Fouling Prevention by Electrically Charged Thin Film Composite Forward Osmotic Membranes

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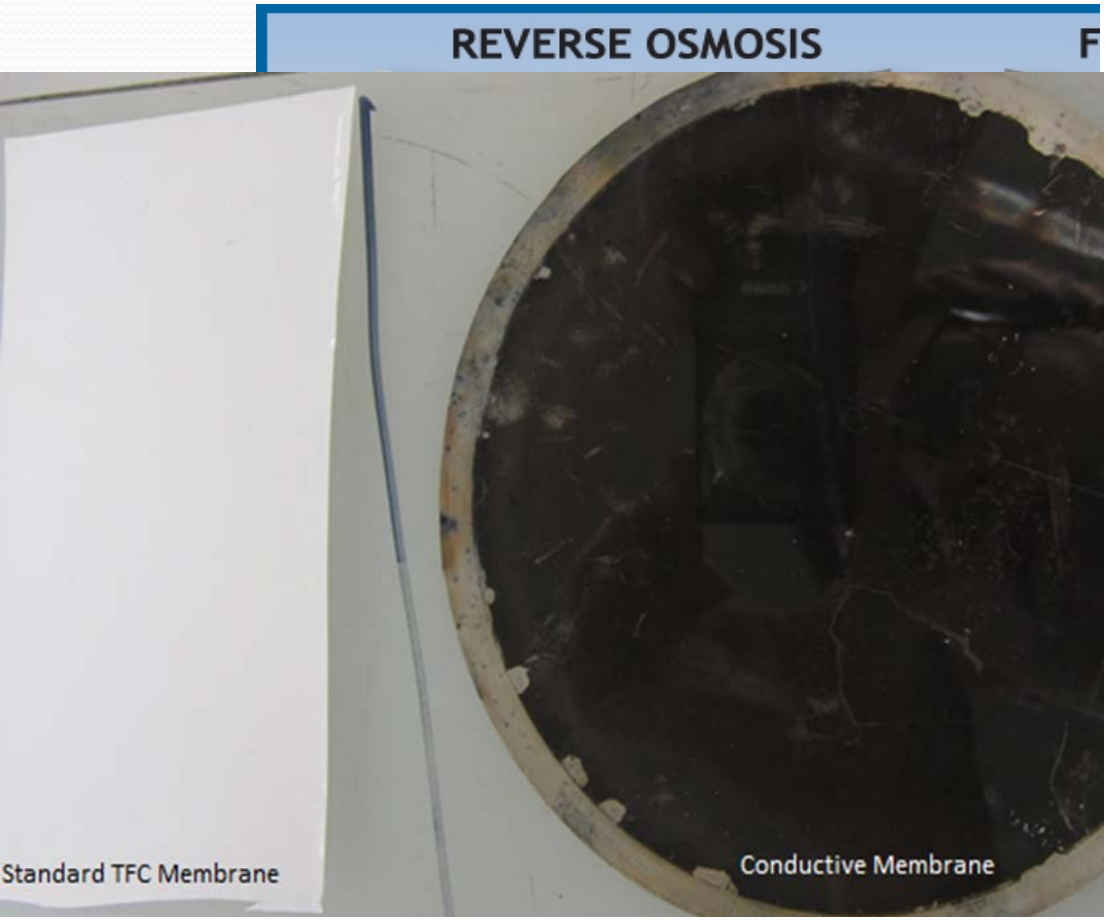
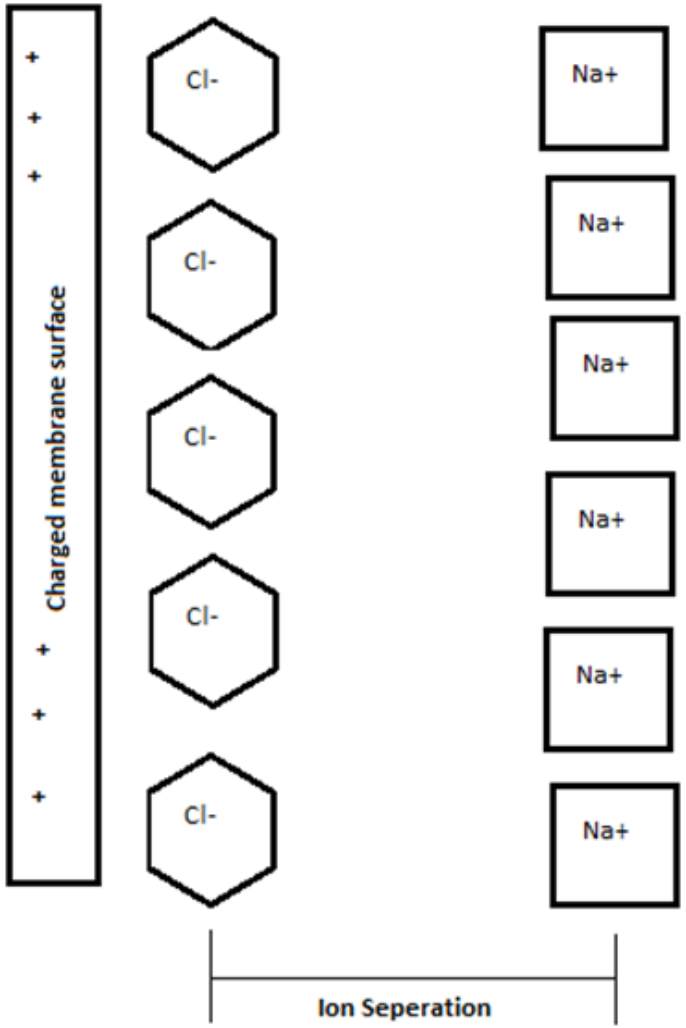
In Partnership with:

