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Preparation of Titania Membranes with Controlled Surface Chemistry and Application to Nanofiltration at High Temperatures

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Summary

Nanofiltration membranes, which shows intermediate separation performances between reverse osmosis and ultrafiltration membranes, can separate ions according to the electrostatic interaction between ions and the surface charge. At present, commercially available NF membranes are polymeric membranes, and the stability needs to be improved to be used in various applications such as filtration at high temperatures. In the present study, nanoporous titania membranes, which have excellent chemical and thermal stability, were prepared by sol-gel processing, using titanium isopropoxide as Ti source and HNO₃ as acid catalyst, and the permeation performance of electrolyte solutions up to 70 °C were investigated.

TiO₂ colloidal diameters were controlled by adjusting HNO₃/TTIP molar ratio, showing the minimal diameter at HNO₃/TTIP molar ratio of 5.2. With an increase in firing temperature, pore sizes of TiO₂ membranes were increased. Nano-size tuning of pore sizes of titania membranes were possible in the range of 1-4 nm, based on colloidal diameters and firing temperature.

Nanopermporometry characterization of TiO₂ membranes using water vapor and hexane vapor, suggested that nanopores became hydrophobic with an increase in firing temperatures.

With an increase in temperature, volumetric water permeabilities of TiO₂ nanoporous membranes, L_p , as well as $L_p\mu$, water permeability multiplied by μ , water viscosity, increased, suggesting the permeation mechanism of water through nanoporous membranes is different from the viscous flow mechanism. On the other hand, rejection of electrolytes were found to be approximately constant, irrespective of permeation temperature, suggesting an advantageous operating condition at high temperatures.