Assessment of Hydropath Technology for Membrane Fouling and Scaling Control During Brackish Groundwater Desalination

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Introduction

With the diminishing water resources and increasing water demands, treatment of alternative waters such as seawater, brackish water, and reclaimed water present a promising solution to augment water supplies. Among the existing technologies, membrane desalination processes have been widely used in treating alternative waters, especially reverse osmosis (RO), which is a core process because of its ability to reject most dissolved constituents. Despite pretreatment and advances in membrane technologies, membrane fouling and scaling continue to be the key impediment for successful application of membrane processes due to declined permeate flux, increased operational cost, and shortened membrane life.

Membrane scaling is generally controlled by pH adjustment, addition of antiscalant, or extensive pretreatment. The Hydropath technology is an innovative method for water conditioning, which induces an electric signal of ±150kHz in the liquid inside of a pipe on which it is installed. A specialized transducer connected to a ring of ferrites performs the electric induction. The HydroFLOW devices, which are powered by Hydropath Technology, could potentially provide a chemical-free alternative to control membrane fouling and scaling by inhibiting the formation of a compact scaling layer.

The goal of the study was to determine if the HydroFLOW devices could reduce membrane scaling during desalination of a brackish groundwater at the Brackish Groundwater National Desalination Research Facility (BGNDRF), Alamogordo, New Mexico. The impact of HydroFLOW on RO performance was evaluated using a pilot-scale RO skid with and without the installation of HydroFLOW models S38 and HS48.

Experiment

Figure 1. Pilot-scale RO skid using three BW30 4040 elements in 1:1:1 array (BGNDRF, Alamogordo, NM)

Water quality	Well 2
Total dissolved solids (TDS, mg/L)	5,470
Conductivity (μS/cm)	6,200
pH	7.31
Total Alkalinity (as mg/L CaCO3)	243
Sodium adsorption ratio (SAR)	5.69
Calcium (mg/L)	474
Magnesium (mg/L)	326
Potassium (mg/L)	2.22
Sodium (mg/L)	660
Chloride (mg/L)	534
Sulfate (mg/L)	3,250

Table 1. Brackish groundwater quality used in the pilot testing

Phase 1 Experiment: HydroFLOW units were installed after permeate flux declined by 30%.

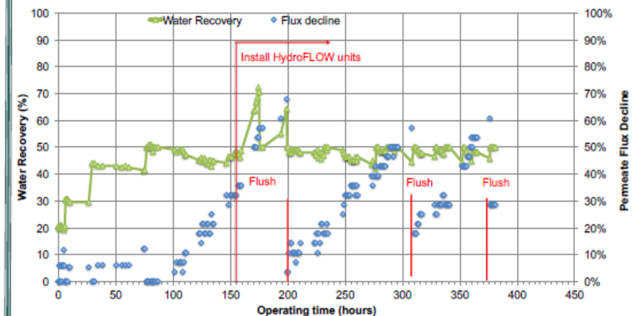

Figure 2. Water recovery and permeate flux decline during Phase 1 experiment

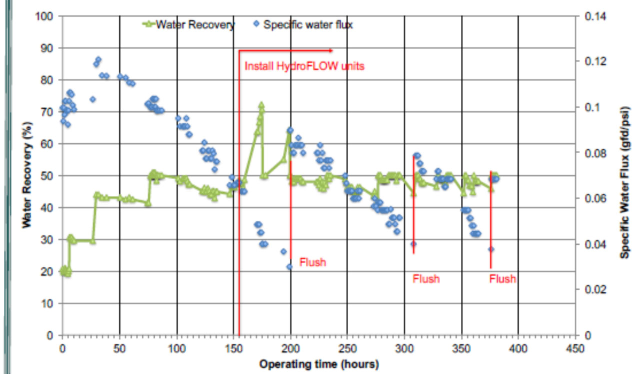

Figure 3. Water recovery and specific water flux during Phase 1 experiment

Phase 2 Experiment: HydroFLOW units were installed at the beginning.

