# BRIAN C. KAUL, PHD

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## WORK EXPERIENCE

Oak Ridge National Laboratory, Knoxville, TN

**Senior Research Staff—Fuel Science and Engine Technologies Research Group** **2012–present**

- Served as principal investigator for research related to nonlinear dynamics analysis of abnormal combustion phenomena
- Coordinated multi-lab research activities related to application of machine learning for mitigation of combustion instabilities as a team lead for the Partnership to Advance Combustion Engines (PACE) consortium
- Led research on the combustion of alternative low-carbon and net-zero-carbon fuels for marine engine applications, including ammonia and novel biofuels
- Conducted research on the effects of lubricants on marine diesel efficiency and durability on a unique single-cylinder, scaled-down, crosshead 2-stroke diesel engine
- Developed, deployed, and maintained in-house LabVIEW-based Oak Ridge Combustion Analysis System (ORCAS)
- Gained extensive experience in setting up engine experiments and data acquisition/control systems and conducting experiments related to engine combustion, efficiency, and emissions: supported carbon capture, buildings experiments
- Communicated findings through publications and presentations and maintained sponsor relationships

Oak Ridge National Laboratory, Knoxville, TN

**Postdoctoral Research Associate—Fuels, Engines, and Emissions Research Center** **2008–2012**

- Conducted second-law thermodynamic analysis of experimental and modeling data for a heavy-duty diesel engine
- Conducted experiments for thermodynamic, material durability, and turbocharger performance studies on a diesel engine
- Oversaw installation and commissioning of a prototype large-bore natural gas single-cylinder research engine
- Designed, installed, and programmed LabVIEW-based engine control system for a single-cylinder natural gas engine
- Designed engine experiments to examine combustion instabilities in lean natural gas engine operation
- Prepared reports and presented results from various studies (largely corporate sponsor proprietary data/unpublished)
- Participated in proposal process for multiple new projects

## PROFESSIONAL AFFILIATIONS AND ACTIVITIES

SAE International

**Member** **2004–Present**

- Engine Combustion Committee member
- Lead session organizer and session chair
- Invited symposium presenter
- Paper author and reviewer

American Society of Mechanical Engineers (ASME)

**Member** **2001–Present**

- Technical committee member and webinar presenter
- Paper author and reviewer

Institute of Electrical and Electronics Engineers (IEEE)

**Senior Member** **2022–Present**

- Elevated to Senior Member 2022
- Paper author and reviewer

Southwest Research Institute

**Project Technical Advisory Committee Member** **2017–2020**

- Participated in project titled “Natural gas dedicated exhaust gas recirculation for improved on-highway efficiency,” sponsored by the California Clean Energy Commission
- Provided technical review and advice on project direction and research approach

## EDUCATION

Missouri University of Science & Technology, Rolla, MO
**PhD in Mechanical Engineering** **2008**
Dissertation: *Addressing nonlinear combustion instabilities in highly dilute SI engine operation*

Missouri University of Science & Technology, Rolla, MO
**MS in Mechanical Engineering** **2003**
Thesis: *Three-dimensional velocity measurements of three-dimensional turbulent separated flow*

Missouri University of Science & Technology, Rolla, MO
**BS in Mechanical Engineering** **2001**
Minor: History
Graduated summa cum laude

## HONORS AND AWARDS

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|---|---|
| Forest McFarland Award, SAE International | **2025** |
| Senior Member, IEEE | **2022** |
| Mentor of the Year, Oak Ridge Postdoc Association | **2021** |
| Exceptional Effort Award, ORNL Energy & Transportation Science Division | **2016** |
| GAANN Fellowship, Missouri University of Science & Technology | **2006–2007** |
| Chancellor's Fellowship, University of Missouri – Rolla | **2001–2006** |
| ΤΒΠ Engineering Honor Society Member, Chapter Officer | **2000–2001** |
| ΠΤΣ Mechanical Engineering Honor Society Member, Chapter President | **1999–2001** |
| ΦΚΦ Honor Society Member | **2000–2001** |

## POSTDOCS AND STUDENTS MENTORED

Postdoctoral Fellows

**Dr. Daanish Tyrewala** **2024–Present**
- Experimental engine combustion R&D exploring ammonia dual-fuel combustion for marine decarbonization
- Multiple publications and presentations

**Dr. Bryan Maldonado** **2020–2022**
- Experimental application of AI/ML-based engine combustion control strategies
- Multiple publications and presentations, ORNL "Your Science in a Nutshell" presentation award winner
- Joint projects with ORNL and University of Tennessee faculty advancing AI/ML capabilities for engine controls
- Currently ORNL R&D Staff

