Paul M. Mathias

Consultant, Paul M. Mathias Consulting, LLC
Technical Director and Senior Fellow, Fluor Corporation
Associate Editor, Journal of Chemical & Engineering Data
AIChE Fellow

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SUMMARY OF EXPERIENCE:

Dr. Mathias is a chemical technologist with over 41 years of broad experience in the chemical process industry, and a specialization in thermophysical properties and process modeling. He is a Technology Director and Senior Fellow at Fluor Corporation, and also manages his consulting business. His chemical-technology experience covers petroleum, inorganics, gas processing, electrolytes and polymers. He previously worked for Aspen Technology, Air Products and Chemicals and the ASPEN Project at MIT. He is an AIChE Fellow and an associate editor of the Journal of Chemical & Engineering Data.

Dr. Mathias' experience spans process evaluation and development, chemical-engineering consulting, research into new materials, teaching at universities and technical organizations, technical publications and presentations, and journal editing.

EDUCATION:

Ph.D., Chemical Engineering, University of Florida
M.S., Chemical Engineering, University of Florida
B.Tech., Chemical Engineering, Indian Institute of Technology, Madras

PROFESSIONAL EXPERIENCE:

Paul M. Mathias Consulting, LLC Aliso Viejo, CA	2020 - Present	Business Owner and Consultant
Fluor Corporation, Aliso Viejo, California	2005 - present	Senior Fluor Fellow, Technical Director
American Chemical Society	2011 - present	Associate Editor, Journal of Chemical & Engineering Data
University of California, Irvine, California	2006 - 2008	Course Instructor
Independent Consultant, Andover, Massachusetts	2004 - 2005	Business Owner and Consultant

Aspen Technology, Cambridge, Massachusetts	1997 - 2004	Technical Director and Product Manager
Air Products and Chemicals, Allentown, Pennsylvania	1981 - 1997	Engineering Associate
Lehigh University, Bethlehem, Pennsylvania	1987 - 1997	Adjunct Professor, Course Instructor
Stone and Webster, Boston, Massachusetts	1979 - 1981	Consultant
Aspen Project, MIT, Cambridge, Massachusetts	1978 - 1981	Engineer
Intera Environmental Consultants, Houston, Texas	1978 - 1978	Engineer

OVERVIEW OF PROFESSIONAL ACTIVITIES:

- ASPEN Project at MIT (1978-1981): Contributed to the design and development of the thermophysical-property system that is now a key component of Aspen Plus.
- Air Products and Chemicals (1981-1997): Developed and applied physical-property packages for technologies such as LNG, air separation, gas adsorption and various chemicals processes, and managed the use of computational-chemistry technology for materials development.
- Aspen Technology (1997-2004): Developed modeling solutions for the fertilizer industry (ammonia, urea, nitric acid and phosphoric acid), and served as the Aspen Properties Product Manager.
- Fluor Corporation (2005-present): Fluor's resident expert in developing thermophysical properties and simulation capabilities in the gas processing and carbon dioxide capture fields, which make Fluor-owned processes more competitive. He is a Fluor subject-matter expert in thermodynamic and physical properties, and process modeling.
- Journal of Chemical & Engineering Data (2011-present). Associate editor.
- Paul M. Mathias Consulting, LLC (2020-present); Consultant providing practical modeling, design and troubleshooting solutions to the process industries.
- Taught chemical undergraduate courses at Lehigh University and the University of California, Irvine.
- 96 publications, 131 technical presentations, and six patents.

SERVICE TO THE PROFESSION:

- Advisory board of the chemical engineering departments at four universities: University of Florida (1990-present), University of Illinois at Chicago (2004-present), Texas A&M University (2004-2006), and University of California, Irvine (2012-present).
- Member of the editorial advisory board of two journals: The *Journal of Chemical & Engineering Data* (1997-2004) and *Industrial and Engineering Chemistry Research* (1997-2001).

