Simcha Singer

♦ Marquette University, Dept. of Mechanical Engineering ♦
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PROFESSIONAL EXPERIENCE

Assistant Professor, Dept. of Mechanical Engineering, **Marquette University** August 2014-present

RESEARCH INTERESTS

- Combustion and Gasification of Porous Solids
- Multicomponent Droplet Vaporization
- Surrogate Fuels
- Pyrolysis

EDUCATION

Massachusetts Institute of Technology, Cambridge, MA

Post-Doctoral Associate, Dept. of Chemical Engineering 2012-2014

PhD in Mechanical Engineering June 2012
Thesis: Gasification and Combustion Modeling of Porous Char Particles

MS in Mechanical Engineering September 2006
Thesis: Low Pt-Loading Electrospun Electrodes for Proton Exchange Membrane Fuel Cells

Northwestern University, Evanston, IL

BS in Mechanical Engineering, Magna Cum Laude June 2004

PUBLICATIONS (PEER-REVIEWED JOURNALS)

D. Liang, **S. Singer**, "Automated combustion model classification for char particle distributions using 3-D morphology analysis and pore-resolving CFD simulations" *Fuel*, 335, 127020 (2023).

D. Liang, **S. Singer**, "Pore-Resolving Simulations of Biomass Char Particle Combustion" *Proceedings of the Combustion Institute*, Volume 39, In Press (2022).

Z. Liu, M. Hughes, Y. Tong, J. Zhou, W. Kreutter, H. Cortes Lopez, **S. Singer**, D. Zitomer, P. McNamara, "Paper mill sludge biochar to enhance energy recovery from pyrolysis: A comprehensive evaluation and comparison" *Energy*, Volume 239, Part A, 121925 (2022).

D. Liang and **S. Singer**, "Pore-Resolving Simulations to Study the Impacts of Char Morphology on Zone II Combustion and Effectiveness Factor Models" *Combustion and Flame*, 229, 111405 (2021).

Z. Liu, M. Hughes, Y. Tong, J. Zhou, W. Kreutter, D. Valtierra, **S. Singer**, D. Zitomer, P. McNamara, "Enhanced Energy and Resource Recovery via Synergistic Catalytic Pyrolysis of Byproducts from Thermal Processing of Wastewater Solids" *Renewable Energy,* 177, 475-481 (2021).

S. Singer, M. Hayes, A. Cooney, "A Hybrid Droplet Vaporization-Adaptive Surrogate Model using an Optimized Continuous Thermodynamics Distribution" *Fuel*, 288, 119821 (2021).

W. Kreutter, Z. Liu, P. McNamara, **S. Singer**, "Kinetic Analysis of Dried Biosolids Pyrolysis" *Energy & Fuels,* 33 (9) 8766-8776 (2019).

S. Jorgensen, **S. Singer**, "Micro-CT-based Approaches for Quantifying the Morphology of Pulverized Char Particles" *Energy & Fuels,* 33 (6), 4826-4834 (2019).

A. Cooney, **S. Singer**, "A hybrid droplet vaporization-chemical surrogate approach for emulating vaporization, physical properties, and chemical combustion behavior of multicomponent fuels" *Proceedings of the Combustion Institute*, 37, 3229-3236 (2019).

Z. Liu, **S. Singer**, D. Zitomer, and P. McNamara. "Sub-pilot-scale Autocatalytic Pyrolysis of Wastewater Biosolids for Enhanced Energy Recovery." *Catalysts,* 8, 524-534, (2018).

G. Fong, S. Jorgensen, and **S. Singer**, "Pore-Resolving Simulation of Char Particle Gasification Using Micro-CT" *Fuel*, 224, 752-763 (2018).

Z. Liu, **S. Singer**, Y. Tong, L. Kimbell, E. Anderson, M. Hughes, D. Zitomer, P. McNamara, "Characteristics and Applications of Biochars Derived from Wastewater Solids," *Renewable and Sustainable Energy Reviews*, 90, 650-664 (2018).

