Assessing Algae-based Desalination Technologies Using WaterVal National Validation Framework

Naveen Arukgoda[a], Li Gao[b], Arash Zamyadi[a,c]*

[a] Chemical Engineering, Faculty of Engineering and Information Technology, The University of Melbourne, Melbourne, Victoria, Australia

[b] South East Water Corporation, Melbourne, Victoria, Australia

[c] Water Research Australia, Melbourne, Victoria, Australia

*Corresponding author: arash.zamyadi@unimelb.edu.au / arash.zamyadi@waterra.com.au, +61-437731414

Abstract:

Algae-based desalination is a promising solution to challenges involved with RO-based desalination processes like high energy requirements, low water recovery rates and production of noxious by-products such as brine. Biological desalination systems rely on the salt removal mechanisms of living organisms. Microalgae utilize both biosorption and bioaccumulation to extract salts from saline solutions. Unlike preceding technologies, these processes are energy-passive and organic. This method also provides the potential to lower CO_2 emissions during the growth stage of the algae. In addition, biomass resource recovery can be used to produce biodiesel and biogas as well as biofertilizers. Algae-based desalination can either be used as a multi-stage system or more feasibly, in conjunction with RO systems as a pre-treatment step.

The main objective of this study is to evaluate a more sustainable desalination approach. Algae-based desalination technology was assessed under the nine steps of the WaterVal national validation framework for its reliability and reproducibility in providing novel water treatment. The WaterVal validation framework maintains consistency throughout the protocol structure and ensures the validity of any reproducible results. Following a comprehensive literature review, vital information regarding salt removal mechanisms, strain selection, and influencing factors was obtained. A hybrid system, where algae-desal is used as pre-treatment for reverse osmosis desalination, was deemed the most feasible economically. For the same pre-cultivation and monitoring procedures, two algae-desal systems (bubble column photobioreactor and high rate algal pond) are compared for their unique operating methodology. Subsequent harvesting of the algal biomass is explored using a combination of chemo-magnetic flocculation and microfiltration to achieve optimal removal efficiencies. Easier lipid extraction for biodiesel production was also facilitated. Ultimately, certain membrane fouling indices such as the silt density index and modified fouling index were employed to evaluate the compatibility of algae-desal as pre-treatment for RO desalination systems.

Keywords: Algae-based desalination, enhanced membrane performance, WaterVal framework, technology validation