- Served on thesis committees at Lehigh University and the University of Pennsylvania.
- Thermodynamics and Transport Properties Committee of AIChE (1986-2002; Chair 1999-2000). A discussion organized by Kenneth Cox (then at Shell, currently at Rice University) and Paul Mathias at the 1992 Area 1a meeting was instrumental in the formation of CoMSEF.
- Director of AIChE's Fuels and Petrochemicals Division (2016-2019).
- Joint ASME/AIChE Committee on Thermophysical Properties (2001-present). Currently serves as vice-chair (2015-).
- Chaired sessions and served as area coordinator at AIChE, ACS and other meetings.
- Fluor's representative to DIPPR (2011-present). Current technical lead of Project 801.
- Reviewer of technical papers for journals such as *AIChE Journal*, *Chemical Engineering Science*, *I&EC Research*, *Fluid Phase Equilibria*, *Journal of Chemical & Engineering Data*, *International Journal of Hydrogen Energy*, and *International Journal of Greenhouse Gas Control*. He was named as one of the outstanding reviewers of *Molecular Systems Design & Engineering* in 2016.

PUBLICATIONS:

96 publications, which include invited papers, a paper that is in the top 10 cited in *Fluid Phase Equilibria*, and chapters in *Perry's Chemical Engineers' Handbook, 8th and 9th Editions*. Selected publications are listed below.

1. Paul M. Mathias, "110th Anniversary: A Case Study on Developing Accurate and Reliable Excess Gibbs Energy Correlations for Industrial Application," *Ind. Eng. Chem. Res*., 58, 12465-12477 (2019).
2. Paul M. Mathias, "Design of Gas Absorption Systems," in Section 14 ("Equipment for Distillation, Gas Absorption, Phase Dispersion, and Phase Separation"), 9th Edition of *Perry's Chemical Engineers' Handbook*, McGraw-Hill Professional, August, 2018.
3. J. Richard Elliott, Carl L. Lira, Timothy C. Frank, Paul M. Mathias, "Thermodynamics," Section 4, 9th Edition of *Perry's Chemical Engineers' Handbook*, McGraw-Hill Professional, August, 2018.
4. Paul M. Mathias, Henry Z. Kister, Bruce Parker, Lydia Narvaez, Thomas Schafer and Alan Erickson, "Component Trapping with VLE Uncertainty: Principles, Design and Troubleshooting," *Ind. Eng. Chem. Res*., 56, 11593-11602 (2017).
5. Feng Zheng, David J. Heldebrant, Paul M. Mathias, Phillip Koech, Mukund Bhakta, Charles J. Freeman, Mark D. Bearden, Andy Zwoster, Bench Scale Testing and Process Performance Projections of CO_2 Capture by CO_2BOLs With and Without Polarity Swing Assisted Regeneration," *Energy and Fuels*, 30, 1192-1203 (2016)
6. Paul M. Mathias, "Sensitivity of Process Design to Phase Equilibrium – A New Perturbation Method Based Upon the Margules Equation," *J. Chem. Eng. Data*, 59, 1006-1015 (2014).
7. Paul. M. Mathias Kash Afshar, Feng Zheng, Mark D. Bearden, Charles J. Freeman, Tamer Andrea, Phillip K. Koech, Igor Kutnyakov, Andy Zwoster, Arnold R. Smith, Philip G. Jessop, Omid Ghaffari Nik, David J. Heldebrant, "Improving the Regeneration of CO_2-Binding Organic Liquids with a Polarity Change," *Energy & Environmental Science*, 6, 2233-2242 (2013).

8. Paul M. Mathias, Satish Reddy, and John P. O'Connell, [***Invited***] "Quantitative Evaluation of the Chilled-Ammonia Process for CO_2 Capture Using Thermodynamic Analysis and Process Simulation," *Int. J. Greenhouse Gas Control*, 4, 174-179 (2010).
9. Paul M. Mathias, [***Invited***] "The Role of Experimental Data in Chemical Process Technology," *Pure Appl. Chem*., 81, 1727-1743 (2009).
10. Paul M. Mathias, "Design of Gas Absorption Systems," in 8th Edition of *Perry's Chemical Engineers' Handbook*, McGraw-Hill Professional, November, 2007.
11. Paul M. Mathias, [***Invited***] "Applied Thermodynamics in Chemical Technology: Current Practice and Future Challenges*," Fluid Phase Equilibria*, 228-229C, 49-57 (2005).
12. Chau-Chyun Chen and Paul M. Mathias, [***Invited***] "Applied Thermodynamics for Process Modeling," *AIChE Journal*, 48, 194-200 (2002).
13. P. M. Mathias, H. Cheng, S. J. Cook, H. C. Klotz and V. S. Parekh, [***Invited***] "Molecular Modeling in Engineering Design and Materials Development," *Fluid Phase Equilibria*, 116, 225-236 (1996).
14. P. M. Mathias, H. C. Klotz and J. M. Prausnitz, "Equation-of-State Mixing Rules for Multicomponent Mixtures: The Problem of Invariance," *Fluid Phase Equilibria*, 67, 31-44 (1991).
15. P. M. Mathias and T. W. Copeman, "Extension of the Peng-Robinson Equation of State to Complex Mixtures: Evaluation of Various Forms of the Local Composition Concept," *Fluid Phase Equilibria*, 13, 91-108 (1983). [**Top 10** list of most cited papers in *Fluid Phase Equilibria*, and with over 670 Google Scholar citations.]