**Dr. Benjamin Lawler** **2013–2014**
- Experimental engine R&D applying novel sensors and data analysis techniques
- Multiple publications and presentations
- Successful proposal exploring novel combustion control techniques with water injection
- Currently Associate Professor at Clemson University Department of Automotive Engineering

Doctoral student dissertation advisory committee

**Dr. Rachel Stiffler—PhD in Mechanical Engineering from Missouri S&T** **2017–2022**
- Provided perspective and advice on research topic and directions
- Multiple publications and presentations
- Hosted at ORNL as summer graduate student intern for two summers

## TEACHING EXPERIENCE

Missouri University of Science & Technology, Rolla, MO
**Instructor: "ME 221—Applied Thermodynamics"** **2007–2008**

Developed syllabus, lectured, tutored students in office hours, administered assignments and grading

## PUBLICATIONS

60+ peer-reviewed articles, 1100+ citations, h-index = 18, i10-index = 33, ORCID 0000-0001-8481-3620, Scopus ID 27171271100

Dal Forno Chuahy F, Finney CEA, Kaul BC, Kass MD, "Comparison of a full-scale and a 1:10 scale low-speed two-stroke marine engine using computational fluid dynamics," *Journal of Engineering for Gas Turbines and Power* 147(9):091008, 2025. doi:10.1115/1.4067472

Kaul B, Kass M, Theiss T, Messner J, Tan E, Dutta A, Li S, Ramasamy K, Masum F, Benvenutti L, Hawkins T, "Biofuels as heavy fuel oil substitutes in the maritime sector: findings and potential pathways," *8th Rostock Large Engine Symposium 2024: The Future of Large Engines VIII: Technology Concepts and Fuel Options: The Route to Clean Shipping,* pp. 1–15. 2024, Rostock, Germany. doi:10.18453/rosdok_id00004632

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Kaul B, Maldonado B, Michlberger A, Halley S, "Analysis of real-world preignition data using neural networks," *SAE Technical Paper 2023-01-1614,* 2023. doi:10.4271/2023-01-1614

Curran S, Onorati A, Payri R, Agarwal AK, Arcoumanis C, Bae C, Boulouchos K, dal Forno Chuahy F, Gavaises M, Hampson GJ, Hasse C, Kaul B, Kong S-C, Kumar D, Novella R, Pesyridis A, Reitz R, Vaglieco BM, Wermuth N, "The future of ship engines: Renewable fuels and enabling technologies for decarbonization," *International Journal of Engine Research* 25(1)*,* 2024. doi:10.1177/14680874231187954

Kaul B, Gillespie T, Curran S, *Hazard and operability study for the ammonia fuel systems at the National Transportation Research Center,* ORNL Report ORNL/TM-2023/2963, 2023. doi:10.2172/1989552

Kaul B, Kass M, Nafziger E, Givens W, Satterfield A, Senzer E, Chen M, "Lubricant impacts on piston deposit formation in the Enterprise marine diesel research engine," *Proceedings of the 30th CIMAC World Congress*. 2023, Busan, Korea.

Sieger M, Turner J, Allu S, Ameen M, Chaudhuri S, Chen J, Chen Y, Chuahy F, Finney C, Gururajan V, Huang H, Kaul B, Klippenstein S, Martin H, Pal P, Peles S, Plotkowski A, Sanyal J, Sengupta M, Som S, Sprague M, *Computational requirements in clean energy and manufacturing: Summary report of the virtual workshop held on June 28–29, 2021.* ORNL Report ORNL/SPR-2023/2707, 2023. doi:10.2172/1971039

Lance MJ, Toops T, Moses-DeBusk M, Kaul BC, Lambert C, Liu X, Luo H, Qu J, Rieth R, Ritchie A, Huff SP, Maricq M, Dobson D, Gangopadhyay A, Chanko T, "Investigation of lubricant additive interactions on gasoline particulate filters," *SAE International Journal of Fuels and Lubricants* 16(3), 2023. doi:10.4271/04-16-03-0019

Kaul BC, Nafziger EJ, Kass MD, Satterfield AD, Conti R, Prabhakar B, Givens WA, "Measurement of piston deposit thickness using laser profilometer," *SAE International Journal of Fuels and Lubricants* 16(3), 2023. doi:10.4271/04-16-03-0014

Maldonado BP, Kaul BC, Schuman CD, Young SR, Mitchell JP, "Next-cycle optimal dilute combustion control via online learning of cycle-to-cycle variability using kernel density estimators," *IEEE Transactions on Control Systems Technology* 30(6):2433–2449, 2022. doi:10.1109/TCST.2022.3149423

Chuahy FDF, Finney CEA, Kaul BC, Kass MD, "Computational exploration of bio-oil blend effects on large two-stroke marine engines," *Fuel* 322, 2022. doi:10.1016/j.fuel.2022.123977

