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Large-eddy simulation for a turbulent swirl-stabilized lifted hydrogen-air flame using a partially premixed flamelet model

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Large-eddy simulations are conducted for the HYLON (HYdrogen LOw NO_x) burner [1] with the focus on the lifted flame, i.e., Flame L, in which both premixed and non-premixed combustion modes exist [2]. A multi-regime flamelet model is proposed to adapt to the different combustion modes in the lifted flame. In the proposed flamelet tabulation method, the flamelet tables generated based on the canonical 1D premixed and diffusion flames are dynamically accessed according to the local combustion regime [3,4]. The turbulence-chemistry interactions in the premixed flamelet table are taken into account by coupling with a dynamic version of the artificially thickened flame (ATF) model, while they are considered with the presumed probability density function (PPDF) approach in the non-premixed flamelet table. The effects of differential diffusion and thermal diffusion are considered by solving the transport equation for mixture fraction with additional terms specifically for the corresponding processes in the solver [5], while the flamelet table is generated based on the non-unity constant Lewis number assumption with the Soret effects. The effects of flame-wall interaction are incorporated in the flamelet model by solving the total enthalpy transport equation with special treatments of the flamelet look-up table at the wall boundaries.
The simulation results are compared with the experimental data and those from the conventional diffusion-flame-based flamelet model, including the velocities and the heat release rate, and good agreements with the experimental data are achieved.

References

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