

## Preparation of ceramic reverse osmosis and nanofiltration membranes having thermal and chemical resistance and its application for ion separation

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### Summary

Nanofiltration and reverse osmosis membranes have separation ability to ions. Commercial RO/NF membranes are prepared by polymeric materials (mostly poly(amide)), and therefore, the thermal and chemical resistance is not enough for expanding application field. The purpose of the present study was aimed at preparing ceramic nanofiltration or reverse osmosis membranes and applying them to electrolyte separation in aqueous solutions. Titania has been chosen for membrane material.

Titania membranes were prepared by the sol-gel process using titanium tetra propoxide (TTIP). Titania colloidal solutions were prepared by hydrolyzing TTIP in isopropanol (IPA) solution with acid catalyst; the molar ration of starting solution was TTIP/ IPA/ H<sub>2</sub>O/ HCl = 1/ 140/ 4/ 0.4. Titania porous membranes were prepared by coating a microfiltration membranes with titania colloidal solutions have different particle diameters, and firing at 450 °C.

Molecular weigh cut-off curves of four membranes used in the present study were determined using saccharide of various molecular weights. The MWCO of M1, 2 and 3 were successfully controlled in a range from 500 to 1,000, which is in a range of nanofiltration membranes, while rejection of  $\alpha$ -cyclodextrin was almost zero. Electrolytes of various valence types (NaCl for 1-1 electrolyte, Na<sub>2</sub>SO<sub>4</sub> for 1-2 type, MgCl<sub>2</sub> for 2-1 type and MgSO<sub>4</sub> for 2-2 type) were nanofiltrated at a pressure of 0.2-1 MPa, at pH of 3-11, at a temperature of 25 °C. Electrolytes were rejected by M4 whose rejection of  $\alpha$ -cyclodextrin was almost zero. Therefore, titania membranes were found to reject electrolytes based on Donnan exclusion.

Rejections of electrolytes were dependent on pH of feed solutions, which reflected by zeta potential of titania. Rejections of electrolytes having divalent coions were high compared to those of monovalent coions. For example, at lower pH where titania is positively charged, MgCl<sub>2</sub> were more rejected than other type of electrolyte, while sodium sulfate was more rejected at higher pH. When counter ions were divalent ion, adsorption of counterions was suggested by rejection data as well as zeta potential measurement. It was also suggested that permeate volume flux was dependent on pH and types of electrolytes.