

Denise A. McKay

Assistant Professor, Picker Engineering Program, Smith College
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Education

University of Michigan, Ann Arbor, Ph.D., Civil and Environmental Engineering (2008)

Dissertation: Stack Level Modeling and Validation of Low Temperature Fuel Cells and Systems for Active Water Management

Thesis Advisors: Professors Nikolaos Katopodes and Anna Stefanopoulou

University of Michigan, Ann Arbor, M.S., Mechanical Engineering (2005)

Thesis: Modeling and Control of PEM Fuel Cell Stack Membrane Humidity

Emphasis: Dynamic Systems and Control Theory

Humboldt State University, Arcata CA, B.S., Environmental Resources Engineering (2002)

Thesis: Design and Construction of an Educational PEM Fuel Cell

Emphasis: Energy Resources

Experience

Fuel Cell Control Laboratory, University of Michigan ~ Ann Arbor, MI

Graduate Student Research Assistant (2003 – 2008)

- Physics based modeling, parameter identification and experimental validation applied to PEM fuel cells for optimal reactant and water management, including i) reactant and water dynamics spanning flooding and drying conditions, ii) polymeric membrane water vapor mass transport, and iii) electrode relative humidity estimators.
- Performed experiments at the National Institute of Standards and Technology using neutron radiography to image liquid water dynamics in an operating PEM fuel cell for model validation.
- Designed, installed and modeled a novel membrane based gas humidifier for independent control of gas temperature and humidity. Developed on-board controllers for active thermal and humidity management.

Laboratory Manager (2003 – 2008)

Advising and aiding students within the FCCL and other research groups on conducting experimental research, testing requirements, equipment modification, and test bench construction. Provided all lab safety and equipment training.

Schatz Energy Research Center (SERC) ~ Arcata, CA (1998 – 2002)

Research Engineer

- Managed fuel cell test benches ~ designed control software, data acquisition and signal conditioning systems, water plumbing and gas delivery systems, established equipment testing and maintenance and operation procedures
- Designed, built and tested PEM fuel cell stacks for power systems ~ purchased and tested all components, established material testing protocols, completed independent testing for manufacturers of new materials, designed and implemented manufacturing and production processes,
- Designed, integrated and tested systems ~ high pressure electrolyzer for hydrogen generation, membrane based gas humidifier, gas reformate mixing unit, 3kW home power fuel cell unit, solar hydrogen generation and fuel cell power system, test benches
- Wrote reports and manuals ~ DOE Final Reports, Manufacturer Materials Test Reports, O&M Manuals for fuel cell power systems and test benches installed off-site
- Produced budgets and quotes for fuel cell power systems and test benches

Fish Passage Project, Humboldt State University ~ Arcata, CA (2000 – 2001)

Undergraduate Research Assistant, under Professor Margaret Lang

Documented the migration of salmon within local streams including their ability to enter and successfully swim through culverts; maintained the data acquisition system used for monitoring tagged fish; took stage and flow measurements.

Environmental Resources Engineering Department, Humboldt State University ~ Arcata, CA

Student Assistant, under Professor Elizabeth Eschenbach (1997 – 1998)

Compiled, formatted and edited the ABET 2000 document; coordinated graduate and employer surveys.

Teaching Experience

Thermodynamics I, Civil and Environmental Eng. Dept., University of Michigan

Teaching Assistant (Winter 2006)

Thermodynamics I, Environmental Eng. Resources Dept., Humboldt State University

Laboratory Equipment Design (Summer 2001)

Renewable Energy Power Systems, Environmental Resources Eng. Dept., Humboldt State University

Invited Lecturer, 4-week series on “Fuel Cell Thermodynamics and Design of Fuel Cell Systems” (Fall 2002)

Laboratory Instructor (Summer 2002, Fall 2001)

Laboratory Curriculum Development (Summer 2001)

Peer-Reviewed Publications

McKay, D.A., Siegel, J., Ott, W., Stefanopoulou, A., *Parameterization and Prediction of Temporal Fuel Cell Voltage Behavior During Flooding and Drying Conditions*. Journal of Power Sources, Vol. 178, No. 1, 2008.

