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An experimental system for characterization of membrane fouling of solar photovoltaic reverse osmosis systems under intermittent operation

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ABSTRACT

Many remote communities struggle to provide a reliable source of clean drinking water. Solar photovoltaic reverse osmosis (PVRO) systems are a stand-alone water purification technology that can help alleviate this need. A challenge associated with these systems is the variation in the available energy, and as a result, the systems are typically designed to operate intermittently which can cause premature membrane fouling. During the design of PVRO systems, basic approximations are typically used to evaluate the performance and economic impact of this membrane fouling caused by intermittent operation. However, this fouling has not been characterized experimentally. This paper describes an experimental lab-scale reverse osmosis system which was developed to study the effects on membrane fouling of this intermittency. The system consists of three stainless steel cross-flow reverse osmosis membrane cells connected in parallel, equipped with automated valves and pumps to evaluate different pre-treatment options, and instrumented to characterize the operating parameters and membrane fouling. This system was used to preliminarily characterize membrane fouling for intermittent operation common of PVRO systems. Two reverse osmosis operating modes were studied, continuous operation (24 h/d) and intermittent operation (8 h/d). During these experiments, it was shown for surrogate brackish water with minimal biological content, there was not a significant change in membrane fouling due to intermittent operation. This experimental system will be applied in future experiments to further evaluate membrane fouling under other operational conditions typical in PVRO systems and extracted models will be used in modular design methods for custom PVRO systems that are robust to variability in operating conditions.

Keywords: Desalination; Reverse osmosis; Brackish water; Photovoltaics; Modular design; Small-scale reverse osmosis water purification

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