

OpenFOAM & Combustion Simulation



Numerical Combustion Research using OpenFOAM from Fundamentals to Industrial Applications

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Host: Prof. Zhi Chen (Peking University)

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Abstract

OpenFOAM (OF) is an open-source C++ software package for Computational Fluid Dynamics (CFD). We have been using both the standard versions (OF-5.0 & OF-6) of The OpenFOAM Foundation and modified OF versions for combustion simulations. In particular, laminarSMOKE [1] has been used to investigate the differential diffusion effect on the stabilization characteristics of methane/hydrogen jet flames [2], the pyrolysis effects on the dimethyl ether (DME) jet flames [3], and the flame structure and stabilization characteristics of n-heptane jet flames [4]. For dual-fuel engine combustion simulations, OF-5 and OF-6 have been used by adopting an adaptive mesh refinement (AMR) model with multi-criteria and a load balancing redistribution model to reduce the computational resources. OF-6 has also been adopted for simulations of supercritical carbon dioxide (sCO₂) oxy-fuel combustion. For this purpose, a new thermophysicalModels library including real fluid models has been implemented providing 20 available options in the use of implemented models for user [5]. Moreover, real-fluid based flamelet combustion models with either two-feed stream or threefeed stream configurations are also developed, which allows to capture the characteristics of flames under supercritical conditions. Some industrial application will be presented at the end of the talk.

[1] A. Cuoci, A. Frassoldati, T. Faravelli, E. Ranzi, *Energy Fuels*, 27 (2013) 7730-7753.

[2] K.S. Jung, S.O. Kim, T. Lu, S.H. Chung, B.J. Lee, C.S. Yoo, *Combust. Flame* 198 (2018) 305-319.

[3] K.S. Jung, B.R. Jung, S.H. Kang, S.H. Chung, C.S. Yoo, *Combust. Flame* 209 (2019) 225238.

[4] K.S. Jung, S.O. Kim, S.H. Chung, C.S. Yoo, *Combust. Flame* 223 (2021) 307-319.

[5] D.N. Nguyen, K.S. Jung, J.W. Shim, C.S. Yoo, *Comput. Phys. Commun.* 273 (2022) 108264.

About the Speaker

Professor Chun Sang Yoo is a professor of Mechanical Engineering at Ulsan National Institute of Science and Technology (UNIST), Republic of Korea. He is the Chairman of the UNIST Council and Director of the UNIST Supercomputing Center. Prof. Yoo received his Ph.D. degree in Mechanical Engineering from the University of Michigan. His Ph.D. work was devoted to direct numerical simulations of strained laminar and turbulent nonpremixed flames. His current research focuses on ammonia combustion and cracking, supercritical CO₂ oxy-fuel combustion, plasma-assisted ammonia/methane/hydrogen combustion in a model gas-turbine combustor, stabilization mechanisms of laminar/turbulent lifted jet flames, effects of thermal stratification and turbulence on the ignition characteristics of liquid fuels under homogeneous charge compression ignition (HCCI) and reactivity-controlled compression ignition (RCCI) conditions, LES/RANS of IC engine combustion, neural network-based combustion simulations. Prof. Yoo received the Young Investigator Prize at the 9th Asia-Pacific Conference on Combustion, and the Best Research Award at the Korean Society of Combustion (KOSCO) in 2016. He is an associate editor for several journals including *Transactions of the Korean Society of Mechanical Engineers B*, *Journal of Mechanical Science and Technology*, and *Journal of the Korean Society of Combustion*. He is also on the editorial board for the journal of *Energies*.

