Ryan S. Kingsbury, P.E.

Education

Ph.D., Environmental Engineering · (Defended; anticipated graduation December 2019)

Investigation of selective mass transport in ion exchange membranes for clean energy and water processes

The University of North Carolina at Chapel Hill

Primary Advisor: Dr. Orlando Coronell

Master of Science, Environmental Engineering · May 2010

Effect of magnetic ion exchange and ozonation on disinfection by-product formation

The University of North Carolina at Chapel Hill

Primary Advisor: Dr. Philip C. Singer

Bachelor of Science, Civil Engineering · December 2007 · GPA 4.0/4.0

The University of Texas at Austin

Bachelor of Arts, Plan II Honors Program · December 2007 · GPA 4.0/4.0

The University of Texas at Austin

Experience

Postdoctoral Researcher, The Materials Project, Lawrence Berkeley National Laboratory

Berkeley, CA (2019-)

Senior Engineering Research Consultant, Membrion Inc.

Seattle, WA (2018-)

Research Assistant, UNC Dept. of Environmental Science and Engineering

Chapel Hill, NC (2015-2019)

- Developed a photocrosslinkable ion exchange membrane chemistry to study the effects of hydrogen bonding sites on membrane performance.
- Worked closely with a colleague to devise a new technique for measuring the hydration numbers of counter-ions in ion exchange polymers.
- Produced three invention disclosures and one patent filing based on my research.
- Performed comprehensive characterization of commercial ion exchange membranes to understand the factors that contribute to non-ideal water and salt transport through these materials.
- Determined the cause of a systematic bias in ion exchange membrane permselectivity measurements that explained non-physical results in literature.
- Demonstrated a chemical technique to enhance the efficiency of a concentration-based energy storage device by more than 3x.

- Initiated a collaboration with Lawrence Berkeley National Laboratory to study synthesized membranes using small-angle X-ray scattering (SAXS).
- Participated in NSF-sponsored HybriD3 workshop to provide hands-on training in density functional theory (DFT) calculations for materials research.
- Utilized a variety of measurement techniques including electrochemical impedance spectroscopy (EIS), linear sweep voltammetry (LSV), quartz crystal microbalance (QCM), inductively-coupled mass spectroscopy (ICP-MS), scanning and transmission electron microscopy (SEM/TEM), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), dynamic mechanical analysis (DMA), Fourier transform infrared spectroscopy (FTIR), and atomic force microscopy (AFM).

Founder and CEO, Bluecell Energy LLC

Research Triangle Park, NC (2013-2015)

- Invented and reduced to practice a novel energy storage technology based on electrolyte concentration gradients.
- Worked in concert with co-founder and two MBA students to analyze system cost-effectiveness relative to market opportunity.
- Trained and supervised laboratory technician.
- Oversaw design, materials selection, fabrication, and testing of three laboratory-scale prototypes.
- Developed test procedures and interpreted performance data based on review of relevant scientific literature.
- Programmed mass transport model to aid in system analysis and optimization.
- Released open-source pyEQL library (~10k lines of Python code) to facilitate thermodynamic calculations for electrolyte solutions.
- Prepared patent filings and managed protection of intellectual property.

Environmental Engineer, CDM Smith

Raleigh, NC (2010-2013)

- Developed and conducted bench-scale experiments to evaluate impact of source water seawater intrusion on treated water corrosivity to lead, copper, and iron.
- Analyzed feasibility of sustainable power generation using a biogas-fueled combined heat and power engine at a wastewater treatment plant.
- Performed shop drawing reviews for mechanical equipment and piping for a water treatment plant. Coordinated review of construction submittals and RFIs with all other disciplines.
- Reviewed algorithms for processing water quality data. Tested and commissioned several dozen remote monitoring systems at groundwater well sites.
- Conducted master planning analysis of water treatment residuals and wastewater biosolids treatment and disposal for three North Carolina utilities.

Research Assistant, UNC Dept. of Environmental Science and Engineering

Chapel Hill, NC (2008-2010)

- Investigated the use of magnetic ion exchange resin in combination with ozone to reduce inorganic disinfection by-product formation in tidally-influenced drinking waters.
- Characterized samples using physical and chemical water quality analysis, gas chromatography, ion chromatography, and excitation-emission spectroscopy.

