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PII: S0376-7388(17)32925-3
DOI: https://doi.org/10.1016/j.memsci.2018.02.021
Reference: MEMSCI15945

To appear in: *Journal of Membrane Science*

Received date: 12 October 2017
Revised date: 7 February 2018
Accepted date: 10 February 2018

Cite this article as: Liang Liu and Sandra E. Kentish, Pervaporation performance of crosslinked PVA membranes in the vicinity of the glass transition temperature, *Journal of Membrane Science,* https://doi.org/10.1016/j.memsci.2018.02.021

Pervaporation performance of crosslinked PVA membranes in the vicinity of the glass transition temperature

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Abstract

This work investigates the pervaporation performance of crosslinked poly (vinyl alcohol) PVA membranes for ethanol dehydration near the glass transition. The solubility of water and ethanol mixture in the membranes was measured as a function of feed composition and sorption temperature, and the data was modelled by perturbed-chain statistical associating fluid theory (PC-SAFT). Importantly, this approach allows the solubility of the two components to be determined individually. Model results show that the heat of sorption of water and ethanol was constant across the temperature range. Water permeance generally decreased when operational temperature increased, indicating a solubility-controlled transport behavior. The permeance also increased when water feed concentration increased. Activation energy analysis provided more insights about the influence of membrane properties on the mass transport mechanism. At 90 wt% ethanol feed composition, the apparent activation energy (E_a) for water permeation changed from 9.6 kJ mol^{-1} when temperature was <70 °C to -9.1 kJ mol^{-1} when temperature was >80 °C. When the feed composition decreased to 80 wt% ethanol, a transition was observed at a lower temperature range (60-65 °C). These changes were related to changes in the activation energy of diffusion, given the heat of sorption was constant. The permeability of ethanol was lower due to its larger molecular size, but a similar transition was observed for the 80 wt% ethanol case.

Keywords: Poly (vinyl alcohol); mixture sorption; PC-SAFT; glass transition.