A. Cooney, **S. Singer**, "Modeling Multicomponent Fuel Droplet Vaporization with Finite Liquid Diffusivity using the Direct Quadrature Method of Moments with Delumping," *Fuel*, 212, 554-565 (2018).

J. Li, **S. Singer**, "An efficient coal pyrolysis model for detailed tar species vaporization," *Fuel Processing Technology*, 171, 248-257 (2018).

S. Singer, "Direct Quadrature Method of Moments with Delumping for Modeling Multicomponent Droplet Vaporization," *International Journal of Heat and Mass Transfer*, 103, 940-954 (2016).

S. Singer, L. Chen, and A. F. Ghoniem, "The Influence of Gasification Reactions on Char Consumption under Oxy-Combustion Conditions: Effects of Particle Trajectory and Conversion," *Proceedings of the Combustion Institute*, 34, (2), 3471–3478) (2013).

S. Singer and A. F. Ghoniem, "Comprehensive Gasification Modeling of Char Particles with Multi-Modal Pore Structures", *Combustion and Flame*, 160 (1), 120–137 (2013).

S. Singer and A. F. Ghoniem, "An Adaptive Random Pore Model for Multi-Modal Pore Structure Evolution with Application to Char Gasification," *Energy and Fuels*, 25 (4), 1423-1437 (2011).

PUBLICATIONS (CONFERENCES)

S. Singer, "Modeling Multicomponent (Preferential) Vaporization and Combustion Properties of Jet Fuel Droplets with Accuracy, Efficiency, and Flexibility" *Spring Technical Meeting, Central States Section of the Combustion Institute*, May 2022.
(Not Peer-reviewed)

M. Hayes, **S. Singer**, "Developing Computationally Efficient Property Calculations for High-Pressure, Multi-Component Droplet Vaporization," *Proceedings of the Wisconsin Space Conference*, August 2021.

D. Liang, **S. Singer**, "Pore-resolving simulations of char particle combustion and automated image analysis to improve models for reactor-scale codes" *U.S. National Combustion Meeting*, May 2021.
(Not Peer-reviewed)

S. Singer, "Modifying continuous thermodynamics droplet vaporization models to predict functional group fluxes" *U.S. National Combustion Meeting*, March 2019.
(Not Peer-reviewed)

S. Jorgensen, **S. Singer**, "Pore-resolving simulation to study the effect of morphology on char combustion" *U.S. National Combustion Meeting*, March 2019.
(Not Peer-reviewed)

A. Cooney, **S. Singer**, "Modeling high-pressure multicomponent droplet vaporization using quadrature moment methods with delumping and the Peng-Robinson equation of state" *ICLASS 2018: 14th International Conference on Liquid Atomization and Spray Systems, Institute for Liquid Atomization and Spray Systems*, July 2018.
(Peer-reviewed)

A. Cooney, **S. Singer**, "A Droplet Vaporization-Adaptive Surrogate Model Applied to Jet Fuels" *Spring Technical Meeting, Central States Section of the Combustion Institute*, May 2018.
(Not Peer-reviewed)

S. Jorgensen, **S. Singer,** "Single Particle, Pore-Resolving Simulation of Coal Char Oxy-Combustion", *Spring Technical Meeting, Central States Section of The Combustion Institute*, May 2018.
(Not Peer-reviewed)

Z. Liu, **S. Singer**, D. Zitomer, P. McNamara, "Can Autocatalytic Pyrolysis of Wastewater Biosolids be Energy Neutral and Generate Value-Added Products?" *Proceedings of the Water Environment Federation*., pp. 360-364, 2017.
(Peer-reviewed)

S. Singer, J. Cai, W. H. Green, "Detailed Modeling of Pyrolysis of Large Lignite Particles", *Proceedings of the 40th International Technical Conference on Clean Coal and Fuel Systems*, pp. 278-289, 2015.
(Not Peer-reviewed)

M. Kumar, R. F. D. Monaghan, **S. Singer**, C. Zhang, and A. F. Ghoniem, "CFD Simulation of Entrained Flow Gasification with Improved Devolatilization and Char Consumption Submodels", *Proceedings of the ASME IMECE*, 2009, Vol. 3, pp. 383-395, 2009.

