

Adam S. Klett

PhD Candidate

Department of Chemical and Biomolecular Engineering

Clemson University

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EDUCATION

Clemson University

Doctor of Philosophy, Chemical Engineering

Dissertation: Purification, Fractionation, and Characterization of Lignin from Kraft
Black Liquor for Use as a Renewable Biomaterial

Clemson, SC

May 2017

GPA: 3.92/4.00

Bachelor of Science, Chemical Engineering

Minor: Mathematical Sciences

Senior Thesis: Liquid-Liquid Equilibrium of the HI-I₂-H₂O System of the Sulfur-Iodine Cycle
Calhoun Honors College

May 2012

GPA: 3.75/4.00

PEER-REVIEWED PUBLICATIONS

1. **Klett, A.S.**; Ding, J; Gamble, J.A.; Tindall, G.W.; Thies, M.C. Liquid-liquid compositions of the pseudo-ternary lignin-acetic acid-water system for applications to lignin purification and fractionation processes. *Fluid Phase Equilibria*, in preparation, 2017.
2. Li, X.; Li, M.; Pu, Y.; Ragauskas, A.; **Klett, A.S.**; Thies, M.C. Inhibitory Effects of Lignin on Enzymatic Hydrolysis: The Role of Lignin Chemistry and Molecular Weight. *Applied Energy*, submitted for publication, 2017.
3. **Klett, A.S.**; Payne, A.M.; Phongpreecha, T.; Hodge, D.B.; Thies, M.C. Fractionating Lignin with CO₂-Expanded Solvents of Acetic Acid + Water. *Green Chemistry*, submitted for publication, 2017.
4. **Klett, A.S.**; Payne, A.M.; Thies, M.C. Continuous-Flow Process for the Purification and Fractionation of Alkali and Organosolv Lignins. *ACS Sustainable Chem. Eng.*, 2016, 4, 6689-94.
5. **Klett, A. S.**; Gamble, J. A.; Thies, M. C.; Roberts, M. E. Identifying thermal phase transitions of lignin-solvent mixtures using electrochemical impedance spectroscopy. *Green Chem.* 2016, 18, 1892.
6. **Klett, A. S.**; Chappell, P.V.; Thies, M. C. Recovering ultraclean lignins of controlled molecular weight from Kraft black-liquor lignins. *Chem. Comm.* 2015, 51, 12855-8.
7. **Klett, A. S.**; Mena, S. E.; Bruce, D. A.; Thies, M. C. Liquid-Liquid Equilibrium Tie-Line Compositions at Elevated Temperatures and Pressures for the I₂-H₂O and HI-I₂-H₂O Systems of the Sulfur-Iodine Cycle. *Int. J. Hydrogen Energy* 2012, 37, 15020-8.

BOOK CHAPTER

1. Thies, M.C.; **Klett, A.S.** Recovery of Low-Ash and Ultrapure Lignins from Alkaline Liquor By-Product Streams. In *Production of Biofuels and Chemicals from Lignin*; Fang, Z., Smith, R.L. Eds.; Springer, 2016, Chapter 3.

PATENT

1. Thies, M. C.; **Klett, A. S.**; Bruce, D. A. Solvent and Recovery Process for Lignin. U.S. Patent Appl. Publ. No. 2016/0137680 A1, May 19, 2016.

ORAL PRESENTATIONS (Presenting author listed first)