McKay, D.A., Stefanopoulou, A.G., Cook, J., *Model and Experimental Validation of a Controllable Membrane-Type Humidifier for Fuel Cell Applications*, IEEE Proceedings of 2008 American Control Conference, 2008. (**invited paper**)

McKay, D.A., Stefanopoulou, A.G., Cook, J., *A Membrane-Type Humidifier for Fuel Cell Applications: Controller design, analysis and implementation*, Proceedings of the ASME 6th International Conference on Fuel Cell Science, Engineering and Technology, FUELCELL2008-65257, June 2008.

Siegel, J., **McKay, D.A.**, Stefanopoulou, A.G., *Modeling and Visualization of Fuel Cell Water Dynamics using Neutron Imaging*, IEEE Proceedings of 2008 American Control Conference, 2008.

Siegel, J., **McKay, D.A.**, Stefanopoulou, A.G., *Measurement of Liquid Water Accumulation in a Proton Exchange Membrane Fuel Cell with Dead-Ended Anode*, Proceedings of the ASME 6th International Conference on Fuel Cell Science, Engineering and Technology, FUELCELL2008-65053, June 2008.

Muller, E.A., Kolb, F., Stefanopoulou, A.G., **McKay, D.A.**, and Guzzella, L., *Correlating Nitrogen Accumulation with Fuel Cell Performance*. ASME Proceedings of the Dynamic Systems and Control Conference, 2008. (submitted, under review)

Ingimundarson, A., Stefanopoulou, A.G., **McKay, D.A.**, *Model Based Detection of Hydrogen Leaks in a Fuel Cell Stack*, IEEE Transactions on Control System Technology, 2007. (accepted, in press)

Schilter, A., **McKay, D.A.**, Stefanopoulou, A.G., *Parameterization of fuel cell stack voltage: issues on sensitivity, cell to cell variation, and transient response*. Proceedings of the ASME 4th International Conference on Fuel Cell Science, Engineering and Technology, FUELCELL2006-97177, June 2006.

McKay, D.A., Ott, W., Stefanopoulou, A.G., *Modeling, Parameter Identification, and Validation of Reactant and Water Dynamics for a Fuel Cell Stack*. ASME Proceedings of the International Mechanical Engineering Congress, IMECE2005-81484, 2005.

McKay, D.A., Stefanopoulou, A.G., *Parameterization and Validation of a Lumped Parameter Diffusion Model for Fuel Cell Stack Membrane Humidity Estimation*. IEEE Proceedings of 2004 American Control Conference, 2004. (**invited paper**)

Non Peer-Reviewed Publications

McKay, D.A., and Stefanopoulou, A.G., *Real-Time Control of PEM Fuel Cell Reactant Humidity*. Fuel Cell Seminar and Exposition, 2006.

McKay, D.A., Ott, W., and Stefanopoulou, A.G., *Reactant and water dynamics during flooding: a low order calibrated PEM fuel cell stack model*. Fuel Cell Seminar and Exposition, 2005.

McKay, D.A., Stefanopoulou, A.G., *Modeling and Validation of a Real-Time Estimator for Fuel Cell Membrane Humidity*. Fuel Cell Seminar and Exposition, 2004.

Lehman, Chamberlin, Chapman, Coleman, Engel, **McKay**, Marshall, Reis, Zoellick. *Field Testing of a PEM Fuel Cell in an Integrated Power System*. Fuel Cell Seminar and Exposition, 2002.

McKay, D.A., and Marshall, M., *Automated Control and Monitoring of a Solar Hydrogen Energy System*. Best Applications of Measurement and Automation Paper Contest, NI Week 2002, National Instruments Conference on Test and Measurement, 2002.