R. F. D. Monaghan, M. Kumar, **S. Singer**, C. Zhang and A. F. Ghoniem, "Reduced Order Modeling of Entrained Flow Solid Fuel Gasification", *Proceedings of the ASME IMECE*, 2009, Vol. 3, 397-409.

PRESENTATIONS

D. Liang, **S. Singer**, "Pore-Resolving Simulations of Biomass Char Particle Combustion" *Proceedings of the Combustion Institute*, July 28, 2022

S. Singer, "Modeling Multicomponent (Preferential) Vaporization and Combustion Properties of Jet Fuel Droplets with Accuracy, Efficiency, and Flexibility" *Spring Technical Meeting, Central States Section of the Combustion Institute*, May 17, 2022.

D. Liang, **S. Singer**, "Pore-resolving simulations of char particle combustion and automated image analysis to improve models for reactor-scale codes" *U.S. National Combustion Meeting*, College Station, TX, May 24, 2021.

S. Singer, "Droplet Vaporization - Chemical Surrogate Models for Multicomponent Fuels" *Center for Energy and Propulsion Research, Reacting Gas Dynamics Laboratory Seminar,* MIT Dept. of Mechanical Engineering, January 22, 2021.

S. Singer, "Modifying continuous thermodynamics droplet vaporization models to predict functional group fluxes" U.S. National Combustion Meeting, Pasadena, CA, March 26, 2019.

S. Jorgensen, **S. Singer**, "Pore-resolving simulation to study the effect of morphology on char combustion" U.S. National Combustion Meeting, Pasadena, CA, March 25, 2019.

A. Cooney, **S. Singer**, "A hybrid droplet vaporization-chemical surrogate approach for emulating vaporization, physical properties, and chemical combustion behavior of multicomponent fuels" International Combustion Symposium, Dublin, Ireland, July 31, 2018.

Cooney, A., **Singer S.**, "Modeling high-pressure multicomponent droplet vaporization using quadrature moment methods with delumping and the Peng-Robinson equation of state" ICLASS 2018: 14th International Conference on Liquid Atomization and Spray Systems, Institute for Liquid Atomization and Spray Systems, Chicago. July 26, 2018.

Cooney, A., **Singer S.**, "A Droplet Vaporization-Adaptive Surrogate Model Applied to Jet Fuels" 2018 Spring Technical Meeting, Central States Section of the Combustion Institute, Minneapolis, MN, May 22, 2018.

Jorgensen, S., **Singer S.**, "Single Particle, Pore-Resolving Simulation of Coal Char Oxy-Combustion", 2018 Spring Technical Meeting, Central States Section of The Combustion Institute, Minneapolis, MN. May 22, 2018.

Tong, Y., McNamara, P.J**., Singer, S.L.**, Mayer, B.K. The Thermodynamics of Attachment: Enthalpy and Free Energy of Adsorption of Neutral and Ionic Micropollutants on Biosolids-derived biochar. *255rd ACS National Meeting*. New Orleans, LA, March 20, 2018.

Liu, Zhongzhe, **Simcha L Singer**, Daniel H. Zitomer, and Patrick McNamara, "Biochar from Wastewater Biosolids: Solids Management to Advance Sustainable Communities", AEESP 2017 Research & Education Conference, June 2017.

Liu, Z, **Singer, S.**, McNamara, P., Zitomer, D, "Can Autocatalytic Pyrolysis of Wastewater Biosolids be Energy Neutral and Generate Value-Added Products?" Presented at Residuals and Biosolids Conference, Seattle, WA, April 2017.

S. Singer, "Modeling pyrolysis and char combustion for porous coal particles" Lindberg Lecture, University of Wisconsin-Madison, Dept. of Mechanical Engineering, April 23, 2015.

S. Singer, "Detailed Modeling of Pyrolysis of Large Lignite Particles", *40th International Technical Conference on Clean Coal and Fuel Systems*, Clearwater, FL, June 2015

S. Singer, Green W. H., "Numerical Simulation of Forward and Static Smoldering Combustion," *COMSOL Conference 2013*, Newton, MA, October 2013.

