

## Kevin Knehr

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### Education

#### **Drexel University**

*B.S. in Mechanical Engineering*

Drexel University Penonni Honors College

Philadelphia, Pennsylvania

Graduated: June 2012

**Cumulative GPA: 3.92**

#### **Columbia University**

*M.S. & Ph.D. in Chemical Engineering*

New York City, New York

Enrollment: Fall 2012

### Honors and Awards

- Columbia University Department of Chemical Engineering Pesco Fellow, 2012-2013
- NSF Graduate Research Fellowship Program (NSF-GRFP) Fellow, 2012-2017
- National Defense Science and Engineering Graduate (NDSEG) Fellowship Awardee, 2012, *Declined*
- Barry M. Goldwater Scholar, 2011
- NSF Research Experience for Undergraduates (REU) Fellowship, Summer 2010 & Summer 2011
- Hess Undergraduate Research Scholarship, 2010 – 2012
- A.J. Drexel Academic Scholarship, 2007 – 2012
- Drexel University Dean's List, 2007 – 2012
- Eagle Scout, Boy Scouts of America, 2007

### Research Interests

Renewable Energy Systems; Electrochemical Energy Conversion and Storage; Vanadium Redox Flow Batteries; Impact of Additives on Secondary Battery Degradation; Nucleation and Growth of Salt Films on Metal Electrodes

### Research Experience

#### **Hess Undergraduate Scholars Research, Drexel University**

*Electrochemical Energy Systems Laboratory*

Philadelphia, PA

January 2010-June 2012

- Independently performed a complete literature review on the redox flow battery
- Developed and published a more complete version of the Nernst equation for predicting the open circuit voltage of a vanadium redox flow battery
- Participated in the development of a 3-D pore scale resolved model of a vanadium redox flow battery in collaboration with the *Complex Fluids and Multiphase Transport Laboratory* at Drexel University
- Developed and published a 2-D, transient performance model regarding the operation of a vanadium redox flow battery

**Electrochemical Energy Systems Laboratory, Drexel University**

Philadelphia, PA

*Research Co-op*

March - September 2011

- Performed a theoretical analysis of the reaction kinetics and transport phenomena that occur in vanadium redox flow batteries
- Completed experimental tests which measured the performance of a vanadium redox flow battery with varying operating conditions
- Mentored a freshman student and assisted PhD students in guiding a NSF-REU student during the summer of 2011

**NSF Research Experience for Undergraduates (REU), Drexel University**

Philadelphia, PA

*Research Fellow, Computing for Power and Energy Program*

June - August 2011

- Conducted theoretical calculations based on current experimental results to predict the projected performance metrics of the electrochemical flow capacitor (a new energy storage concept)

**NSF Research Experience for Undergraduates (REU), Drexel University**

Philadelphia, PA

*Research Fellow, Computing for Power and Energy Program*

June - August 2010

- Formulated a 1-D mathematical model predicting the performance of a vanadium redox flow battery

**Industry Experience****Teledyne Energy Systems**

Hunt Valley, MD

*Advance Power Group Intern/Co-op*

March – September 2010

- Tracked the performance degradation of various testing units for radioisotope thermoelectric generators (RTG)
- Updated, edited, and designed QuickBasic program codes used to normalize RTG data and predict RTG performance
- Developed and implemented throughout the company a part drawing search program designed with Visual Basic for Applications software that collects, organizes, and opens data from five different data repositories in the company's system. (Includes training the employees)
- Created a model in MATLAB that predicts the performance of a thermoelectric couple

**PECO Energy**

Philadelphia, PA

*Reliability Intern*

March – September 2009

- Assisted engineers in improving the reliability of distribution circuits
- Analyzed and recorded operations of reliability distribution equipment
- Performed an analysis on vegetation related outages on poor performing circuits

**Journal Publications**

- E. Agar, K.W. Knehr, D. Chen, M. A. Hickner, and E.C. Kumbur, "Species transport mechanisms governing capacity loss in vanadium flow batteries: comparing Nafion® and sulfonated radel membranes," *Electrochimica Acta*, in press (2013).
- Ertan Agar, C. R. Dennison, K. W. Knehr, and E. C. Kumbur, "Identification of performance limiting electrode using asymmetric cell configuration in vanadium redox flow batteries," *Journal of Power Sources*, **225**, 89-94 (2012).
- K. W. Knehr and E. C. Kumbur, "Role of convection and related effects on species crossover and capacity loss in vanadium redox flow batteries," *Electrochemistry Communications*, **23**, 76-79 (2012).
- K.W. Knehr, Ertan Agar, C. R. Dennison, A. R. Kalidindi, and E. C. Kumbur, "A transient vanadium flow battery model incorporating vanadium crossover and water transport through the membrane," *Journal of the Electrochemical Society*, **59**, A1446-A1459 (2012).

