Efficient and low-energy microalgae harvesting is essential for sustainable biofuel production. Forward osmosis (FO) can provide a potential alternative for algae separation with low energy consumption by using osmotic pressure. In this study, an aquaporin-based polyethersulfone (PES) membrane was evaluated for algae dewatering using FO with three different types of draw solutions (DSs: NaCl, KCl and NH4Cl), and under different cross flow velocities (CFVs). 81% of algae dewatering was achieved with a 29% flux drop. Among three different DSs, although NH4Cl was the best candidate for improved water flux and low reverse salt flux (RSF), it could accelerate cell division, reducing settleability during the FO process. However, RSF originated from NaCl could increase lipid content (~49%) in algal biomass probably due to the osmotic imbalance in algal cells.

During FO operations, membrane fouling would be an inherent problem against sustainable algae dewatering. In this study, a novel approach was investigated by coupling the FO with an electric field for developing repulsion forces that can prolong the filtration cycle and mitigate foulant attachment. Several electric fields (0.33, 0.13 and 0.03 V mm⁻¹) were applied in continuous and pulsing modes (10sec intervals) to mitigate membrane fouling for effective algae dewatering. The electric field FO configuration used in this study was able to produce 3.8, 2.2 and 2.2 times greater flux at the applied potential of −1.0, −0.4, and −0.1V, respectively, compared to the control (without an electric field). A high potential of −10V for 60 sec was applied as an optimal cleaning procedure with a high ability to recover flux (99%). The study also investigated the effect of the electric fields on bulk pH, conductivity, settling velocity, lipid content and microalgal morphology. Overall, this study demonstrates a novel technology for algae dewatering in FO application using the aquaporin-based PES membrane.

Major: Environmental Engineering

Educational Career:
Bachelor's of Civil Engineering, BS, 2006, Umm Al-Qura University
Master's of Environmental Engineering, MS, 2009, University of New South Wales

Committee in Charge:
Woo Hyoung Lee, Chair, Civil, Environmental, and Construction Engineering
Steven Duranceau, Civil, Environmental, and Construction Engineering
Karin Chumbimuni-Torres, Chemical Department
Anwar Sadmani, Civil, Environmental, and Construction Engineering

Approved for distribution by Woo Hyoung Lee, Committee Chair, on February 28, 2019.

The public is welcome to attend.