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A non-invasive optical method for mapping temperature polarization in direct contact membrane distillation

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Abstract

Membrane Distillation (MD) is a thermal membrane process allowing for a theoretical 100% rejection of non-volatile compounds (i.e. ions, macromolecules, colloids, cells), whereas vapour molecules permeate through a micro-porous hydrophobic membrane due to a difference of vapour pressure established across the membrane-self. The effective driving force and, then, the vapour trans-membrane flux is affected by temperature polarization phenomena occurring in the boundary layers adjacent to the membrane. The temperature values at the membrane surface are usually difficult to measure and only recently some invasive techniques were adopted for this scope.

The aim of this work was to introduce luminescent molecular probing as an innovative technology for non-invasive and in-situ monitoring of thermal polarization in MD. Tris(phenantroline)ruthenium(II) chloride ($Ru(phen)_3$) was selected as temperature sensitive luminescent probe and immobilized in a flat poly(vinylidene fluoride) electrospun nanofibrous membrane (PVDF ENM). Experiments showed the key role of the $Ru(phen)_3$ and Lithium Chloride (LiCl) in the preparation of homogeneous PVDF ENM due to their ionic nature that improved the electrical conductivity of the polymeric solution favouring the electrospinning. Furthermore, PVDF ENM showed a good performance in Direct Contact Membrane Distillation (DCMD) process. The immobilization of the molecular probe allowed to optically monitoring the membrane surface

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