Desalination and Water Treatment
www.deswater.com
doi: 10.5004/dwt.2019.23746

152 (2019) 197–207
June

Modification of SiO_2 by n-dodecyltrimethoxysilane and preparation of SiO_2-filled regenerated cellulose nanocomposite membranes for dehydration of caprolactam by pervaporation

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Received 9 July 208; Accepted 2 January 2019

ABSTRACT

Novel organic–inorganic nanocomposite pervaporation membranes were prepared by the incorporation of the unmodified and modified SiO_2 nanoparticles with a silane coupling agent (WD10, $C_{12}H_{25}Si(OCH_3)_3$) into regenerated cellulose (RC) membranes. The WD10-modified SiO_2 particles were characterized by FTIR. The chemical and physical properties of the membranes were characterized by attenuated total reflection-Fourier transform infrared, AFM, scanning electron microscopy, thermogravimetric analysis, XRD and degree of swelling measurements. Furthermore, the effects of nano-SiO_2, WD10-modified SiO_2, WD10, feed temperature and feed concentration on the pervaporation performances were investigated for caprolactam dehydration by pervaporation. Among all the prepared membranes, RC-SiO_2 (5%)-WD10 nanocomposite membrane exhibited excellent pervaporation (PV) properties with a flux of 611.3 g m^{-2} h^{-1} and separation factor of 95,404.8 at 333 K, for 70 wt.% caprolactam. Diffusion coefficient of water and caprolactam molecules was analyzed by Fick's equation. The results show that the diffusion plays a dominant role in the transport of binary liquid molecules in PV process. The membranes developed in the present study have the ability for the separation of caprolactam–water mixture.

Keywords: Regenerated cellulose; Pervaporation; SiO_2; WD10; Caprolactam–water

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