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Maldonado BP, Kaul BC, Szybist JP, "Artificial neural networks for in-cycle prediction of knock events," *SAE Technical Paper* 2022-01-0478, 2022. doi:10.4271/2022-01-0478

Maldonado B, Stefanopoulou A, Kaul B, "Chapter 8 – Artificial-intelligence-based prediction and control of combustion instabilities in spark-ignition engines," in *Artificial Intelligence and Data Driven Optimization of Internal Combustion Engines,* Editors: Badra J, Pal P, Pei Y, Som S, Elsevier, 2022, pp 185–212. doi:10.1016/B978-0-323-88457-0.00006-0

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Curran S, Szybist J, Kaul B, Easter J, Sluder S, "Fuel stratification effects on gasoline compression ignition with a regular-grade gasoline on a single-cylinder medium-duty diesel engine at low load," *SAE International Journal of Advances and Current Practices in Mobility* 4(2):488–501, 2021. doi:10.4271/2021-01-1173

Lerin C, Edwards K, Curran S, Nafziger E, Moses-Debusk M, Kaul B, Singh S, Allain M, Girbach J, "Exploring the potential benefits of high-efficiency dual-fuel combustion on a heavy-duty multi-cylinder engine for SuperTruck I," *International Journal of Engine Research,* 2021. doi:10.1177/14680874211006943

Lerin C, Curran S, Moses-Debusk M, Cook A, Colomer V, Kaul B, Deter D, "Hardware-in-the-loop investigation of emissions challenges in hybrid medium- and heavy-duty powertrains using a pre-production diesel-electric parallel hybrid system with and without stop-start operation," *Proceedings of the ASME 2021 Internal Combustion Engine Division Fall Technical Conference,* 2021. doi:10.1115/ICEF2021-68317

Maldonado BP, Kaul BC, Schuman CD, Young SR, Mitchell JP, "Next-cycle optimal fuel control for cycle-to-cycle variability reduction in EGR-diluted combustion," *IEEE Control Systems Letters* 5(6):2204–2209, 2021. doi:10.1109/LCSYS.2020.3046433

Maldonado BP, Kaul BC, Schuman CD, Young SR, Mitchell JP, "Dilute combustion control using spiking neural networks," *SAE Technical Paper* 2021-01-0534, 2021. doi:10.4271/2021-01-0534

Stiffler R, Kaul B, Drallmeier J, "Cyclic dynamics of misfires and partial burns in a dilute spark-ignition engine," *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering* 235(2–3):333–345, 2021. doi:10.1177/0954407020964004

Maldonado BP, Kaul BC, "Evaluation of residual gas fraction estimation methods for cycle-to-cycle combustion variability analysis and modeling," *International Journal of Engine Research,* 2021. doi:10.1177/1468087420983087

Kass MD, Sluder CS, Kaul BC, *Spill behavior, detection, and mitigation for emerging nontraditional marine fuels*, Oak Ridge, Tennessee, USA: Oak Ridge National Laboratory, 2021. ORNL Report No. ORNL/SPR-2021/1837

Kaul B, Finney C, Stiffler R, Drallmeier J, "Advanced intra-cycle detection of pre-ignition events through phase-space transforms of cylinder pressure data," *SAE International Journal of Advances and Current Practices in Mobility* 3(1):215–222, 2021. doi:10.4271/2020-01-2046

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Maldonado BP, Kaul BC, "Control-oriented modeling of cycle-to-cycle combustion variability at the misfire limit in SI engines," *Proceedings of the ASME 2020 Dynamic Systems and Control Conference,* 2020. doi:10.1115/DSCC2020-3255

Kass MD, Armstrong BL, Kaul BC, Connatser RM, Lewis S, Keiser JR, Jun J, Warrington G, Sulejmanovic D, "Stability, combustion, and compatibility of high-viscosity heavy fuel oil blends with a fast pyrolysis bio-oil," *Energy & Fuels* 34(7):8403–8413, 2020. doi:10.1021/acs.energyfuels.0c00721

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Jatana GS, Splitter DA, Kaul BC, Szybist JP, "Fuel property effects on low-speed pre-ignition," *Fuel* 230:474–482, 2018. doi:10.1016/j.fuel.2018.05.060

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Kaul BC, Lawler BJ, Finney CEA, Edwards ML, Wagner RM. "Effects of data quality reduction on feedback metrics for advanced combustion control," *SAE Technical Paper* 2014-01-2707, 2014. doi:10.4271/2014-01-2707

Kaul BC, Finney CEA, Wagner RM, Edwards ML. "Effects of external EGR loop on cycle-to-cycle dynamics of dilute SI combustion," *SAE International Journal of Engines* 7(2), 2014. doi:10.4271/2014-01-1236