- V. Presser, C. R. Dennison, J. Campos, K. W. Knehr, E. C. Kumbur, and Y. Gogotsi, "The electrochemical flow capacitor: a new concept for rapid energy storage and recovery," *Advanced Energy Materials*, **2**, 895-902 (2012).
- Gang Qiu, C. R. Dennison, K. W. Knehr, E. C. Kumbur, and Ying Sun, "Pore-scale analysis of effects of electrode morphology and electrolyte flow conditions on performance of vanadium redox flow batteries," *Journal of Power Sources*, **219**, 223-234 (2012).
- Gang Qiu, Abhijit S. Joshi, C. R. Dennison, K.W. Knehr, E. C. Kumbur, and Ying Sun, "3-D pore-scale resolved model for coupled ion/charge/fluid transport in a vanadium redox battery using x-ray tomography and the lattice boltzmann method," *Electrochimica Acta*, **64**, 46-64 (2012).
- K. W. Knehr and E. C. Kumbur, "Open circuit voltage of vanadium redox flow batteries: discrepancy between models and experiments," *Electrochemistry Communications*, **13**, 342-345 (2011).

### **Abstracts and Presentations**

- C. R. Dennison, V. Presser, J. Campos, K. W. Knehr, E. C. Kumbur, and Y. Gogotsi, 2012, "Electrochemical flow capacitors: a new concept for high-power scalable energy storage," *PRiME 2012*, October 7-12, Honolulu, HI (Abstract).
- K. W. Knehr, Ertan Agar, C. R. Dennison, A. R. Kalidindi, M. Hickner and E. C. Kumbur, 2012, "Role of membrane properties on species crossover and capacity loss of a vanadium redox flow battery," *PRiME 2012*, October 7-12, Honolulu, HI (Abstract).
- Ertan Agar, K. W. Knehr, A. R. Kalidindi, C. R. Dennison, and E. C. Kumbur, 2012, "Multi-ionic transport and effects of crossover in vanadium redox flow batteries," *221<sup>st</sup> ECS Meeting and Electrochemical Summit*, May 6-10, Seattle, WA (Abstract + Presentation).
- K. W. Knehr, Ertan Agar, C. R. Dennison, A. R. Kalidindi, and E. C. Kumbur, 2011, "Modeling species crossover and related effects on the performance of a vanadium redox flow battery," *The 4<sup>th</sup> International Forum on Multidisciplinary Education and Research for Energy Science*, December 17-21, Honolulu, HI (Abstract).
- C.R. Dennison, A. R. Kalidindi, J. J. Biel-Gobel, W. Commons, Ertan Agar, K. W. Knehr, and E. C. Kumbur, 2011, "Ionic transport and kinetic processes in vanadium redox flow batteries," *The 4<sup>th</sup> International Forum on Multidisciplinary Education and Research for Energy Science*, December 17-21, Honolulu, HI (Abstract).
- C. R. Dennison, K. W. Knehr, Ertan Agar and E. C. Kumbur, 2011, "Component and performance analysis of vanadium redox flow batteries: experimental and modeling studies," *2011 AIChE Annual Meeting*, October 16-21, Minneapolis, MN (Abstract).
- Ertan Agar, K. W. Knehr, C. R. Dennison, and E. C. Kumbur, 2011, "Modeling the effects of crossover on the performance of a vanadium redox flow battery," *Comsol Conference 2011*, Oct. 13-15, Boston, MA (Abstract).
- Ertan Agar, K. W. Knehr, C. R. Dennison, and E. C. Kumbur, 2011, "Investigation of performance limiting issues in vanadium redox flow batteries: a macroscopic modeling approach," *220<sup>th</sup> ECS Meeting and Electrochemical Summit*, October 9-14, Boston, MA (Abstract + Presentation).
- C. R. Dennison, K. W. Knehr, and E. C. Kumbur, 2011, "Characterization of electrode and cell potential in vanadium redox flow batteries," *5<sup>th</sup> International Conference on Energy Sustainability*, August 7-10, Washington DC (Abstract).
- K. W. Knehr, Ertan Agar, and E. C. Kumbur, 2011, "Modeling the performance of a vanadium redox flow battery," *Research Experience for Undergraduates Poster Session*, August 11, Philadelphia, PA (Poster + Presentation).
- C. R. Dennison, K. W. Knehr, and E. C. Kumbur, 2010, "Open circuit voltage and effects of electrode compression in vanadium redox flow batteries," *Third International Forum on Multidisciplinary Education and Research for Energy Science*, December 9-14, Tokyo Institute of Technology COE Program, Japan (Abstract).
- K. W. Knehr, Ertan Agar, and E. C. Kumbur, 2010, "Modeling of a vanadium redox flow battery," *Research Experience for Undergraduates Poster Session*, August 12, Philadelphia, PA (Poster + Presentation).

### **Activities and Affiliations**

- Pi Tau Sigma, Drexel – Mechanical Engineering Honor Society
- International Association for Hydrogen Energy (IAHE) – Student Member
- The Electrochemical Society – Student Member

### **Computer Skills**

Matlab, Comsol, Labview, ProE, Microsoft Office Suite, AutoCad, Visual Basic, QuickBasic, Maple