Engineer-in-Training, CDM

Austin, TX (2007-2008)

- Designed chemical storage and pumping systems, disinfection basin, and associated yard piping for a 42 MGD drinking water treatment facility.
- Analyzed a proposed water transmission main alignment for conflicts with buried utilities and proposed alternatives as necessary.
- Assessed the condition of treatment equipment at a 50 MGD water treatment facility, identified capacity bottlenecks, and made recommendations for expansion based on available hydraulic head and site area.

Publications

Peer Reviewed (* = Corresponding Author)

Hossen, E., Gobetz, Z., **Kingsbury, R.S.**, Liu, F., Palko, H. C., Dubbs, L. L., Coronell, O., Call, D. F.* Impact of temporal changes in coastal salinity gradient resources on power output in reverse electrodialysis. *Submitted*.

Kingsbury, R.S., Bruning, K., Zhu, S., Flotron, S.,Miller, C.T., Coronell, O.* Influence of water uptake, charge, manning parameter and contact angle on water and salt transport in commercial ion exchange membranes. *Industrial & Engineering Chemistry Research* 58(40): 18663–18674, 2019. DOI:10.1021/acs.iecr.9b04113

Kingsbury, R.S., Zhu, S., Flotron, S., Coronell, O.* Microstructure determines water and salt permeation in commercial ion exchange membranes. *ACS Applied Materials & Interfaces* 10(46): 39745–39756, 2018. DOI:10.1021/acsami.8b14494

Kingsbury, R.S., Flotron, S., Zhu, S., Call, D. F., Coronell, O.* Junction potentials bias measurements of ion exchange membrane permselectivity. *Environmental Science & Technology* 52(8):4929-4936, 2018. DOI:10.1021/acs.est.7b05317

Zhu, S., **Kingsbury, R.S.**, Call, D.F., Coronell, O. Impact of solution composition on the resistance of ion exchange membranes. *Journal of Membrane Science* 554: 39–47, 2018. DOI:10.1016/j.memsci.2018.02.050

Kingsbury, R.S., Liu, F., Zhu, S., Boggs, C., Armstrong, M.D., Call, D. F., Coronell, O.* Impact of natural organic matter and inorganic solutes on energy recovery from five real salinity gradients using reverse electrodialysis. *Journal of Membrane Science* 541:621-632, 2017. DOI:10.1016/j.memsci.2017.07.038

Wang, J., **Kingsbury, R.S.**, Perry, L., Coronell, O.* Partitioning of alkali metal salts and boric acid from aqueous phase into the polyamide active layers of reverse osmosis membranes. *Environmental Science & Technology* 51(4): 2295-2303, 2017. DOI:10.1021/acs.est.6b04323

Kingsbury, R.S., Coronell, O.* Osmotic ballasts enhance faradaic efficiency in closed-Loop, membrane-based energy systems. *Environmental Science & Technology* 51(3): 1910-1917, 2017. DOI:10.1021/acs.est.6b03720

Kingsbury, R.S.*, Chu, K., and Coronell, O. Energy storage by reversible electrodialysis: the concentration battery. *Journal of Membrane Science* 495:502-516, 2015. DOI:10.1016/j.memsci.2015.06.050

Kingsbury, R.S.*, Singer, P.C. Effect of magnetic ion exchange and ozonation on disinfection by-product formation. *Water Research* 47(3):1060-1072, 2013. DOI:10.1016/j.watres.2012.11.015

In progress (* = Corresponding Author)

Kingsbury, R.S., Wang, J., Coronell, O.* Comparison of water and salt transport properties of ion exchange, reverse osmosis, and nanofiltration membranes for desalination and energy applications. *In preparation*.

Pre-prints (* = Corresponding Author)

Kingsbury, R.S., Zhu, S., Flotron, S., Coronell, O.* Microstructure determines water and salt permeation in commercial ion exchange membranes. *ChemRxiv*, 2018. DOI:10.26434/chemrxiv.6987248

Kingsbury, R.S., Flotron, S., Zhu, S., Call, D. F., Coronell, O.* Junction potentials bias measurements of ion exchange membrane permselectivity. *ChemRxiv*, 2017. DOI:10.26434/chemrxiv.5497099

Non-peer Reviewed

Kingsbury, R.S., Dowbiggin, W.B., Edwards, M., and Singer, P.C. Impact of harbor deepening and seawater intrusion on treated drinking water quality. *Proceedings of the American Water Works Association Annual Conference and Exhibition*, 2012. http://acumen-va-publish.com/awwaACE2012/contents.php?s=THU09

Kingsbury, R.S., Marriott, B.D. Optimize climate-controlled sodium hypochlorite storage for cost savings and improved sustainability. *Proceedings of the NC-AWWA/WEA Annual Conference*, 2011.

