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Understanding & Predicting Soot Formation from Combustion

Speaker: Dr. Seth Dworkin



Abstract

The rising concentrations of soot particles in the atmosphere lead to climate change and adverse health effects. It is imperative that we gain a better understanding of combustion-borne soot in order to suppress its formation and eliminate it from the air we breathe. Modelling soot formation in combustion is complex, as it relies on accurate computational fluid dynamics, chemical reactions, and particle dynamics. When turbulent flows or complex geometries are considered, the added complexity often leads to prohibitively high computational cost. This talk will showcase some of the fundamental research conducted in the Dworkin group which has led to improved understanding of soot formation processes. Furthermore, details will be provided on a computationally inexpensive soot estimator framework that has been developed and applied to laminar and turbulent flames. With this technique, correlative functions have been developed that relate soot formation to fluid parcel histories. Those correlations are extracted from a variety of validated flame simulations and used to teach an Artificial Neural Network (ANN). The ANN can then be used to predict soot formation in more complex systems, *a posteriori*, based on more readily achievable simulation parameters, such as temperature, gas velocity, and a few major species. The results demonstrate accurate prediction and great potential to be applied in industrial applications.

Biography

Dr. Seth Dworkin is an Associate Professor of Mechanical Engineering at Ryerson University. He holds the Canada Research Chair position in High-Performance computing for Sustainable Energy. He pursued a combined Masters and PhD at Yale University, supervised by Prof. Mitchell Smooke, focusing on Computational Fluid Dynamics and combustion. Dr. Dworkin returned to Canada in 2009, taking a Post-Doctoral Fellowship at the University of Toronto, supervised by Prof. Murray Thomson. He then joined the faculty at Ryerson in 2011, where he established the “Emerging new Green Technologies in Energy and Combustion” or “ENGTEC” lab. He has trained 36 graduate students and post-doctoral fellows, and published 48 peer-reviewed journal papers in the areas of combustion simulation, soot formation, and other sustainable energy technologies. Dr. Dworkin has received numerous awards for his research, including the 2013 Canadian Society for Mechanical Engineering “I. W. Smith Award,” and the 2015 Professional Engineers of Ontario, Young Engineer’s Medal. In 2019, Dr. Dworkin was named a Fellow of the Canadian Society for Mechanical Engineering, recognizing his career research achievements.

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