Valerolactone (GVL) as a green polar aprotic solvent for polyvinylidene fluoride (PVDF) membranes preparation

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Membrane technology can be considered a green separation process according to Process Intensification (PI) Strategy [1]. However, the membranes' manufacturing via the traditional phase inversion still requires the use of toxic solvents, as N-methyl-2-pyrrolidone (NMP), N,Ndimethylacetamide (DMA) or N,Ndimethylformamide (DMF), and fossil-based polymers . For this reason, in this work, γ-Valerolactone (GVL) was chosen as an innovative renewable green solvent for the preparation of polyvinylidene fluoride (PVDF) membranes. GVL is a biodegradable, non-toxic chemical obtained from biomass. Membranes were prepared by coupling vapor induced phase separation (VIPS) and non-solvent induced phase separation (NIPS) techniques using polyvinylpyrrolidone (PVP) and polyethylene glycol (PEG) as pore forming agents. The structure of the membranes was tailored by acting on the exposure time to humidity during VIPS process (from 0 to 5 min) and by varying the water coagulation bath composition during NIPS process (water and water/isopropanol). The thermodynamic aspects (i.e. solubility parameters and polymer-solvent distance) and kinetic parameter in term of viscosity were well studied. The effect of selected solvent on the morphology and performance of prepared membranes was investigated. It was possible, indeed, to produce membranes with a finger-like and a spherulitic structure or characterised by macrovoids when water/isopropanol was used as a coagulation bath. The membranes presented a pore size in the range of ultrafiltration (UF) and microfiltration (MF), from 0.04 to 0.84 µm and good water permeability making them ideal to be applied in water filtration processes.

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References
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