Invited Talks

A Controllable Membrane Based Gas Humidifier for Active Fuel Cell Water Management, Fundamentals and Latest Developments in Automotive Control, Applied Technology Control Consortium, Dearborn Michigan, April 1, 2008.

Towards Sustainability: Building Renaissance Engineers, Seminar Series in Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, March 20, 2008.

Parameterization of Fuel Cell Dynamics Using Stack Level Measurements, Annual Automotive Research Center Conference, Ann Arbor MI, May 16 2007 and Automotive Research Center Thrust Area 1 Technical Presentation, Ann Arbor MI, Nov 28, 2007.

Sensing Sensitive Stuff – A Review of Data Acquisition and Signal Conditioning/Filtering, Workshop to College of Engineering graduate students and faculty, University of Michigan, Ann Arbor, June 30, 2006.

Modeling and Identification of a Membrane Humidifier for Dynamic Fuel Cell Power and Fuel Processing, Annual Automotive Research Center Conference, Ann Arbor MI, May 24, 2006 and Automotive Research Center Thrust Area 1 Technical Presentation, Ann Arbor MI, Aug 31, 2006.

Control of Fuel Cell Power Systems, Automotive Research Center Collaborative Research Seminar on Progress Towards Integrated Vehicle System, Driver and Environment Modeling, Simulation and Control, Ann Arbor MI, March 23, 2006.

Fuel Cell Technology Research Topics, University Undergraduate Outreach Program Research Seminar, University of Michigan, Ann Arbor, Feb 15, 2006.

Combined Heat-Power PEM Fuel Cell Systems: A Membrane Gas Humidifier, Automotive Research Center Thrust Area 1 Technical Presentation, Feb 14, 2006.

Modeling and Control of PEM Fuel Cell Stack Membrane Humidity, Seminar Series in Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, January 26, 2006.

Overview of Fuel Cell Control Laboratory Research at the University of Michigan, Schatz Energy Research Center, Arcata CA, July 25, 2005.

Fuel Cell Stack Membrane Humidity: Modeling and Experimental Validation, Annual Automotive Research Center Conference, Ann Arbor MI, May 19th 2003.

Applications of Electrochemistry, General Chemistry II course lecture, Humboldt State University, Arcata CA, Fall 2001 and Spring 2002.

Awards

- **Best Presentation**, University of Michigan, College of Engineering, Graduate Symposium, Controls, 2004.
- **Best Presentation**, American Controls Conference, 2003.
- **Homer Arnold Award**, Humboldt State University, presented to one senior for outstanding work in applied engineering, 2001.

Professional Service

- **Session Chair**
International Federation for Automatic Control, American Control Conference (2008)
- **Reviewer**
European Union Control Association, European Control Conference
IEEE Control Systems Society, International Conference on Control Applications
International Federation for Automatic Control, American Control Conference
- **Consultant**
Occupational Safety and Environmental Health Staff along with Facilities Manager on the safety design, installation and operation of fuel cell and hydrogen test equipment, reviewed schematics, advised professors and graduate students, University of Michigan, Ann Arbor, 2003-2008.

Community Service

- **Fuel Cell Technology Mentor**, *Undergraduate Research Opportunities Program*, University of Michigan, Summer 2004.
- **Fuel Cell and Renewable Energy Mentor**, for local and national youth science fair competitions in CA and MI, 2002-2004.
- **Instructor of K-12 Teachers**, *The Power of Teaching*, weekend course to explore energy topics and educate instructors on teaching renewable energy in the classroom, Humboldt State University, Arcata CA, 2002.
- **Renewable Energy Careers Outreach Liaison**, Science Career Fairs (*Expanding Your Horizons and High School*), throughout Humboldt County CA, 1998-2002.
- **Outreach Representative**, *Society of Women in Engineering Ice-cream Socials*, attracting young women to science and engineering careers, presentations on renewable energy and fuel cell technologies 2000-2002.

Professional Memberships

- Electrochemical Society
- American Society of Mechanical Engineers