EFFECT OF SURFACTANTS ON THE LONG-TERM PROCESS STABILITY OF OMNIPHOBIC MEMBRANE DURING THE PROCESS OF MEMBRANE-DISTILLATION

Yair Kaufman, Ben Gurion University of the Negev, ZIWR
Yairkau@post.bgu.ac.il

Key Words: Membrane-Distillation, Omniphobicity, Re-entrants, Surface-Wetting.

Membrane-distillation of liquids that exhibit low surface tension, such as aqueous solutions with surfactants (e.g., industrial wastewater) is challenging. The low surface tension facilitates the liquid penetration into the membrane pores, which ultimately diminishes the membrane-distillation process.

To overcome this challenge, membranes with re-entrant pores – pores that open-up below the surface – were tested by other authors\(^1,2\). Re-entrant pores render the membrane surface omniphobic, i.e., the macroscopic contact angles of water and organic solvents in atmospheric conditions are larger than 90°. It has been demonstrated that omniphobic membranes with re-entrant pores allow the process of membrane-distillation of aqueous solution with surfactants for at least 480 minutes\(^1\).

However, two different mechanisms can diminish the process of membrane-distillation in the long term (hours-days) even while using omniphobic membranes; (1) surfactants in the ‘feed’ compartment are expected to adsorb on to the membrane surface, which would reduce the intrinsic contact angle of the membrane. The reduced intrinsic contact angle can then allow the ‘feed’ to contact the ‘permeate’ compartment, which consequently can diminish the distillation process. Furthermore, (2) liquid condensation in the membrane pores can bridge the ‘feed’ and the ‘permeate’ compartments and diminish the distillation process as well.

Recently, we have derived a theoretical model that allows for predicting whether liquid can fill a pore by liquid-penetration or by condensation. In additions, the model allows for engineering geometries that can prevent the spontaneous penetration and condensation of any liquid, including liquids with low surface tension, e.g., ethanol. Our model accounts for the intrinsic contact angle of the membrane material and the pore geometry, which can be with or without re-entrants.

During the talk, the theoretical model will be presented and supported by experimental results. Then, the model will be used to explain the effects of surfactants on the long term stability of membrane-distillation processes. Lastly, we will present a pore geometry that is expected to prolong the process of membrane-distillation even in the presence of surfactants.

References