PATENTS:

1. Paul M. Mathias, "Selective Caustic Scrubbing Using a Driver Gas," US 20130/149224 A1, June 13, 2013.
2. Ravi Ravikumar, Paul M. Mathias, Paul Koppel, Sanjiv Dabee, "Claus Plant Preprocessing Systems And Methods For Removal Of Ammonia From Claus Plant Feed Gases," US 9,181,095 B2, November 10, 2015.
3. Ravi Ravikumar, Paul M. Mathias, "Production of Pure Hydrogen from Ammonia Rich Sour Water Stripper Overhead, US 2017/0203963 A1 (July 20, 2017), WO 2017/127121 A1 (July 27, 2017).
4. Satish Reddy, Joseph Yonkoski, Paul M. Mathias, "Configurations and Methods of CO_2 Capture from Flue Gas by Cryogenic Desublimation," US 9,339,752 B2, May 17, 2016.
5. Paul M. Mathias, Satish Reddy, "Methods and Systems for Improving the Energy efficiency of Carbon Dioxide Capture," US 2016/0214057 A1, published July 28, 2016.
6. Paul M. Mathias, Satish Reddy, Joseph Yonkoski, "Methods and Systems for Improving the Energy Efficiency of Carbon Dioxide Capture," provisional patent filed on June 2017.

CONFERENCE PRESENTATIONS:

131 conference presentations. Selected presentations are listed below.

1. Paul M. Mathias, “The Value of Thermodynamics for Safe and Trouble-Free Process Operation,” presented at the International Conference on Properties & Phase Equilibria for Process & Product Design 2019, Vancouver, Canada, 12-16 May, 2019
2. Paul M. Mathias, Henry Z. Kister, Bruce Parker, Lydia Narvaez, Thomas Schafer and Alan Erickson, “Component Trapping with VLE Uncertainty: Principles and Troubleshooting,” presented at the 2017 Spring AIChE Meeting, San Antonio, 26-30 March, 2017.
3. Paul M. Mathias, “Process Sensitivity to Phase Equilibrium – A New Perturbation Method Based Upon the Margules Equation,” presented at the 2013 AIChE Annual Meeting, San Francisco, CA, November 3-8, 2013.
4. Paul Mathias, “Some Examples of the Contribution of Applied Thermodynamics to CO_2-Capture Technology,” presented at Properties and Phase Equilibria for Product and Process Design, Iguazu Falls, Argentina – Brazil, May 26-30, 2013.
5. Paul M. Mathias, “Explicit and Tacit Knowledge in the Development and Use of Property Databases,” [***Invited***], presented at the Eighteenth Symposium on Thermophysical Properties, Boulder, CO, 24-29 June, 2012.
6. Paul M. Mathias, [***Invited Plenary***] “The Role of Experimental Data in Chemical Process Technology,” presented at 20th International Conference on Chemical Thermodynamics, Warsaw, Poland, 3-8 August 2008.
7. Paul M. Mathias, [***Invited***] “Applied Thermodynamics in Chemical Technology: Current Practice and Future Challenges,” presented at the Tenth International Conference on Properties and Phase Equilibria for Product and Process Design (PPEPPD 2004), Snowbird, Utah, 16-21 May 2004.
8. Paul M. Mathias and Lloyd C. Brown, [***Invited***] “Thermodynamics of the Sulfur-Iodine Cycle for Thermochemical Hydrogen Production,” presented at the 68th Annual Meeting of the Society of Chemical Engineers, Japan, The University of Tokyo, 23-25 March 2003.
9. P. M. Mathias, H. Cheng, S. J. Cook, H. C. Klotz and V. S. Parekh, [***Invited***] “Molecular Modeling in Engineering Design and Materials Development,” presented at the Seventh International Conference on Fluid Properties & Phase Equilibria for Chemical Process Design, Snowmass, Colorado, 18-23 June 1995.
10. P. M. Mathias, H. C. Klotz and J. M. Prausnitz, “Equation of State Mixing Rules for Multicomponent Nonideal Mixtures,” presented at the AIChE Annual Meeting, Chicago, 11-16 November 1990.
11. J. F. Boston and P. M. Mathias, “Phase Equilibrium in a Third Generation Process Simulator,” presented at “Phase Equilibria and Fluid Properties in the Chemical Process Industry,” Berlin, West Germany, March 1980.

