Mitigation of Scaling and Fouling in Membrane Distillation Process for Industrial Water Treatment and Reuse

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Membrane Distillation (MD) is a promising technology that can treat water with very high Total Dissolved Solids (TDS) that are commonly encountered in industrial processes, such as oil and gas production. The high TDS levels in concentrated brines (often 8 times higher than that of seawater) make the current state-of-the art approaches to water treatment untenable. MD has an advantage over thermal evaporator in that the materials of construction do not have to be exotic alloys. Like other membrane processes, MD can suffer from scaling and fouling of the membrane surface which can increase the energy requirement for water production. Our approach addresses the two major challenges associated with these waters: 1) the membrane distillation process removes the high TDS content and produces high quality effluent suitable for beneficial reuse, and 2) the charged CNT membrane coating prevents the formation of scale that would otherwise pose a significant operational hurdle.

This study examined the potential of using carbon nanotubes (CNT) as a method of mitigating scaling and biofouling in Membrane Distillation (MD) process. The membrane surface is made electrically conductive and a counter electrode is used to provide the conductive layer for the polarity. Our experimental results showed that such charge induced by electrically conductive surface can extend the operation by at least three fold duration, compared to normal hydrophobic surface (Figure 1). In the bench scale testing and modeling, it was demonstrated that the nucleation zone where scaling occurs is pushed away from the membrane surface via electrostatic repulsion, and the result is that the membrane was able to operate without cleaning for a longer period.

With funding from the U.S. Department of Energy, RTI, in collaboration with industrial partner Veolia, has developed a lab-scale ECMD process. In this presentation, we will discuss this new class of advanced, electrically conductive membranes that will mitigate the fouling issues that occur during water treatment of high concentration brines; thus paving the way for expanded water reuse and discharge options beyond what is currently feasible. The efficacy of the ECMD approach will be demonstrated on the bench scale by treating both synthetic and actual high TDS wastewaters that have high scaling potential.

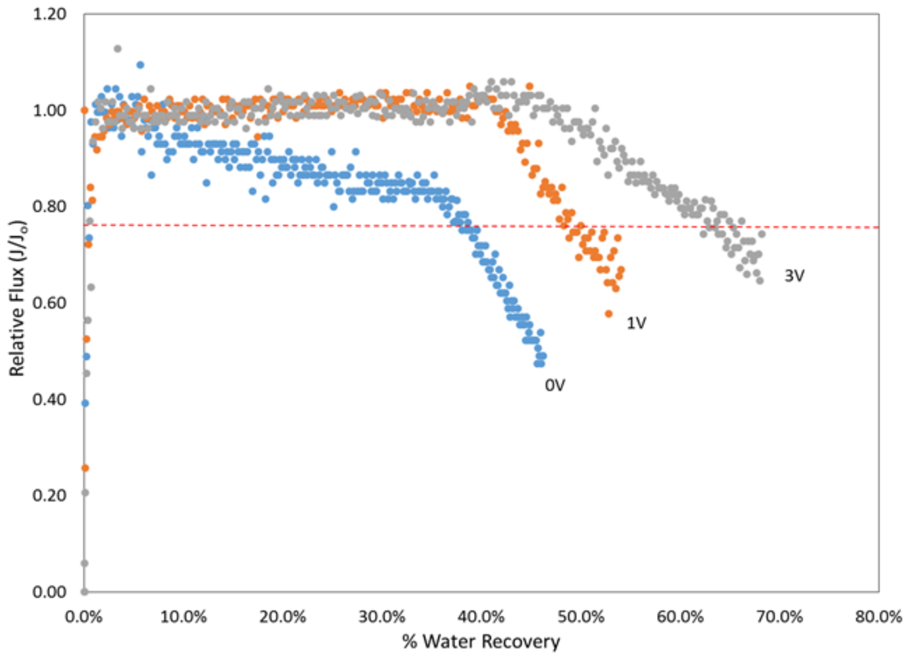

Figure 1. Relative flux as function of time for both MD (0V) and ECMD (1V and 3V membrane as cathode) treatment of $CaSO_4$ scaling solution. Feed temperature inlet = 60^oC, permeate temperature inlet = 20^oC. Average salt rejection for the test was 99.99%.