Presentations

Invited Presentations

Kingsbury, R.S. Accelerating development of ion-selective membranes through experiment and computation. Presentation to the Materials Project, Lawrence Berkeley National Laboratory, Berkeley, CA, February 20, 2019.

Kingsbury, R.S. Energy from saltwater. Annual Presentation to Duke Energy Foundation, Duke Energy Offices, Raleigh, NC, June 8, 2017.

Kingsbury, R.S., Coronell, O. Osmotic ballasts make saltwater energy more efficient. UNC Innovation Showcase, Chapel Hill, NC, April 19, 2017.

Kingsbury, R.S. A novel approach to energy storage based on blue energy and saltwater. Annual Presentation to Duke Energy Foundation, UNC Institute for the Environment, Chapel Hill, NC, April 30, 2016.

Oral Presentations

Kingsbury, R.S., Wang, J., Hegde, M., Dingemans, T., You, W., Coronell, O. Physically-crosslinked ion exchange membranes defy conductivity-selectivity tradeoff. Materials Research Society Spring Meeting, Phoenix, AZ, April 22-26, 2019.

Kingsbury, R.S., Wang. J., Coronell, O. Beyond swelling degree: Counter-ion hydration and its effect on ion exchange membrane performance. 257th American Chemical Society National Meeting, Division of Environmental Chemistry, Orlando FL, March 31-April 4, 2019.

Kingsbury, R.S., Bruning, K., Zhu, S., Flotron, S., Miller, C.T., Coronell, O. Towards understanding the conductivity-selectivity-permeability tradeoff in ion exchange membranes: Swelling modulates water and salt transport. North American Membrane Society Annual Meeting, Lexington, KY, June 10-13, 2018.

Kingsbury, R.S., Coronell, O. Osmotic ballasts enhance efficiency in closed-loop membrane systems for energy conversion and storage. 11th International Congress on Membranes and Membrane Processes, San Francisco, CA, July 29-August 4, 2017.

Kingsbury, R.S., Boggs, C., Liu, F., Zhu, S., Armstrong, M.D., Call, D. F., Coronell, O. Impact of natural organic matter and ionic composition on energy recovery from five real salinity gradients using reverse electrodialysis. AEESP Research and Education Conference, Ann Arbor, MI, June 20-22, 2017.

Kingsbury, R.S., Coronell, O. Osmotic ballasts improve the energy efficiency of closed-loop electrodialytic processes. 252nd American Chemical Society National Meeting, Division of Environmental Chemistry, Philadelphia, PA, August 21-25, 2016.

Kingsbury, R.S., Chu, K., Coronell, O. Energy storage by reversible desalination: A concentration battery based on electrodialysis. 251st American Chemical Society National Meeting, Division of Environmental Chemistry, San Diego, CA, March 13-17, 2016.

Kingsbury, R.S. Impacts of harbor deepening and seawater intrusion on treated drinking water quality. AWWA Distribution System Security Conference, St. Louis, Missouri, September 10, 2012.

Kingsbury, R.S. Impacts of harbor deepening and seawater intrusion on treated drinking water quality. Georgia Association of Water Professionals Annual Conference, Savannah, Georgia, July 16, 2012.

Kingsbury, R.S. Impacts of harbor deepening and seawater intrusion on treated drinking water quality. AWWA Annual Conference and Exposition, Dallas, Texas, June 14, 2012.

Kingsbury, R.S. Impacts of harbor deepening and seawater intrusion on treated drinking water quality. North Carolina AWWA/WEA Spring Conference, Wilmington, North Carolina, April 17, 2012.

Kingsbury, R.S. Optimize climate-controlled sodium hypochlorite storage for cost savings and improved sustainability. NC-AWWA/WEA Annual Conference, Concord, North Carolina, November 15, 2011.

Kingsbury, R.S. Evaluation of MIEX pre-treatment on ozonation performance and disinfection by-product formation. AWWA Annual Conference and Exposition, Chicago, Illinois, June 21, 2010.

Poster Presentations

Kingsbury, R.S., Flotron, S., Zhu, S., Call, D. F., Coronell, O. Junction potentials bias measurements of ion exchange membrane permselectivity. Poster presented at the North American Membrane Society Annual Meeting, Lexington, KY, June 2018.

Kingsbury, R.S., Coronell, O. Energy storage by reversible electrodialysis: the concentration battery. Poster presented at the Triangle Student Research Competition, Durham, NC, September 2015.

