Transported Probability Density Function Modeling of Fire Extinction

Tianfang Xie (xie183@purdue.edu), Haifeng Wang (haifeng@purdue.edu)
School of Aeronautics and Astronautics
Purdue University

Capturing fire extinction limit in simulations is critically important for developing predictive capabilities for fire. In this work, the combined large-eddy simulation (LES) and transported probability density function (PDF) methods are assessed for the predictions of fire extinction. The University of Maryland line burner is adopted as a validation test case. The NIST Fire Dynamics Simulator (FDS) code for LES is combined with an in-house PDF code called HPDF for the fire simulations. The simulation results are validated by using the available experimental data. The combustion efficiency under the different oxygen depletion levels in the oxidizer is analyzed. Fire extinction occurs when the oxygen depletion level reduces to a certain level. The model's capability to capture this extinction limit is assessed by using the experimental data. Different mixing models and model parameters are examined. It is found that the fire extinction limit is very sensitive to the different mixing models and mixing parameters. The level of sensitivity is higher than momentum-driven turbulent flames. This suggests the importance of mixing modeling in fire simulations. The existing mixing models need further enhancement for predicting fire extinction.

Keywords: Large-eddy simulation, transported PDF, FDS, HPDF, mixing, fire extinction.