Storey JM, Theiss TJ, Kass MD, Finney CEA, Lewis SA, Kaul BC, Besmann TM, Thomas JF, Rogers H, Sepaniak M. *Fuel flexibility: landfill gas contaminant mitigation for power generation,* Oak Ridge, Tennessee, USA: Oak Ridge National Laboratory, 2014. Report No. ORNL/TM-2014/44

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Kaul BC, Wagner RM, Green JB. "Analysis of cyclic variability of heat release for high-EGR GDI engine operation with observations on implications for effective control," *SAE International Journal of Engines* 6(1), 2013. doi:10.4271/2013-01-0270

Kaul BC, Vance JB, Drallmeier JA, Sarangapani J. "A method for predicting performance improvements with effective cycle-to-cycle control of highly dilute spark ignition engine combustion," *Proceedings of the Institution of Mechanical Engineers Part D: Journal of Automobile Engineering* 223(3):423–438, 2009. doi:10.1243/09544070JAUTO943

Shih P, Kaul BC, Jagannathan S, Drallmeier JA. "Reinforcement-learning-based output-feedback control of nonstrict nonlinear discrete-time systems with application to engine emission control," *IEEE Transactions on Systems, Man, and Cybernetics—Part B: Cybernetics* 39(5):1162–1179, 2009. doi:10.1109/TSMCB.2009.2013272

Vance JB, Kaul BC, Jagannathan S, Drallmeier JA. "Neuro emission controller for minimising cyclic dispersion in spark ignition engines with EGR levels," *International Journal of General Systems* 38(1):45–72, 2009. doi:10.1080/03081070802193028

Shih P, Kaul BC, Jagannathan S, Drallmeier JA. "Reinforcement-learning-based dual-control methodology for complex nonlinear discrete-time systems with application to spark engine EGR operation," *IEEE Transactions on Neural Networks* 19(8):1369–1373, 2008. doi:10.1109/TNN.2008.2000452

Vance JB, Kaul BC, Jagannathan S, Drallmeier JA. "Output feedback controller for operation of spark ignition engines at lean conditions using neural networks," *IEEE Transactions on Control Systems Technology* 16(2):214–228, 2008. doi:10.1109/TCST.2007.903368

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Vance JB, He P, Kaul BC, Sarangapani J, Drallmeier JA. "Neural network-based output feedback controller for lean operation of spark ignition engines," *Proceedings of the American Controls Conference,* 2006. pp 1898–1905. doi:10.1109/ACC.2006.1656497

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## PATENTS

Maldonado Puente BP, Kaul BC, Schuman CD, Mitchell JP, Young SR, "Combustion Control using Spiking Neural Networks," U.S. Patent No. US 11,655,775 B1

## SELECTED INVITED PRESENTATIONS, PANELS, AND SEMINARS

Kaul B, Curran S, "Ammonia as a hydrogen carrier for marine engine applications," 2024 ERC Symposium: Hydrogen for Mobility and Power, University of Wisconsin—Madison Engine Research Center, Madison, WI, June 2024.

Kaul B, "Environmental and safety considerations for potential future fuels," Concawe (The European Fuel Manufacturers Association) FEMG Meeting, Brussels, Belgium, October 2022.

Kaul B, "Environmental and safety considerations for potential future fuels," *Expert Panel on Future Fuels* SAE WCX22, Detroit, MI, April 2022.

Kusnezov D, Davies M, Zjajo, A, Schuman C, Kaul B, *Keynote Panel: The Commercial Case for Using Neuromorphic Computing to Drive Edge AI Innovation,* The Edge AI Summit, Mountain View, CA, November 2021.

Kaul B, "Computing utilization of AI/ML for advanced engine controls and experimental analysis," *LCF-6: Computational Resource Requirements in Clean Energy and Manufacturing*, OLCF Workshop, Oak Ridge, TN, June 2021.

Kaul B, Maldonado B, Schuman C, Young S, Mitchell P, "Abnormal combustion detection and control," U.S. DRIVE Advanced Combustion & Engine Control Tech Team, Southfield, MI, January 2021.

Kaul B, Wagner R, Edwards D, Finney C, Schuman K, Patton R, "Next-cycle controls to mitigate dynamical combustion instabilities," SAE High-Efficiency Engine Symposium, Detroit, MI, April 2019.

Kass M, Kaul B, Nafziger E, "Powering marine cargo vessels: ORNL's role in advancing marine engines," ORNL Transportation Science Seminar Series, Oak Ridge, TN, May 2018.

Kaul BC, Jatana GS, Wagner RM, Finney CEA, Edwards KD, Daw CS, "Deterministic cyclic variability: characterization and control," VERIFI 2017 Workshop: Understanding Cyclic Variability (CCV) in Internal Combustion Engines, Argonne, IL, November 2017.