

## Effect of counterions on filtration performance of electrolyte solutions through nanoporous ceramic membranes

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### Summary

Inorganic membranes have excellent resistance to chemicals and organic solvents, and have been expected to be utilized to the separation fields where organic membranes cannot stand. Titania has superior stability in aqueous solution of alkali as well as acidic pH to other kinds of inorganic materials such as silica and zirconia. The purpose of the present study is to prepare titian porous membranes and evaluate the filtration performance of electrolyte solutions.

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.

Porous titania membranes having molecular weigh cut-offs (MWCO) of titania membranes of 250 (pore size: 0.8nm), 400 (1 nm), 500 (1 nm), 2000 (2 nm), and >1000 (3.5 nm), were successfully prepared. 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.

On the other hand, permeate volume flux shows an interesting dependency on pH, types of electrolytes, and pore size of titania membranes. At basic pH, where titania is negatively charged, permeate volume flux for electrolytes having divalent cations showed a decrease in comparison with those of electrolytes having monovalent cations. Moreover, this tendency is pronounced for membranes having small pore sizes.

Various types of electrolytes (1-1 type: KCl, NaCl, LiCl, (CH<sub>3</sub>)<sub>4</sub>NCl, (C<sub>2</sub>H<sub>5</sub>)<sub>4</sub>NCl, (C<sub>3</sub>H<sub>7</sub>)<sub>4</sub>NCl); 2-1 type: MgCl<sub>2</sub>, CaCl<sub>2</sub>) were filtrated through titania porous membranes having MWCO of 250. Volume fluxes of 1-2 type electrolytes were almost half of that of 1-1 type one at the same ionic size. Therefore, it was strongly suggested that for negatively charged porous membranes, divalent cations, which have relatively large Stoke radius, adsorbed on the surface and became a resistance of permeation of volume flux.