DEPARTMENT OF MECHANICAL ENGINEERING
WILLIAM MAXWELL REED SEMINAR SERIES

"Local Extinction and Edge Flame Propagation in Gas Turbine Engines"

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Abstract: In augmentors used for gas turbine engines, flames are stabilized in high speed flows using bluff body flame holders. The limiting conditions for flame stability are shown to be impacted by the formation of holes in the reacting flame sheet due to interactions between the flow and flame. The formation of these holes lead to a flame edge at the boundary of products and reactants and the overall behavior of the flame is governed by the properties of this edge flame. In this seminar, a range of optical diagnostics are shown for understanding edge flame behavior both in augmentors and in simplified combustors designed to understand details of edge flame propagation. High-speed chemiluminescence imaging, planar laser-induced fluorescence (PLIF) and particle image velocimetry (PIV) are used in the augmentor to identify conditions under which flame holes lead to destabilization of the augmentor flame. An improved model for predicting flame blowoff was developed that relies on a single parameter for defining the formation of flame holes. This parameter is an extinction scalar dissipation rate that has been well studied in the literature. In a separate series of measurements and numerical simulations on a laminar counterflow flame, this extinction scalar dissipation rate is studied in greater detail using PIV, PLIF, Rayleigh- and Raman-scattering spectroscopy. The results show that the previously defined rate for local extinction does not capture the full behavior of edge flames and that consideration of heat flux through the edge is required to correctly predict extinction limits. A simplified approach to measure the heat flux non-intrusively is described and the impact of unsteady flame oscillations is also discussed.

Bio: Dr. Michael Renfro is a Professor and Chair of the Department of Mechanical Engineering at the University of Kentucky. Prior to joining Kentucky in 2015, he was on the faculty at the University of Connecticut where he also served as Associate Department Head from 2009-2014 and as the Director of Graduate Studies from 2006-2009. He received his Ph.D. from Purdue University in 2000. Dr. Renfro's research is in the area of optical diagnostics applied to power production technology, particularly combustion, gas turbine and fuel cell systems. Current research focuses on the development and use of laser-based measurement tools to study flame stability and propagation; ignition and extinction; sensor development for high temperature fluid systems; and non-destructive optical evaluation of high-temperature coatings. He has advised 8 doctoral and 13 master's theses students, and has supervised over 35 undergraduate research projects. Dr. Renfro's research has been supported by NSF, AFOSR, ARO, DOE, and industry with total funding over $5M. Dr. Renfro has published over 60 journal and 100 conference papers. Professor Renfro teaches undergraduate and graduate courses in thermodynamics and fluid mechanics and has received multiple department and university awards for teaching.

Date: Friday, April 6
Time: 3PM
Place: CB 122
Contact: Dr. Alexandre Martin 257-4462

Meet the speaker and have refreshments
Attendance open to all interested persons

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