface chemically and morphologically. The characteristics of the supports, modified or unmodified, were carefully studied; The morphology of those were observed with a field emission scanning electron microscopy (FESEM) and an atomic force microscopy (AFM). The change of the chemical structure of those by the NaOH treatment was studied using a FTIR-ATR spectroscopy and an ESCA. The permeation properties of those were also determined at 1 to 5 bar of operation pressure using a PEG 35,000 aqueous feed solution.

RESULTS AND DISCUSSION

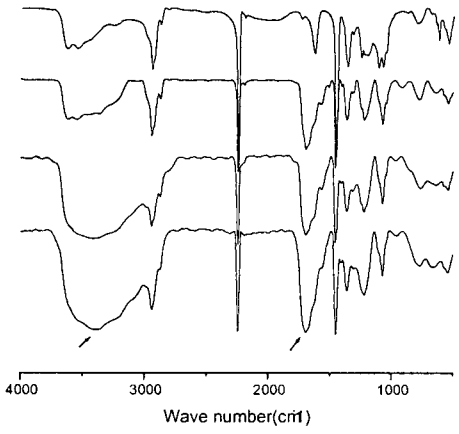

Figure 1. FTIR-ATR spectra of the PAN membranes prepared from 15 wt% PAN solution and modified with a 2 M NaOH solution at 40℃ for different reaction time, (a) 0, (b) 0.5, (c) 1, and (d) 3 hrs

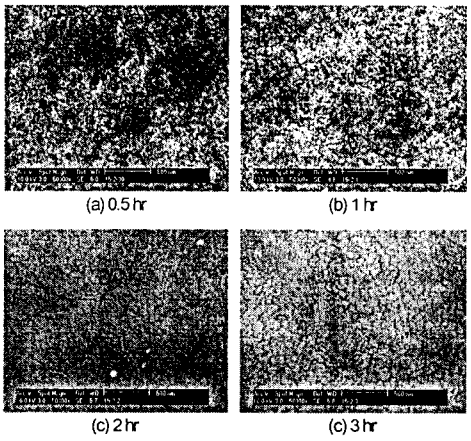

Figure 2. FESEM photographs of the surfaces of the PAN membranes prepared from 15 wt% PAN solution and modified with a 2 M NaOH solution for different reaction times: (a) 0.5, (b) 1, (c) 2, and (c) 3 hrs.

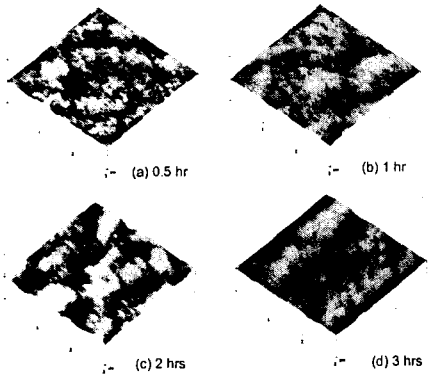

Figure 3. AFM photographs of the surfaces of the PAN membranes prepared from 15 wt% PAN solution and modified with a 2 M NaOH solution for different reaction times: (a) 0.5, (b) 1, (c) 2 and (d) 3 hrs.

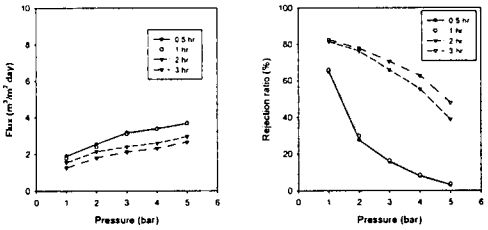

Figure 4. Permeation properties of the PAN membranes prepared from 15 wt% PAN solution and modified with a 2 M NaOH solution for different reaction times: (a) flux, (b) rejection ratio (Feed solution; 1,000 ppm PEG 35,000 aqueous solution)

REFERENCES

1. J. G. Jegal and K. H Lee, *J. Appl. Polym. Sci.*, **61, 3**89 (1999)
2. J. G. Jegal N.-W. Oh and K.-H. Lee, *J. Appl. Polym. Sci.*, in press (2000)
3. N.-W. Oh, J. G. Jegal and K.-H. Lee, *J. Appl. Polym. Sci.*, in press (2000)