Aerospace and Mechanical Engineering Seminar

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Modelling Extinction in Turbulent Swirling Non-Premixed Flames

Local and global extinction in turbulent swirling non-premixed flames is investigated with the Large Eddy Simulation, or LES, and the sub-grid-scale Conditional Moment Closure, or CMC, combustion model.

The Sydney swirling air-diluted methane flame is simulated for validating the newly developed finite volume CMC model. Good agreements are achieved in terms of velocity and mixture fraction statistics, averaged reactive scalars in both physical and mixture fraction space. The local extinction level from the increased central fuel velocity is reasonably predicted. The occurrence of local extinction is typically manifested by low heat release rate and hydroxyl mass fraction, as well as low or medium temperature. It is also accompanied by high scalar dissipation rates. It is also found that both micromixing and flow transport may induce the localized extinction.

Localized extinction features of a swirling non-premixed methane flame in a model gas turbine combustor are investigated, and it is observed that fast mixing in this burner leads to spatially and temporally rapidly changing regimes of non-premixed flames. The globally lean blow-off conditions and dynamics in the same model gas turbine combustor are predicted. The present LES/CMC model predicts an air blow-off velocity within 25 percent of the experimentally determined value for a range of fuel jet velocities. The predicted blow-off transient lasts finitely long duration quantified by the blow-off time, in good agreement with the experiments. When the current swirling flame is close to blow-off, high-frequency and high-amplitude fluctuations of the conditionally filtered stoichiometric scalar dissipation rate on the iso-surfaces of the filtered stoichiometric mixture fraction are evident.

Bio

Huangwei Zhang received his BEng in engineering mechanics and MEng in fluid mechanics in 2007 and 2009 respectively from Beihang University (formerly Beijing University of Astronautics and Aeronautics, or BUAA). He obtained his PhD degree in energy and combustion from the Department of Engineering at the University of Cambridge (United Kingdon) in 2015. Before studying in Cambridge, Zhang worked as a full-time research associate in the State Key Laboratory of Turbulence and Complex Systems at Peking University from 2009 to 2011. Currently, he is a postdoctoral research associate at the University of Cambridge.

Zhang's research fields are combustion and reacting flows, turbulent combustion modelling, pulverized coal combustion, near-limit flame dynamics, and high performance computing of reacting flows and parallel algorithm development. He was awarded the Professor Qingzhi He Memorial Scholarship, the Professor Allen T. Chwang Fluid Mechanics Scholarship, the Excellent Graduate of Beijing City award, the Cambridge Overseas Trust Scholarship, the Dorothy Hodgkin Postgraduate Award and the Postdoctoral Research Fellowship from the Center for Turbulence Research at Stanford University. He was also selected by the United Kingdom Pilot Centre for the European Research Community on Flow, Turbulence and Combustion, or ERCOFTAC, as a finalist for the Osborne Reynolds Research Student Award for excellence in PhD research.

Zhang is a member of the Combustion Institute's British Section and the United Kingdom's Turbulent Reacting Flows Consortium.

AME Lecture Hall, Room S212
Tuesday, April 25, 2017
4 p.m.
Refreshments and socializing 3:45 p.m. at the east end of the AME Courtyard