Synthesis of High-Strength Anion-Exchange Membrane

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INTRODUCTION

In Japan, most table salt is manufactured by ion-exchange membrane electrodialysis. Synthesis of ion-exchange membranes is one of the most important issues in electrodialysis. Low electric resistance, high mechanical strength and high concentrating performance are necessary for an ion-exchange membrane. In this study, in order to develop a high-strength anion-exchange membrane, we undertook the synthesis of an anion-exchange membrane by changing the diameter of the supporting fabric of the membrane and selecting appropriate anion-exchange groups.

EXPERIMENTAL

Synthesis of membranes

Styrene, divinylbenzene and acrylonitrile-butadiene rubber at the weight ratio of 9:1:0.5 were mixed by agitation for 18 hours. 2,2'-azobis-(isobutyronitrile) was added to the mixed solution and this solution was agitated for 30 minutes. The paste obtained by previous operation was coated on Teviron fabrics made of polyvinyl chloride with diameters of 50, 75, 100, 125 denier, wrapped with polyester film, and heated at 85℃ for 20 hours, and then at 115℃ for 30 minutes. The polyester film was removed and anion exchange groups were introduced into the base membranes in the following manner.

The base membrane was chloromethylated with chloromethyl methyl ether and zinc chloride for 48 hours and then placed into a 30% ethanol solution of trimethylamine (TMA) or N,N,N',N'-tetramethyl-1,6-hexanediamine (TMHD) for 48 hours.

Properties of membranes

Elecrtric resistance was measured on the membrane dipped in a 4M aqueous solution of NaCl at 25℃. The mullen test-burst strength was measured to determine mechanical strength.

Concentrating performance

Five desalting chambers and four concentrating chambers were arranged using the synthesized anion-exchange membranes and commercially available cation-exchange membranes (effective membrane area, 8cm^2) in a small electrodialyzer. NaCl solution of 0.5M was supplied to the electrodialyzer and 2.5A/dm^2 of electric current was passed through the electrodes. The concentration of NaCl in the concentrated solutions was analyzed.

RESULT AND DISCUSSION

The burst strength increased according to the increase of the thickness of the membrane, and was not influenced by the amine species (Fig.1).

The electric resistance of the membrane increased according to the increase of the thickness of the membrane. The electric resistance of samples treated with TMA was lower than that of TMHD-treated samples (Fig.2).

The concentration of NaCl in the concentrated solution increased according to the increase of the thickness of the membrane. Samples treated with TMA showed lower NaCl concentration than TMHD-treated samples (Fig.3).

When using 120 denier fabric and TMA treatment, the burst strength of the synthesized membrane was three times higher than that of the commercial membrane, while the electric resistance and the concentrating performance were nearly equal to those of the commercial membrane.

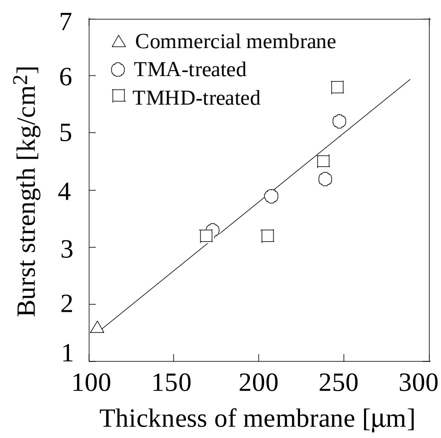

Fig.1 The relationship between the thickness and the burst strength of the synthesized membranes and commercial membrane

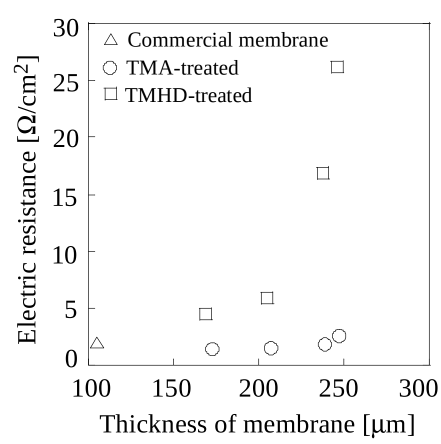

Fig.2 The relationship between the thickness and the electric resistance of the synthesized membranes and commercial membrane

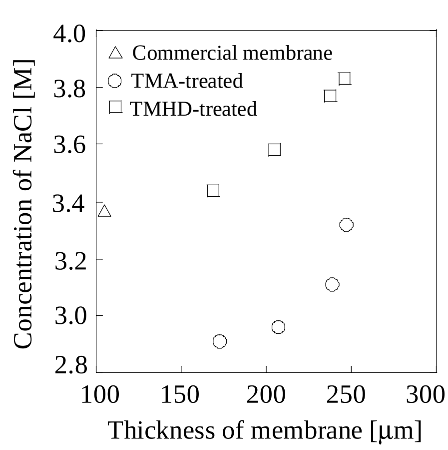

Fig.3 The relationship between the thickness of the membrane and the NaCl concentration of the concentrated solution