1. **Klett A. S.**, Thies M. C. Liquid-liquid compositions of the lignin-acetic acid-water system for applications to lignin purification and fractionation processes. Presented at *Clemson Chemical and Biomolecular Engineering Graduate Student Symposium*, April 2017, Clemson, SC.
2. **Klett, A. S.** Purification, Fractionation, and Characterization of Lignin from Kraft Black Liquor for Renewable Biopolymer Applications. Presented at the *National Institute of Standards and Technology*, Boulder, CO, November 2016.
3. **Klett, A. S.;** Thies, M. C. Fine Fractionation of Lignin by Molecular Weight Using Supercritical Fluids. Presented at *AIChE Annual Meeting 2016*, San Francisco, CA, November 2016, paper 91e.
4. Ding, J.; **Klett, A. S.;** Thies, M. C. Biopolymer–Solvent Phase Behavior for the Lignin–Acetic Acid–Water System. Presented at *AIChE Annual Meeting 2016*, San Francisco, CA, November 2016, paper 241c.
5. Thies, M. C.; **Klett, A. S.** CO₂ As an Expanded Solvent for the Fractionation of Lignin. Presented at *AIChE Annual Meeting 2016*, San Francisco, CA, November 2016, paper 299f.
6. **Klett, A. S.;** Velez, J.; Thies, M. C. High-Pressure, Global Phase Behavior for the Guaiacol–CO₂ System. Presented at *AIChE Annual Meeting 2016*, San Francisco, CA, November 2016, paper 52f.
7. **Klett, A. S.;** Thies, M. C. Low-ash Lignin Biofuel from Black-Liquor Streams. Presented to D. W. Daniel High School AP Environmental Science and College-Prep Environmental Studies classes, Six Mile, SC, April 2016.
8. [3rd Place Presentation Award] **Klett A. S.**, Thies M. C. Purification and Fractionation of Lignin from Kraft Black Liquor for use as a Renewable Biopolymer. Presented at *Clemson Graduate School Three Minute Thesis Competition*, April 2016, Clemson, SC.
9. [1st Place Presentation Award] **Klett A. S.**, Thies M. C. Determination of the Solid-Liquid to Liquid-Liquid Phase Transition for Lignin-Acetic Acid-Water Mixtures using Electrochemical Impedance Spectroscopy. Presented at *Clemson Chemical and Biomolecular Engineering Graduate Student Symposium*, February 2016, Clemson, SC.
10. [Best Presentation Award] **Klett, A. S.;** Thies, M. C. Extraction, Fractionation, and Purification of Lignin from Biomass By-Product Streams Via the ALPHA Process. Presented at *AIChE Annual Meeting 2015*, Salt Lake City, UT, November 2015, paper 732a.
11. **Klett, A. S.;** Roberts, M. E.; Thies, M. C. Electrochemical Impedance Spectroscopy for Determining the Solid-Liquid to Liquid-Liquid Phase Transition for Lignin-Acetic Acid-Water Mixtures at Elevated Temperatures. Presented at *AIChE Annual Meeting 2015*, Salt Lake City, UT, November 2015, paper 437b.
12. **Klett, A. S.;** Thies, M. C. Generating Ultrapure Lignins from Kraft Pulp Mill Lignins via the ALPHA Technique. Presented at *AIChE Annual Meeting 2015*, Salt Lake City, UT, November 2015, paper 191d.
13. **Klett, A. S.;** Velez, J.; Thies, M. C. Low-ash Lignin Biofuel from Black-Liquor Streams. Presented to D. W. Daniel High School AP Environmental Science and College-Prep Environmental Studies classes, Six Mile, SC, April 2015.
14. [Student’s Choice Award – Best Presentation] **Klett A. S.**, Thies M. C. Extracting Ultrapure Lignin from Biomass By-Product Streams with a Tunable, Renewable Solvent System. Presented at *Clemson Chemical and Biomolecular Engineering Graduate Student Symposium*, March 2015, Clemson, SC.

15. Thies, M. C.; Velez, J.; **Klett, A. S.** Low-Ash and Ultrapure Lignin from Kraft Black Liquor. Presented at *Cross Border Commercial Innovations in Forestry, The Canadian Trade Commissioner Service*, Clemson, SC, January 2015.
16. **Klett, A. S.**; Thies, M. C. Phase Behavior of Kraft Lignins with a Tunable, Renewable Solvent System. Presented at *AIChE Annual Meeting 2014*, Atlanta, GA, November 2014, paper 614d.
17. **Klett, A. S.**; Thies, M. C. Extracting Ultrapure Lignin from Biomass By-Product Streams with Tunable, Renewable Solvent Systems. Presented at *AIChE Annual Meeting 2014*, Atlanta, GA, November 2014, paper 441f.
18. **Klett A. S.**; Velez J.; Thies M. C. Biofuels from Black Liquor for Greenhouse Gas Reduction. Presented at *EPA Environmental Youth Symposium*, September 2014, Atlanta, GA.
19. **Klett, A. S.**; Velez, J.; Thies, M. C. Low-ash Lignin Biofuel from Black-Liquor Streams. Presented to D. W. Daniel High School AP Environmental Science and College-Prep Environmental Studies classes, Six Mile, SC, April 2014.
20. **Klett A. S.**; Mena S. E.; Thies M. C.; Bruce D. A. Liquid-Liquid Equilibrium Compositions of the Iodine-HI-Water System of the Sulfur-Iodine Cycle at Elevated Temperatures and Pressures. Presented at *ACC Meeting of the Minds*, March 2012, Blacksburg, VA.
21. **Klett, A. S.**; Bruce, D. A.; Thies, M. C. Liquid-Liquid Equilibrium Compositions for the Iodine-HI-water System of the Sulfur-Iodine Cycle at Elevated Temperatures and Pressures. Presented at *AICHE Annual Meeting 2011*, Minneapolis, MN, November 2011, paper 66b.

POSTER PRESENTATIONS (Presenting author listed first)

1. Ding, J.; **Klett A.S.**; Thies, M. C. Generating ultrapure lignins from Kraft pulp mill lignins via the ALPHA technique. Presented at *Symposium on Biotechnology for Fuels and Chemicals*, Baltimore, MD, April 2016, paper M5.
2. [First Place Poster Award] **Klett A. S.**; Velez J.; Thies M. C. Biofuels from Black Liquor for Greenhouse Gas Reduction. Presented at *EPA Environmental Youth Symposium*, September 2014, Atlanta, GA.
3. Velez, J.; **Klett A.S.**, Thies, M. C. Recovering liquid-lignin fractions with well-defined molecular properties via the SLRP[®] Process. Presented at *Symposium on Biotechnology for Fuels and Chemicals*, Clearwater Beach, FL, April 2014, paper T82.
4. **Klett A. S.**; Velez J.; Thies M. C. Recovering a Liquid-Lignin Phase from Paper Mill Black Liquors. Presented at *Clemson Chemical and Biomolecular Engineering Graduate Student Symposium*, March 2014, Clemson, SC.
5. **Klett, A. S.**; Velez, J.; Thies, M. C. Recovering a Liquid-Lignin Phase from Paper Mill Black Liquors. Presented at *AICHE Annual Meeting 2013*, San Francisco, CA, PA, November 2013, paper 220l.

