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www.elsevier.com/locate/memsci

PII: S0376-7388(17)32360-8
DOI: https://doi.org/10.1016/j.memsci.2018.01.018
Reference: MEMSCI15872

To appear in: *Journal of Membrane Science*

Received date: 17 August 2017
Revised date: 7 January 2018
Accepted date: 10 January 2018

Cite this article as: Huanhuan Wu, Fei Shen, Junfeng Wang and Yinhua Wan, Membrane fouling in vacuum membrane distillation for ionic liquid recycling: Interaction energy analysis with the XDLVO approach, *Journal of Membrane Science,* https://doi.org/10.1016/j.memsci.2018.01.018

Membrane fouling in vacuum membrane distillation for ionic liquid recycling: Interaction energy analysis with the XDLVO approach

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Abstract

Membrane fouling, essentially originated from the interactions between foulant and membrane surface, is a big obstacle to use membrane distillation (MD) for ionic liquid recycling from its aqueous solution. By applying the extended Derjaguin-Landau-Verwey-Overbeek (XDLVO) approach and surface element integration method, this study mainly investigated the fouling behavior of three kinds of hydrophobic membranes during the vacuum MD (VMD) separation of 1-butyl-3-methylimidazolium chloride ([Bmim]Cl) solutions. Effects of membrane surface chemical properties (e.g. elemental composition and zeta potential), membrane surface morphology (e.g. roughness), and [Bmim]Cl concentration on the interaction energy between [Bmim]Cl and membrane surface were studied. The results showed that the Lifshitz-van der Waals (LW) and electrostatic interaction (EL) components were positive (repulsion), while the acid-base (AB) interaction component was negative (attraction). Roughening membrane surface significantly decreased the interaction energy barrier, indicating a greater risk of being fouled. Even so, membrane surface chemical properties had more important impact on membrane fouling than surface morphology. Energy barrier would be also reduced when [Bmim]Cl concentration increased, signifying a severer membrane fouling potential in a concentration process. These results were expected to help to understand ILs-fouling mechanism in VMD process and guide the selection and fabrication of promising membrane for ILs recovery.