

Challenge of Organic Solvent Mixture Separation by Membrane in Membrane Center of Kobe University

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Abstract

Organic liquid mixture separations occupy an important position in many industries, such as the petroleum industry, biochemical production, and pharmaceutical manufacturing. Membrane separation is an economically favorable alternative to the well-established distillation process due to its substantially low energy requirements. In recent years, the majority of membranes developed for organic media are organic solvent nanofiltration (OSN) membranes, which cannot efficiently separate organic liquids with molecular weights lower than 100 Da. In contrast, organic solvent reverse osmosis (OSRO) membranes have great potential for the organic liquid separations.

We prepared a polyamide thin film composite (TFC) membrane from *m*-phenylenediamine (MPD) and trimesoyl chloride (TMC) for OSRO. This membrane showed very good performance in the separation of polar solvent and nonpolar solvent, where preferential permeation of polar solvent such as methanol was observed.

In addition, a hydrophobic fluorine-incorporated TFC membrane for OSRO was also prepared from 5-trifluoro-1,3-phenylenediamine (TFMPD) and TMC. In the pure solvent permeation test, this membrane was able to allow the permeation of nonpolar solvents, such as aliphatic and aromatic hydrocarbons, which could not permeate through the hydrophilic polyamide membranes prepared using *m*-phenylenediamine (MPD) as a diamine monomer. In addition, the OSRO test showed high performance in toluene mixed solvent systems with selective permeation of toluene and 93% rejection of triisopropylbenzene (TIPB). In conclusion, this study has successfully developed a hydrophobic fluorine-incorporated polyamide TFC membrane suitable for OSRO for separation of nonpolar solvents in mixture, providing new insights to the study of OSRO and its application for larger-scale demonstrations.

Another OSRO membrane was fabricated by spin coating a Teflon polymer, AF2400, onto a porous solvent-resistant polyketone support. AF2400 promotes the permeation of nonpolar liquids while inhibiting the transportation of polar liquids, resulting in the efficient separation of polar and nonpolar liquids. The separation performances in alcohol/alkane and alcohol/toluene mixtures were investigated and the results demonstrated that the molecular size and polarity of the liquids affected the selectivity.

OSRO performances of the prepared inorganic membrane (TiO₂-ZrO₂) are also introduced.

Hideto Matsuyama has more than 30 years of academic experiences in membrane-based separation science and technology for application targeted in water purification and gas separation. He obtained his PhD in Chemical Engineering from Kyoto University in 1990. After his early career research at the Kyoto Institute of Technology, he worked as an associate Professor at Okayama University. From 2004, he moved to Kobe University as full Professor and diversified his research areas in membrane preparation and application of MF, UF, NF, RO, FO and gas separation membranes. He tried to establish the first university-driven membrane center in Japan at Kobe University in 2007. He has so far published 11 books, more than 695 journal articles and owns 62 patents. The citation number is 20,477 and H-Index is 71 (Scopus).

