Prediction of Water Flux Using Excel for Different Modification Methods in Forward Osmosis Membrane Fabrication

Tang Pui Mun[1,a)] and Mazrul Nizam bin Abu Seman [1,2,b)]

[1]*Faculty of Chemical and Process Engineering Technology, University Malaysia Pahang, Persiaran Tun Khalil Yaakob, 26300 Gambang, Kuantan, Pahang, Malaysia.*
[2]*Earth Resources and Sustainability (ERAS) Center, University Malaysia Pahang, Persiaran Tun Khalil Yaakob, 26300 Gambang, Kuantan, Pahang, Malaysia.*

[a)] First author: *esthertang97@gmail.com*
[b)] Corresponding author: *mazrul@ump.edu.my*

Abstract Recently, forward osmosis (FO) is developed rapidly and widely used in many applications such as water treatment and food processing. This research is aim to predict and compare the water flux (J_w) of modified membranes by different modification methods which are interfacial polymerization (IP), layer by layer (LbL) and UltraViolet-photografting (UVP) by a suitable model at vary osmotic pressure of draw solution. Predicted water flux of modified membranes under a different range of osmotic pressure (π_D) of draw solution were generated by Microsoft Excel from the water flux model with the consideration effects of internal concentration polarization (ICP) which expressed by reverse salt diffusion (RSD). The predicted J_w of each membrane was analyzed and compared. Overall, the predicted J_w increases with the π_D. The membranes modified by interfacial polymerization shows the good predicted J_w among the modification methods with IP 1 ranges from 13.07 LMH to 23.35 LMH while IP2 ranges from 24.90 LMH to 25.02 LMH. LbL 2 has the highest predicted J_w among the modified membranes at 44.34 LMH. In conclusion, the theoretical water flux model is capable to predict the water flux of modified membranes. Optimum modification parameters of membrane can be determined from the predicted water flux generated by the model.

INTRODUCTION

Nowadays, freshwater scarcity has become one of the most challenging problems globally. Rapidly growth of world population and industrialization have created high demand of fresh water. Forward osmosis (FO) process has become the emerging technology for the desalination of seawater, and water treatment. The working principle of forward osmosis is based on concentration-dilution concept. The higher osmotic pressure of the draw solution than the feed solution creates a driving force to draw water from the feed solution to permeate across the semi-permeable membrane while the solutes in the feed water is rejected by the semi-permeable membrane. Therefore, this provides the benefits for the FO process as compared to conventional technology which are reverse osmosis (RO) and thermal evaporation. FO process requires low energy for the transportation of water and have higher water recovery. In addition to that, FO process has lower membrane fouling potential, and the fouling is almost reversible due to the absence of compression as compared to pressure driven process [1].

However, FO process still have several technical challenges need to overcome for the maximum performance of the forward osmosis process. One of the drawbacks for FO process is the lower water flux. This is affected by key components of FO which are the effective driving force as well as the structure of FO membrane. The effective driving force is affected by the osmotic pressure of draw solution. The osmotic pressure of the draw solution must sufficiently be higher than the feed solution to create greater osmotic pressure difference and results to the greater osmotic driving force for the water to permeate across the membrane. Next, the concentration polarization (CP) that take place during

2nd Process Systems Engineering and Safety (ProSES) Symposium 2021
AIP Conf. Proc. 2792, 040006-1–040006-10; https://doi.org/10.1063/5.0148962
Published by AIP Publishing. 978-0-7354-4640-3/$30.00