Outline

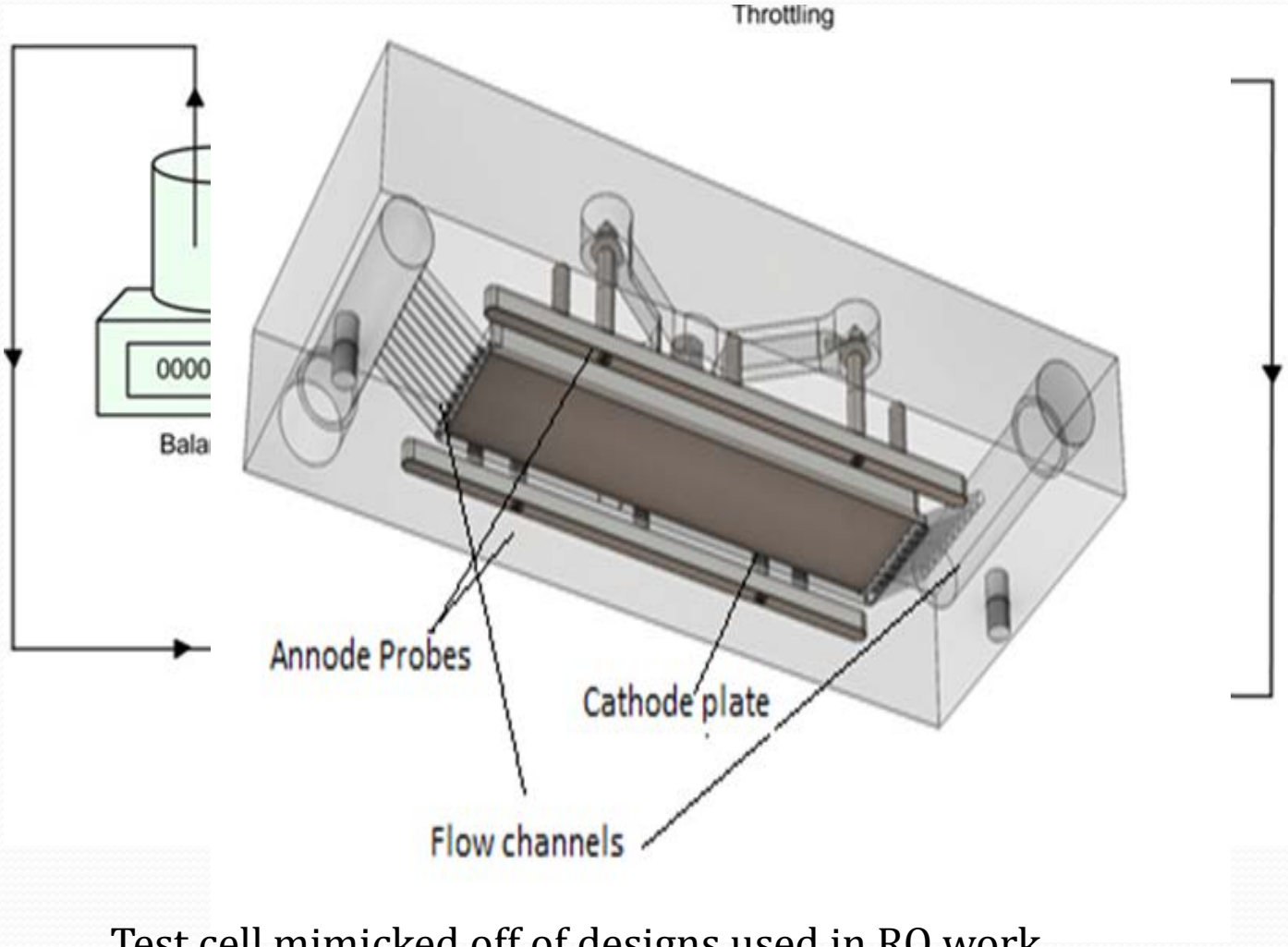
- An Introduction to the Forward Osmosis process
  - Previous Applications of Charged Membranes
- Description of Testing Apparatus and Procedure
- Results
  - Effect of Membrane Acting as an Anode
  - Effect of Membrane Acting as an Cathode