Patents

Kingsbury, R.S., Wang, J., Hegde, M., Dingemans, T., You, W., Coronell, O. Hydrogen-bond enriched ion exchange membranes. U.S. Provisional Patent Application No. US 62/837,674, 2019. Pending.

Kingsbury, R.S., Coronell, O. Osmotic ballasts for membrane-based energy processes. PCT Application No. PCT/US17/40047, 2016. Abandoned.

Kingsbury, R.S. Energy generation and storage using electro-separation methods and devices. U.S. Patent Application No. 14/201,687, 2014. Abandoned.

Grants, Fellowships, and Awards

UNC Graduate Student Transportation Grant Award (2019)

Finalist, University of North Carolina 3 Minute Thesis (3MT) competition (2018)

North American Membrane Society Student Poster Award, 3rd Place in the Energy Category (2018)

American Environmental Engineering and Science Professors Hydromantis Student Scholarship Award (2017)

One of 22 travel awards provided to students and postdocs attending the 2017 AEESP bi-annual meeting.

North American Membrane Society (NAMS) Student Fellowship Award (2017)

One of 3 fellowship awards provided to students and postdocs presenting at ICOM 2017.

Participant in Eschelman School of Pharmacy E(I) Lab Program

The E(I) Lab is a six-month experiential program designed to expose participants to the entire lifecycle of creating and bringing to market an innovative product. An overarching goal of the Carolina E(I) Lab is to inspire, cultivate and accelerate entrepreneurship and innovation among graduate students, professional students and postdocs

National Science Foundation Graduate Research Fellowship (2016)

UNC Duke Energy Fellowship (2015)

UNC Bunker Award (2010)

The Bunker Award is given annually by the Department of Environmental Sciences and Engineering to a master's student in environmental engineering who shows the most outstanding scholarship and professional promise.

UNC Order of the Golden Fleece (2010)

The Order of the Golden Fleece was founded in 1904 to unite student leaders at the University of North Carolina at Chapel Hill. Considered the highest honorary society at the University, the Golden Fleece selects its members based upon service to the University as reflected in scholarship, motivation, creativity, loyalty, and leadership in academic and extracurricular pursuits.

UNC Order of the Old Well (2009)

The Order of the Old Well recognizes students and faculty members of high character who have demonstrated outstanding humanitarian service and whose service has gone uncompensated and unrewarded.

American Water Works Association Thomas R. Camp Scholarship (2008)

Sponsored by Camp Dresser and McKee, Inc., this scholarship provides support to outstanding graduate students doing applied research in the drinking water field.

Teaching and Mentoring

Guest Lecturer in Physical / Chemical Processes for Water Treatment (ENVR 756) at University of North Carolina at Chapel Hill (Spring 2017-2018)

Taught three 1-hr lectures on electromembrane processes and the infrastructure project lifecycle to graduate students.

Guest Lecturer in Membrane Technology for Water Purification (ENVR 890) at University of North Carolina at Chapel Hill (Fall 2016)

Taught two 3-hr lectures on electrodialysis and reverse electrodialysis to graduate students.

Guest Lecturer in Chemical Equilibria in Natural Waters (ENVR 419) at University of North Carolina at Chapel Hill (Fall 2017)

Taught three 1-hr lectures on acid-base chemistry to graduate and undergraduate students.

Research Mentor

Supervised research of two undergraduates and one graduate student (2015-2017).

Professional Activities

Licensed Professional Engineer

North Carolina, License No. 040310

Peer Reviewer

- *ChemSusChem* (1 manuscript)
- *Journal of Membrane Science* (5 manuscripts)
- *Water Research* (1 manuscript)
- *Journal of the American Water Works Association* (1 manuscript)
- *Industrial & Engineering Chemistry Research* (1 manuscript)

Affiliations

- American Chemical Society
- Materials Research Society
- North American Membrane Society
- European Membrane Society

Service and Outreach

- Department Liason, Materials Research Society UNC student chapter (2018)
- Volunteer, STEM in the Park (middle school outreach activity) (2018)
- Volunteer, UNC Science Expo (public outreach event) (2017-2018)
- High school outreach project with NC School of Science and Math (2016-2017)
- Presenter, Science in the Stacks (elementary school activity) (2016)

- Member, American Water Works Association Climate Change Committee (2012-2013)
- Member, North Carolina American Water Works Association Drinking Water Rules and Regulations Seminar Planning Committee (2011-2012)
- President, Daniel A. Okun Chapter of Engineers Without Borders (2008-2009)