Development of Turbulent Combustion Libraries based on Conditional Averaging in OpenFOAM for Engineering Problems

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The current version (ver. 1.7) of OpenFOAM provides the PaSR (Partially stirred reactor) model and the Weller model respectively for turbulent nonpremixed and premixed combustion problems. In this work we implemented the CMC (Conditional Moment Closure) model [1] in the spatially one dimensional and zero dimensional forms for conditionally averaged scalars in nonpremixed combustion. Different modeling strategies, e.g. mean scalars and mean reaction rates, Eulerian and Lagrangian, etc. are tried and compared for defining and tracking multiple flame groups in the zero dimensional CMC[2].

In premixed combustion the mean reaction progress variable is solved with the turbulent burning velocity specified according to the recently derived form [3] from the asymptotic behavior at the leading edge of a flame brush. Results are compared with the PaSR and Weller models for simple canonical problems in the TNF (Turbulent Nonpremixed Flame) website [4] and literature.

Validation is performed for spray development and skeletal combustion chemistry for n-heptane as a diesel substitute and NOx emission as well. Examples are shown for realistic application in spark ignition and compression ignition IC engines, a gas turbine combustor including nozzles and liner structures.

REFERENCES


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