An Introduction to Forward Osmosis and the Project



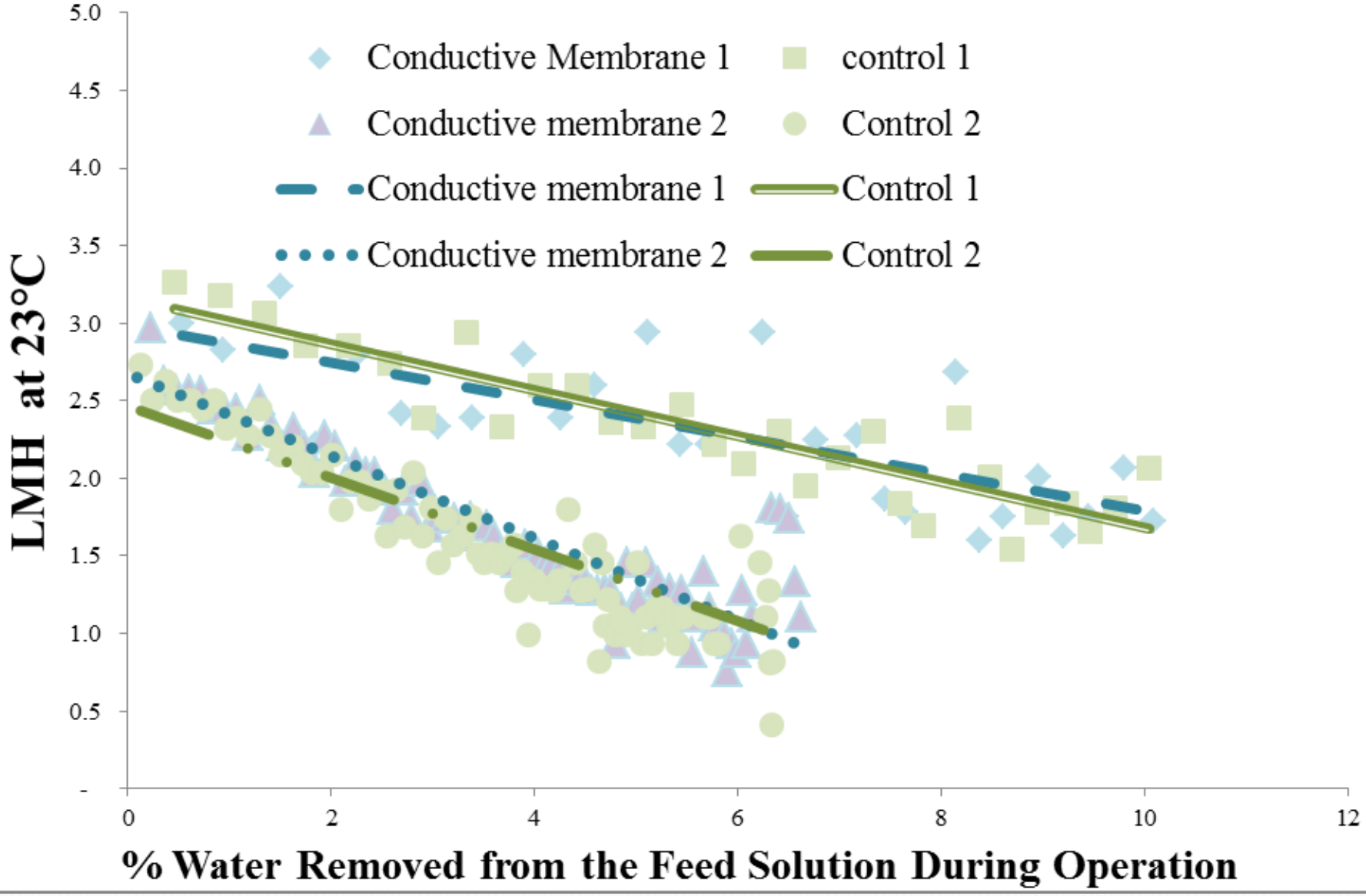


Testing Apparatus

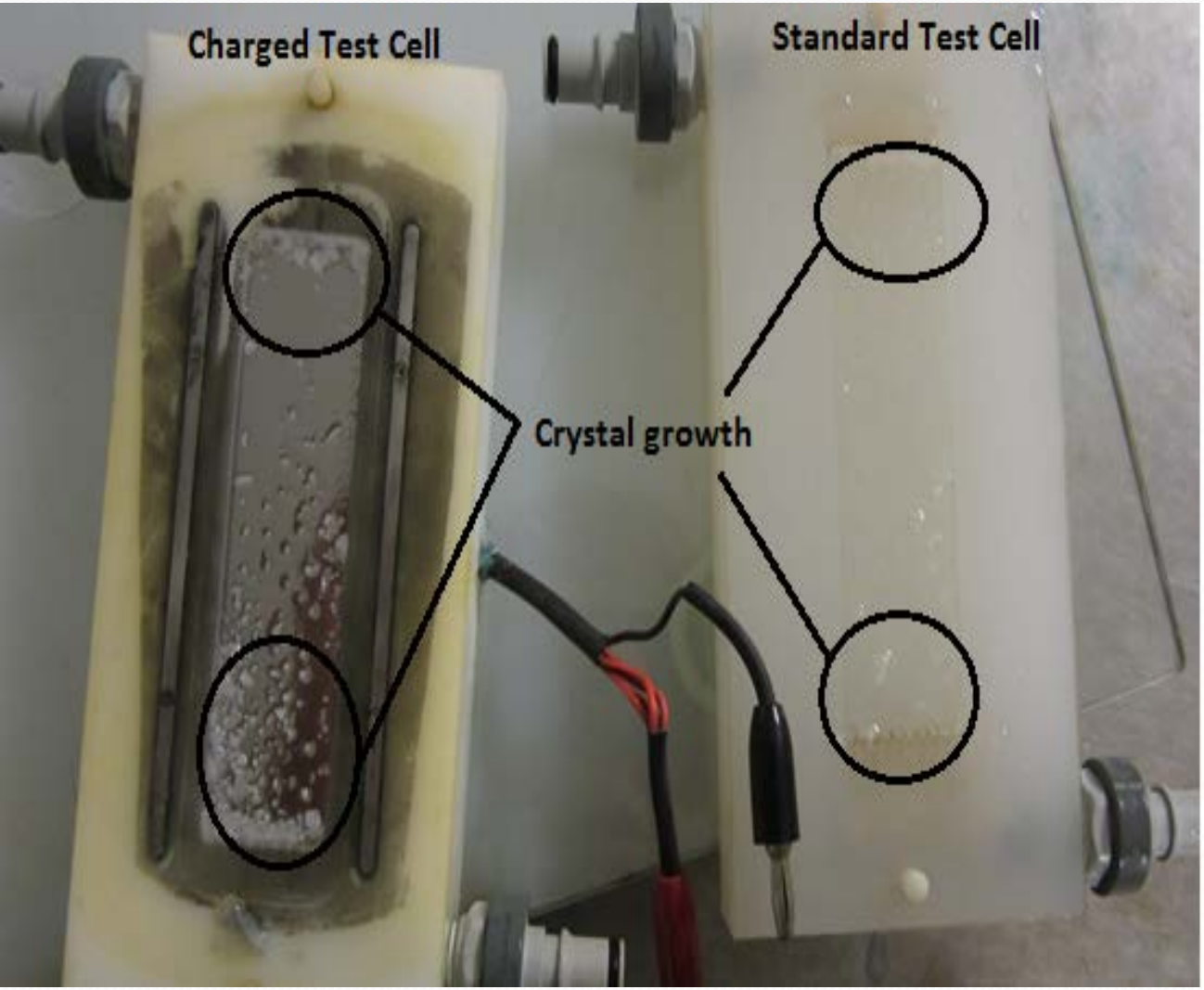


Test cell mimicked off of designs used in RO work

Membrane as Anode

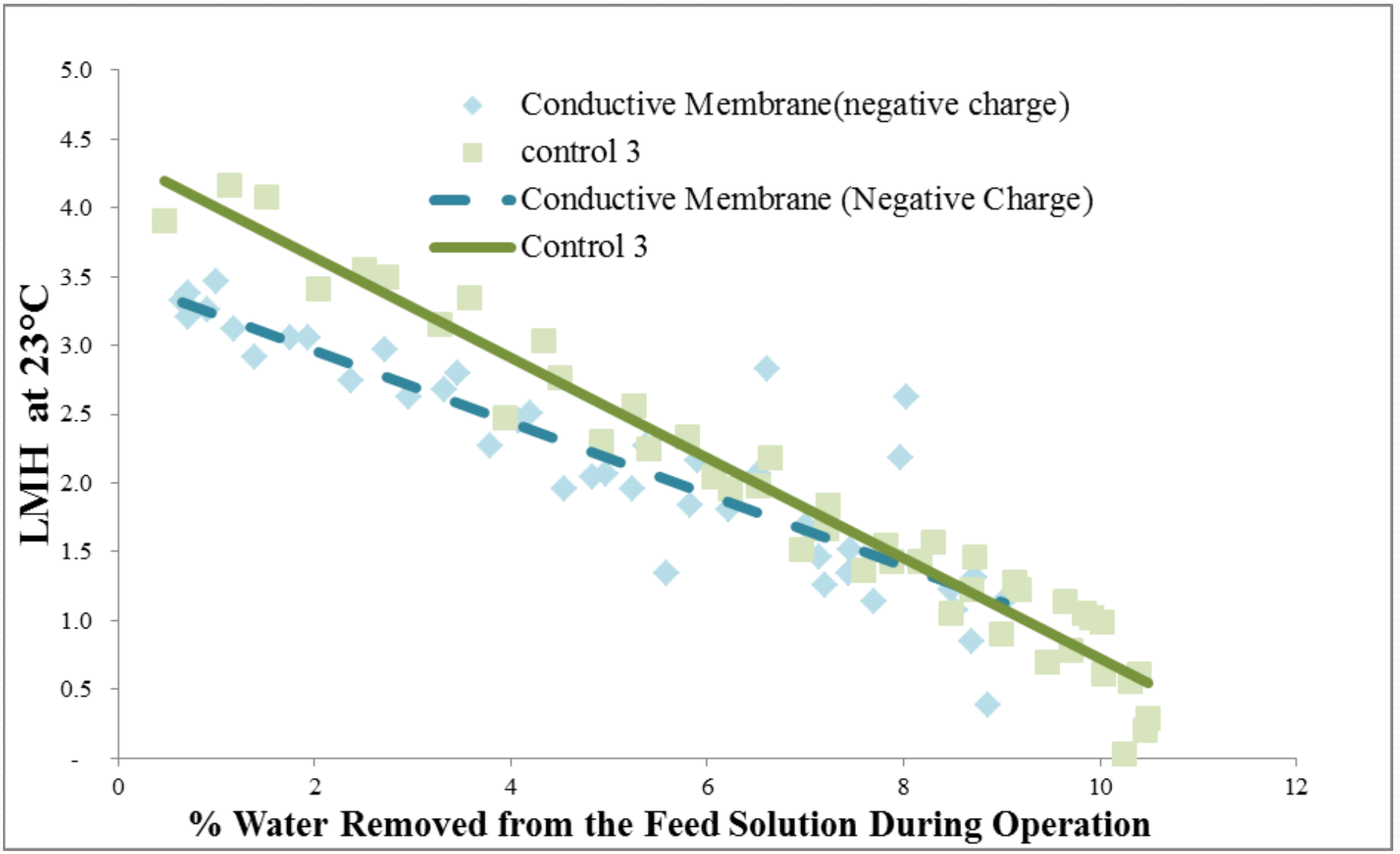


Membrane as Anode

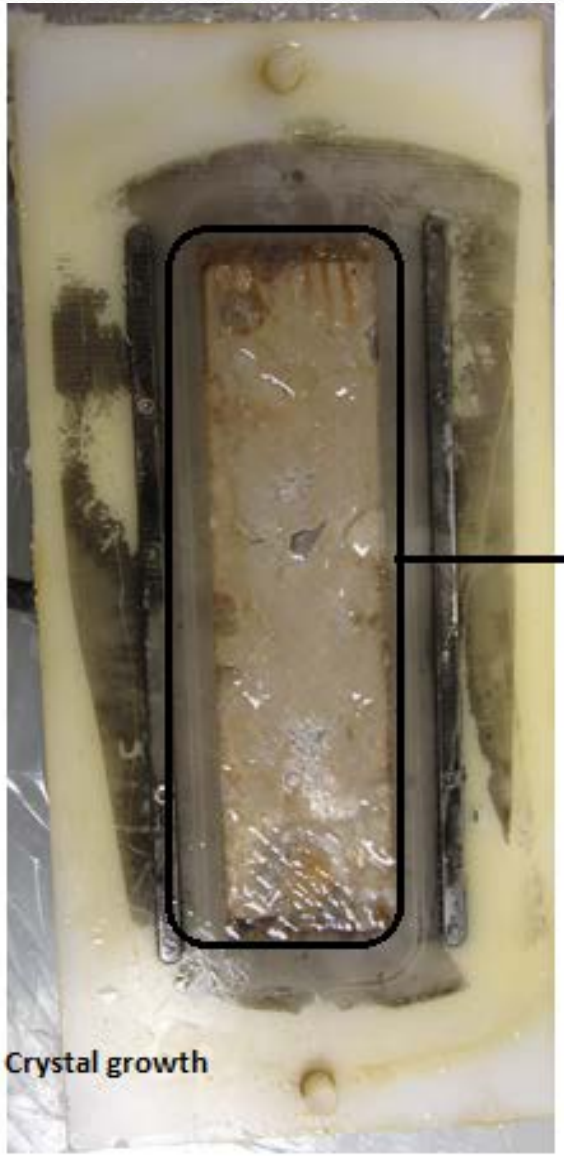


- **Little to no difference seen in crystal growth on both control and conductive membrane test cell**
- **No visible crystallization on membrane with the naked eye or with SEM imaging**

Membrane as Cathode



Membrane as Cathode



- **Visible crystal growth found on membrane surface**
- **Large crystal formation on the charged plate**
- **Crystal formation likely restricting proper flow within test cell**

Summary

