Numerical simulation of the HYLON Burner with a hybrid Lattice-Boltzmann Method

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Recent studies have demonstrated that Lattice-Boltzmann methods hold considerable promise for reactive flows [1]. In order to fully establish their capability to address complex reacting cases, further research is needed. In this work, the HYdrogen LOw NOx burner (HYLON [2]) is simulated using the hybrid Lattice-Boltzmann method.
The injector consists of two coaxial ducts equipped with swirlers, in which air and hydrogen are introduced separately. Depending on the operating conditions, the resulting flame can be lifted above the injector or anchored on its lips.
In the first part of this study, cold flow simulation results for both cases are compared to the experimental data [2]. The low-Mach number approximation is adopted to reduce the computational cost. The resulting molar fraction and velocity fields at different heights of the chamber show good agreement with the reference data and good computational efficiency.
In the second part, reactive simulations are conducted using a 12-step chemistry [3]. The velocity fields at different heights are compared with the experimental data. Heat release rate fields are compared to the experimental OH* fields. The combustion modeling and the ignition strategy are discussed. Results also show good agreement with the experimental data.
However, the calculation is constrained by the chemistry time step, which is very small due to the explicit formulation. In order to reduce the computational cost of the simulation, we consider operating with a 1-step chemistry [4] for reactive conditions.

References

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