Potable-quality water recovery from primary effluent through a coupled algal-osmosis membrane system

Wenbin Jiang, Lu Lin, S.M. Henkanatte Gedara, Xuesong Xu, Nagamany Nirmalakhandan, Pei Xu

Department of Civil Engineering, New Mexico State University, 3035 S Espina Street, Las Cruces, NM, 88003, USA
(575)646-5870 Emails: wbjiang@nmsu.edu, lulin@nmsu.edu, shanka84@nmsu.edu, xuesong@nmsu.edu, nkhandan@nmsu.edu, pxu@nmsu.edu

A coupled algal-osmosis membrane treatment system was studied for recovering potable-quality water from municipal primary effluent. The core components of the system included a mixotrophic algal process for removal of biochemical oxygen demand (BOD) and nutrients, followed by a hybrid forward osmosis (FO)-reverse osmosis (RO) system for separation of biomass from the algal effluent and production of potable-quality water.

Pilot-scale experiments demonstrated consistent performance of the algal system to meet surface discharge standards for BOD and nutrients within a fed-batch processing time of 2-3 days. The hybrid bench-scale FO-RO system reached water productivity of 1.57 L/m^2-h in FO using synthetical seawater as draw solution; and permeate flux of 3.50 L/m^2-h in brackish water RO (BWRO) and 2.07 L/m^2-h in seawater RO (FILMTEC SW30 4040) at approximately 300 psi. Water flux in the pilot-scale FO-RO system increased with the increase of the FO flowrate, with an average of 10 L/m^2-h and permeate flux of 23.5-30 L/m^2-h using FILMTEC SW30 2540 at approximately 600 psi.

The coupled algal-membrane system achieved complete removal of ammonia, fluoride, and phosphate; over 90% removal of calcium, sulfate, and organic carbon; and 86-89% removal of potassium and magnesium. Broadband characterization using high resolution mass spectrometry revealed extensive removal of organic compounds, particularly wastewater surfactants upon algal treatment. This study demonstrated feasibility of long-term performance of the FO-RO system to recover potable-quality water from primary effluent.