Hollow fiber membrane production via the sustainable aqueous phase separation technique

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Abstract:

The recent sustainability drive in the membrane industry has steered the research towards finding greener alternatives for the production of polymeric membranes. One such approach is the Aqueous Phase Separation (APS) technique where polymeric membranes are prepared in a completely aqueous environment, thereby replacing the traditional organic solvents. The phase inversion in APS can be achieved via two routes: a) pH shift or b) salinity gradient, between the aqueous polymer solution and a non-solvent bath. Accumulated research on APS membranes has already demonstrated its versatility by producing flat sheet membranes having tunable morphologies and performances using both these routes. In this work, we take the APS approach one step further towards scalability by producing hollow fiber (HF) membranes in a dry-jet wet spinning process. Here, an aqueous dope solution along with a bore fluid are pushed through a single orifice spinneret into a coagulation bath. The solution precipitates and takes the shape of a hollow fiber in either a low pH acidic buffer, or just demineralized water depending upon the APS route. In case of pH shift, the pH and concentration of the acidic coagulation bath were varied to control the structure and morphology of the HF membranes. Using this route, membranes with water permeabilities in the range of 12–800 $L\cdot m^{-2}\cdot h^{-1}\cdot bar^{-1}$ were successfully obtained which showed excellent performance in micro-and ultrafiltration applications. On the other hand, the HF membranes obtained via salinity change induced APS showed swelling in water and could not be used for traditional water filtration applications. Instead, the membranes showed excellent stability in alcohol-based solvents like ethanol and propanol with permeabilities in the range of 20–200 $L\cdot m^{-2}\cdot h^{-1}\cdot bar^{-1}$. The presented research demonstrates that the APS technique is certainly a scalable and a sustainable alternative to the traditional NIPS method.

Keywords: aqueous phase separation; sustainable; polyelectrolyte complex; hollow fiber..