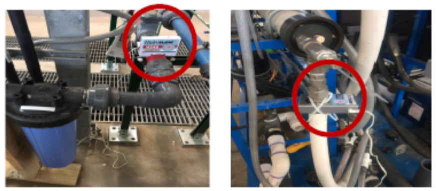

Figure 4: Locations of the HydroFLOW units installed on the RO skid – before cartridge filter (HS48) and in the RO feed inlet (S38)

Contacts

- This poster was presented at the 10th Anniversary of Brackish Groundwater National Desalination Research Facility (BGNDRF), September 12-13, 2017, Alamogordo, NM
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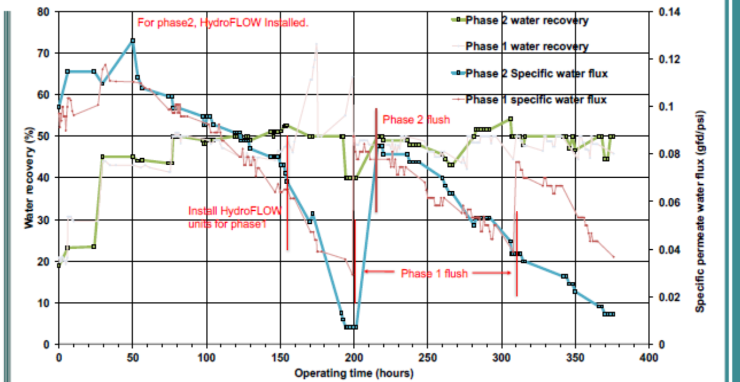

Figure 5. Comparison of specific water flux from Phase 1 and Phase 2 testing

Data Analysis

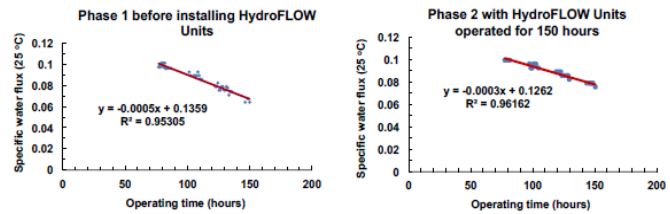

Figure 6. Specific water flux for Phase 1 and Phase 2, from water recovery reaches 50% to 150 hours operation time

- Slope value from Figure 6 (| k | value) is the performance decreasing rate for the membrane. Large |k | means membrane's performance is decreasing fast.

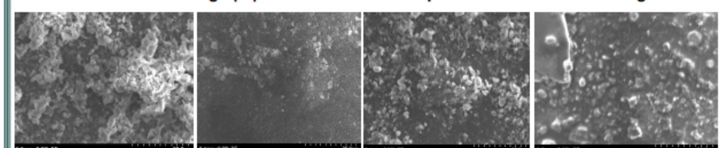

Figure 7. Scanning electron micrographs of membranes at the end of the testing. From left to right: Phase 1 lead (1st) and end (3rd) elements; Phase 2 lead (1st) and end (3rd) elements

Conclusion

- Comparing the first 150 hours of RO operation in Phase 1 and 2, |k | for Phase 2 decreased by 40%, which means the HydroFLOW devices reduced initial membrane scaling by 40%. However, the permeate flux declined continuously despite the installation of HydyoFLOW.
- Water flush can recover RO membrane performance to a certain extent by removing the foulants accumulated on membrane surface and flow channels.
- Permeate water quality was not affected by the HydroFLOW devices.
- Membrane autopsy results showed the fouling in the 1st element of Phase 2 is less compact than in Phase 1. But there was no difference in the end elements. The scalants were identified primarily silica, calcium and magnesium sulfate.
- This study demonstrated the Hydropath is a promising technology to minimize membrane fouling. Further experiments are needed to evaluate HydroFLOW units for other types of water, at different water recovery, with addition of acids and antiscalants, and the effectiveness and duration of hydraulic flushing.