EXPERIENCE

Clemson University

Clemson, SC

Graduate Research Assistant

Aug. 2012 – Present

Department of Chemical and Biomolecular Engineering

- Developed a patent-pending process to produce ultrapure lignin derived from Kraft black liquor for advanced carbon materials such as carbon fibers and carbon nanotubes
- Supervised the work of 12 undergraduate students for their creative inquiry projects and senior theses
- Designed a method for the fractionation of lignin utilizing gas-expanded liquids to produce narrow fractions for use as an advanced carbon material precursor
- Established a technique for the measurement of phase-transition temperatures of polymer-solvent systems using electrochemical impedance spectroscopy where traditional methods (e.g., DSC) fail
- Contributed to work studying carbonaceous pitches for applications to high thermal conductivity carbon composites
- Helped in the writing of 6 research proposals, 4 of which were funded

Undergraduate Research Assistant

Jan. 2010 – May 2012

Department of Chemical and Biomolecular Engineering

- Studied the liquid-liquid equilibrium of the HI-I₂-H₂O system using a custom built continuous-flow apparatus with wetted parts fabricated from a tantalum-tungsten alloy for applications to the Sulfur-Iodine Process for hydrogen production
- Improved an analytical method for quantitative determination of liquid phase compositions to construct equilibrium ternary phase diagrams for further use in developing a thermodynamic model of this system
- Responsibilities included project planning, equipment maintenance, running experiments, data acquisition, data analysis, budgeting, scheduling timelines, and writing reports for project advisors

Residents in Science and Engineering (RISE) Tutor/Mentor

Aug. 2009 – May 2012

- Advised over 200 freshman engineering students to facilitate the transition into university life
- Tutored freshman engineering students in physics, calculus, and chemistry

Supplemental Instruction Leader

Aug. 2009 – Jan. 2010

- Tutored students from historically high fail rate classes as part of the Academic Success Center on campus
- Aided students in individual and group work sessions four times per week during class time

SKILLS

Languages: Intermediate Spanish

Software: Microsoft Office, Aspen, SolidWorks, Adobe Photoshop, Adobe Illustrator

Programming: Matlab, LaTeX, Python. Intro experiences in C and HTML

Analytical: **Spectroscopy:** UV-Vis, FTIR, NMR (¹H, ¹³C, HSQC), XRD, EIS

Chromatography: HPLC, GPC, GC

Mass spectrometry: MALDI-TOF-MS

Thermal analysis: TGA, DSC

Coursework also included studies of Raman, SEM, AFM, STM, AES, XPS, TMA, and DMA.

Relevant coursework: Analytical methods, Separation science, Polymer science, Diffusion in polymers, Numerical methods, Surface science and catalysis, Polymer thermodynamics, Advanced kinetics

HONORS/AWARDS

- College of Engineering and Applied Sciences Outstanding Graduate Researcher Award *Mar. 2017*
 - Selected out of 1,800 in the college as the top graduate researcher
- ChBE Department Graduate Student of the Year Award *April 2016*
 - Selected out of 35 in the department as top graduate student
- ChBE Graduate Research Symposium Award, 1st Place – Presentation *Feb. 2016*
- AIChE Best Presentation Award *Nov. 2015*
 - Identified by AIChE as the best paper of session
- AIChE Separations Division Graduate Student Research Award *Nov. 2015*
 - Identified by AIChE Separations Division as best paper of 2015
- Clemson Graduate School Three Minute Thesis Competition – 3rd Place *April 2016*
- Clemson University Professional Enrichment Grants (6) - \$4,500 *Aug. 2013 – Aug. 2016*
- ChBE Graduate Research Symposium Award, Student’s Choice- Presentation *Feb. 2015*
- EPA Environmental Youth Symposium Sustainable Energy Award - \$1,000 *Sep. 2014*
- Graduate Student Recruitment Fellowship - \$6,000 *Aug. 2012*
- Philip Prince Alumni Academic Scholarship *Aug. 2008 – May 2012*
- ACCIAC Fellowship in Creativity and Innovation - \$4,000 *Oct. 2011*
- Calhoun Honors College Summer Research Grant - \$400 *June 2011*
- Eagle Scout *May 2005*

LEADERSHIP

- Graduate Student Recruitment Committee Member *Aug. 2013 – May 2016*
- President of the Chemical Engineering Graduate Student Organization *June 2015 – May 2016*
- Professional Enrichment Grant Reviewer for Graduate Student Government *Aug. 2013 – Dec. 2015*
- Vice President of the Chemical Engineering Graduate Student Organization *June 2014 – May 2015*
- Student Guidance Committee Member, Annual World Conference on Carbon *July 2010*