- Using a membrane with a conductive layer a charge was applied to attempt to prevent the formation of foulants
- Both the application of positive and negative charges were shown to have no observable benefit to membrane fouling resistance
- With the membrane acting as a cathode fouling drastically increased

References

- Cath, T.Y., Childress, A.E., Elimelech, M., “Forward Osmosis: Principles, Applications, and recent developments,” Mem. Sci. 2006, 281 (1), pp. 70-87
- Yip, N.Y, Tiraferri, A., Phillip, W.A., Schiffman, J.D., Elimelech, M., “High Performance Thin-Film Composite Forward Osmosis Membranes,” *Environ. Sci. Technol.*, 2010, *44* (10), pp 3812–3818
- Liu, Z., Bai, H., Lee, J. & Sun, D. 2011, "A low-energy forward osmosis process to produce drinking water", ENERGY & ENVIRONMENTAL SCIENCE, vol. 4, no. 7, pp. 2582-2585.
- Kim, Y., Elimelech, M., Shon, H.K. & Hong, S. 2014, "Combined organic and colloidal fouling in forward osmosis: Fouling reversibility and the role of applied pressure", Journal of Membrane Science, vol. 460, pp. 206-212.
- Mi, B. & Elimelech, M. 2010, "Organic fouling of forward osmosis membranes: Fouling reversibility and cleaning without chemical reagents", Journal of Membrane Science, vol. 348, no. 1, pp. 337-345.
- Iglic, A., Gongadze, E. & Bohinc, K. 2010, "Excluded volume effect and orientational ordering near charged surface in solution of ions and Langevin dipoles", Bioelectrochemistry (Amsterdam, Netherlands), vol. 79, no. 2, pp. 223-227.
- Hahn, J. 2011, "Surfactant effect on electrical conductivity of carbon nanotube thin films", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY, vol. 242.
- Lannoy, C.F., Jassby, D, Gloe, K, Gordon, A.D., Wiesner, “Aquatic biofouling prevention by electrically charged nanocomposite polymer thin film membranes,” M.R. *Environ. Sci. Technol.*, 2013, *47* (6), pp 2760–2768
- Duan Wenyan, Dudchenko Alexander, Mende Elizabeth, “Electrochemical Mineral Scale Prevention and Removal on Electrically Conducting Carbon Nanotube – Polyamide Reverse Osmosis Membranes,” Unpublished
- Flatt, R.J. & Bowen, P. 2003, "Electrostatic repulsion between particles in cement suspensions: Domain of validity of linearized Poisson–Boltzmann equation for nonideal electrolytes", Cement and Concrete Research, vol. 33, no. 6, pp. 781-791.