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Development of High Flux Ultrafiltration Polyphenylsulfone Membranes Applying the Systems with Upper and Lower Critical Solution Temperatures: Effect of Polyethylene Glycol Molecular Weight and Coagulation Bath Temperature

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Abstract

A novel phase inversion technique for preparation of high flux polyphenylsulfone (PPSU) ultrafiltration membranes employing the systems which feature upper critical solution temperature (UCST), gel point and lower critical solution temperature (LCST) is proposed. These systems include PPSU, polyethylene glycol (PEG) with molecular weight in the range of $6\div40\times10^3$ g·mol^{-1} and N-methyl-2-pyrrolidone (NMP) as a solvent. According to the triangular phase diagrams obtained, the polymer solutions consisting of 20 wt.% PPSU – 15 wt.% PEG ($M_w=6\div40\times10^3$ g·mol^{-1}) – NMP are revealed to be two-phase systems at T>100°C and gels at T<38-40°C. The developed technique involves PPSU solution processing at the temperature region between LCST and UCST (gel point). Meanwhile, the coagulation bath temperature has to be between UCST (gel point) and LCST. The effect of PEG molecular weight, casting solution composition and coagulation bath temperature on membrane structure, performance and hydrophilic-hydrophobic balance of the membrane selective layer was studied. Applying the proposed technique flat-sheet membranes with pure water flux of 486 L·m^{-2}h^{-1}·bar^{-1} and human serum albumin rejection of 90% were prepared which is the best performance for PPSU ultrafiltration membranes reported up-to-date. It was found that introduction of PEG ($M_w=6\div40\times10^3$g·mol^{-1}) into the casting solution results in the efficient membrane hydrophilization, which is confirmed by FTIR spectroscopy of the membrane selective layer.