Fabrication of PVDF multi-channel capillary membranes and their application in water treatment

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Multi-channel capillary membranes (MCM) exhibit considerable advantages over conventional membrane designs, such as higher packing density and mechanical strength, with comparable separation performance. Successful fabrication of MCM from the easy-to-handle polymer polyethersulfone (PES) has been reported over the last few years. However, there is still a lack of high performance polymers in MCM production, which would open up a wider range of applications.

We applied polyvinylidene fluoride (PVDF), a highly durable, thermally resistant, and hydrophobic polymer in preparation and characterization of MCM. These were fabricated from different polymer solutions under varied spinning conditions via a steam-dry-wet phase-inversion spinning process. A fractional factorial screening design has been used in order to evaluate the effect of the investigated parameters on permeability, rejection, and morphology of the fabricated membranes. Polymer solutions were prepared from PVDF as bulk polymer, polyvinylpyrrolidone (PVP) as co-polymer and *N,N*-dimethylacetamide (DMAc) as solvent. Studied parameters included concentration and molecular weight (M_w) of the bulk and co-polymer, as well as temperatures of the polymer solution and coagulation bath.

Resulting MCM showed ultrafiltration characteristics with a permeability up to 320 L m^{-2} h^{-1} bar^{-1} (PWF) and dextrane (M_w = 500 kDa) rejection up to 80 %. From the examined parameters, only copolymer M_w and PVDF concentration were statistically significant, i.e. an increase in polymer concentration and co-polymer M_w led to lower permeability and increased rejection. Additionally, the formation of finger-like marcovoids could be suppressed by borefluid modification, i.e. ethanol/DMAc addition. Burst pressures of up to 5 bar showed that PVDF MCM are approximately twice as stable as comparable single-channel PVDF membranes. Ongoing research envisages applying the optimized PVDF MCM in several water treatment disciplines, while taking advantage of the superior properties of PVDF, including oil-water separation, nanofiltration after surface modification, and down-stream processing in biotech applications.