INVITED SEMINARS AND PRESENTATIONS:

25 invited seminars and presentations. Selected seminars are listed below.

1. “Importance of Tacit Knowledge and Uncertainty Analysis in Chemical Process Design,” seminar presented to University of Minnesota, Minneapolis, May 10, 2017.
2. “Expertise in Chemical Process Modeling,” seminar presented to Instituto Superior Technico, Lisbon, Portugal, September 21, 2012.

3. "Expertise in Chemical Process Modeling. The Importance of Problem Formulation and Pattern Recognition," seminar presented to University of California, Irvine, December 2, 2011.
4. "Analysis of CO_2 Capture," seminar presented at Rice University, Houston, Texas, October 26, 2010.
5. "Thermodynamics of the Sulfur-Iodine Cycle for Thermochemical Hydrogen Production," seminar presented at Texas A&M University, March 19, 2003.
6. "Electrolytes in Education, Research and Engineering Design," seminar presented at the University of Virginia, Charlottesville, Virginia, January 31, 2002.
7. "Molecular Modeling in Engineering Design and Materials Development," seminar presented at The University of Pennsylvania, November 3, 1997.
8. "Correlation and Prediction of Physical Properties for Engineering Design and Materials Development," seminar presented at Michigan State University, East Lansing, Michigan, February 19, 1993.

CONFERENCE SESSIONS CHAIRED:

40 conference sessions chaired. Selected sessions are listed below.

1. Group chair for Fuels & Petrochemicals sessions at the 2020 AIChE Annual meeting San Francisco, 15-20 November, 2020.
2. "Poster Session: Fuels and Petrochemicals Division," 2019 AIChE Annual meeting, Orlando, 10-15 November, 2019.
3. "Highlights from the 20th Symposium on Thermophysical Properties," 2018 AIChE Annual meeting, Pittsburgh, 28 October – 2 November, 2018.
4. "Correlations and Engineering Equations of State 6 - Mixture Models 2," Nineteenth Symposium on Thermophysical Properties, Boulder, CO, 21-26 June, 2015.
5. "Thermodynamic Needs of Chemical Industry," 2013 AIChE Annual meeting, San Francisco, CA, November 3-8, 2013.
6. "Correlations of the Fluid Phase Equilibrium Symposium," ICCT06 19th International Conference on Chemical Thermodynamics), Boulder, CO, 30 July – August 4, 2006.
7. "Thermodynamics for Process Design and Simulation," 2005 AIChE Spring Meeting, Atlanta, Georgia, 10-14 April, 2005.
8. "Thermodynamic Properties for Process Design and Simulation," 2002 AIChE Spring Meeting, New Orleans, Louisiana, 10-14 March, 2002.
9. "Bridging the Gap Between Modeling in Chemistry and Chemical Engineering," symposium at the 1999 Spring ACS Spring Meeting, March 21-25, Anaheim, California.
10. "Molecular Simulation. Application to Real Systems," 1998 AIChE Annual Meeting, Miami Beach, November 15-20, 1998.
11. Area 1a (Thermodynamics and Transport Properties) coordinator for the 1997 Spring AIChE Meeting, Houston, Texas, March, 1997.

12. “Fundamentals of Advanced Materials Processing III: Thermodynamics,” Fifth World Congress of Chemical Engineering, San Diego, 14-18 July, 1996.
13. Area 1a (Thermodynamics and Transport Properties) coordinator for the 1988 Annual AIChE Meeting, Washington, D.C., November, 1988.