Toward a sustainable membrane fabrication by electrospinning

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According to the Process Intensification (PI) strategy, membrane science is widely recognized as a green and friendly technology. However, the membranes' manufacturing still requires the use of toxic solvents such as N-methyl-2-pyrrolidone (NMP), N,N-dimethylacetamide (DMA) or N,N-dimethylformamide (DMF). The use of green solvents as substitutes for traditional solvents is the unavoidable trend of the future in phase inversion processes and electrospinning technique. In this regard, during the last years, a new class of solvents, with more benign properties, have been introduced and are now being used in the preparation of more sustainable membranes. Among them, Cyrene^{TM} is a bioderived-green solvent that was used, for the first time, for the preparation of polyether sulfone (PES) and polyvinyl difluoride (PVDF) flat-sheet membranes allowing their production with a microporous morphology and tunable structure. The use of green solvents, such as Cyrene^{TM} and/or dimethyl sulfoxide (DMSO), is also receiving increasing interest for the preparation nanofiber-based membranes produced by electrospinning technique for possible application in water treatment and purification. In this work, DMSO was found to be the best candidate for dissolving PVDF and producing uniform nanofiber membranes with homogenous distribution at room temperature. Their properties are comparable with the analogous nanofibers produced with DMF solvent. The pore size of prepared membranes was in the microfiltration (MF) range (0.2-0.8 µm) suggesting a potential application in water treatment applications. In the second of the work, in order to overcome the low productivity of traditional needle electrospinning, a needleless electrospinning machine, commercialized as Nanospider^{TM} (Elmarco, Czech Republic), was used to produce nanofiber membranes. Different attempts were carried out in order to study the electro-spinnability of polymeric solutions prepared using polyethersulfone (PES) as polymer which were solubilized in Cyrene^{TM} as a green solvent. The optimal nanofibers operating conditions were determined, starting with 12wt% of PES and by varying different voltage and different height of the wire from flat collector (35-75 kV). Moreover, the solution conductivity was enhanced by salts and the nanofiber membranes were produced with a wide range of pore size (from 0.8 to 0.4 µm).

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