S. Singer, Chen, L. and Ghoniem, A. F., "The Influence of Gasification Reactions on Char Consumption under Oxy-Combustion Conditions: Effects of Particle Trajectory and Conversion," *34th International Symposium on Combustion*, Warsaw, Poland, August 2012.

GRANTS

Singer, S. (PI), Roy S. (co-PI). Capturing the impact of realistic multicomponent fuels in high-pressure spray combustion simulations. **National Science Foundation**, 1/2023 - 12/2025; $318,990.

Singer, S. (PI). Capturing the impact of real, complex biomass char particle morphology during gasification. **National Science Foundation**, 7/2022 - 6/2025; $275,112.

Singer, S. (PI). Quantifying Interactions between Chemical Reaction, Gas Transport and Morphology in Porous Char Gasification. **Marquette University ORSP Regular Research Grant**, 5/2020-8/2020; $6,000.

Singer, S. (PI). Adaptive Surrogate Models for High Pressure Combustion. **Opus College of Engineering, Wallace Fund**, 9/2018-5/2019; $20,000.

Borg, J. (PI), Coutu, R. (co-PI), Roy, S. (co-PI), **Singer, S.** (co-PI), Connecting Experiments and Simulations while Designing Functionality into the Dynamic Behavior of Surrogate Energetic Systems. **Air Force Office of Scientific Research**, 9/30/2018–9/29/2023; $1,502,289.

Singer, S. (PI). Pore-Resolving Simulations of Coal Gasification using Micro-CT Imaging. **American Chemical Society – Petroleum Research Fund**, 9/2016-8/2018; $110,000.

McNamara, P. (PI), **Singer, S.** (Co-PI), Liu, Z. (Co-PI). Pilot-Scale Pyrolysis: [Auto-] Catalysis to Improve Yields and Quality. **Milwaukee Metropolitan Sewerage District.** 7/2016-8/2017; $156,936.

Singer, S. (PI), LaDisa J. (Co-PI). Modeling Chemical Deposition in the Human Airway from Electronic Cigarettes. **Marquette University – Opus College of Engineering Seed Grant**, 7/2016-6/2017; $75,000.

McNamara, P. (PI), Mayer, B. (Co-PI), **Singer, S.** (Co-PI). Removal of Pollutants from Contaminated Fluids using a Novel Adsorbent: Combining Experiments and Modeling to Decipher Fundamental Mechanisms, **Marquette University – Opus College of Engineering Seed Grant**, 1/2017-12/2017; $75,000.

Singer, S. (PI), McNamara, P.J. (Co-PI). Thermo-Gravimetric Analyzer (TGA) System, **Marquette University – Opus College of Engineering Equipment Grant,** 7/2016-6/2017; $39,900.

Singer, S. (PI). Hybrid Models to Reduce the Computational Cost of Simulating Energy Conversion Processes– **Marquette University ORSP Regular Research Grant,** 5/2016-8/2016; $5,500

ADVISING

Theses Directed

Graduated

Jianqing Li, *Modeling Pyrolysis of Large Coal Particles with Many Species*, M.S., November 2016
Greg Fong, *Pore-Resolved Simulations of Char Particle Gasification*, M.S., May 2017
Alanna Cooney, *Computational Methods for Modeling Multicomponent Droplet Vaporization*, M.S., May 2018
Scott Jorgensen, *Pore-Resolved Simulations of Char Particle Combustion*, M.S., May 2019
William Kreutter, *Biosolids pyrolysis: Experiments and Modeling*, M.S., May 2019
Dongyu Liang, *Improving Char Combustion Models using Micro-CT, Automated Image Analysis, and Pore-Resolving Simulations*, Ph.D, December 2022

Current

Wilbert Cruz, M.S., (co-advisee) Anticipated 2023

Dissertation/Thesis Committee Member

David Wilson, M.S., April 2016, Casey Allen chair
Logan Beaver, M.S., May 2017, John Borg chair
Jenna Ezzell, M.S., May 2017, Casey Allen chair
Yiran Tong, Ph.D., March 2018, Patrick McNamara, and Brooke Mayer chairs
Jonathan Bruss, M.S., July 2018, John Borg chair
Woojae Chung, M.S., November 2018, Chunghoon Lee chair
Joseph Farmer, M.S., April 2019, Somesh Roy chair
Dylan Lehmier, M.S., April 2019, Casey Allen chair
David Wilson, Ph.D, April 2019, Casey Allen chair
David Roulo, M.S., June 2019, Casey Allen chair
Ashley Hatzenbihler, M.S., June 2019, Casey Allen chair
Khaledmosharraf Mukut, M.S. June 2019, Somesh Roy chair
Chloe David, M.S. April 2021, Somesh Roy chair
Tyler Reaker, M.S. April 2021, Casey Allen chair
Jared Zeman, M.S. July 2021, Adam Dempsey chair

Undergraduate Researchers

Renata Vinhas (Fall 2015)
Yuxing Zhang (Summer 2016)
Jonathan Blanchard (Spring 2017)
William Kreutter (Spring 2017)
Scott Jorgensen (Spring 2017)
Michael Hayes (Recipient of NASA WSGC Undergraduate Research Award, 2019-2020)
Wilbert Cruz (McNair Scholar, Summer 2021)

Senior Design Teams/Sponsors

M80/Briggs and Stratton (2015-2016)
M82/Briggs and Stratton (2016-2017)
M99/Grumman Butkus Associates (2016-2017)
M74/Modine (2017-2018)
M84/Broan-NuTone (2020-2021)
M77/Marquette University (2021-2022)
M77/Marquette University (2022-2023)

TEACHING

Dept. of Mechanical Engineering, Marquette University

Courses taught:

Thermodynamics I (MEEN 3310), an undergraduate course (Fall 2014 - Fall 2022)
Fluid Mechanics (MEEN 3320), an undergraduate course (Fall 2020)
Thermodynamics II (MEEN 3340), an undergraduate course (Spring 2021)
Intermediate Thermodynamics (MEEN 4360/5360), graduate/undergraduate course (Spring 2017-2023)

Courses developed and taught:

Radiation Heat Transfer (MEEN 6340), a graduate course (Fall 2016, Fall 2017, Fall 2019)
Multicomponent Mass Transfer (MEEN 6931), a graduate course (Fall 2018)

Dept. of Mechanical Engineering, MIT

TA for *Fundamentals of Advanced Energy Conversion*, a graduate/undergraduate course (Spring 2008)

SERVICE

MEEN Graduate Committee (2014-2015)
MEEN Faculty Search Committee (2015-2016)
MEEN Undergraduate Committee (2016-2017)
MEEN Faculty Search Committee (2017-2018)
MEEN Undergraduate Committee (2018-2023)
MEEN Department Secretary (2018-2019)
MEEN Course Scheduling (2019-2023)
Tau Beta Pi – Faculty Advisor (2016-present)
Referee for:

AIChE Journal
Brazilian Journal of Chemical Engineering
Chemical Engineering Journal
Combustion and Flame
Fuel
Energy and Fuels
Fuel Processing Technology
International Journal of Heat and Mass Transfer
Proceedings of the Combustion Institute

HONORS/AWARDS

Distinguished Paper Award in the *Spray, Droplet, and Supercritical Combustion* section for the 37th International Symposium on Combustion, January 16, 2019

Outstanding Teacher in Mechanical Engineering for 2017-2018, April 20, 2018

INVITED LECTURES

"Droplet Vaporization - Chemical Surrogate Models for Multicomponent Fuels" MIT, Dept. of Mechanical Engineering, Reacting Gas Dynamics Seminar, January 22, 2021

"Modeling pyrolysis and char combustion for porous coal particles" Lindbergh Lecture, University of Wisconsin-Madison, Dept. of Mechanical Engineering, April 23, 2015

MEMBERSHIP

Combustion Institute, Tau Beta Pi