Project 34
Area #7 Common Format Routine (CFR) Development

Motivation and Objectives

Motivation:

State-of-the-art combustion tools, i.e. academic models not commercially existing, are typically not readily available to OEMs due to commercial lag, usability, and code inconsistencies. Here we've begun to package the latest academic, state-of-the-art, tools in a simple easy to use Common Formate Routine (CFR) package.

Objectives:

To code Stanford's flamelet model so that it can be accessible through commercial numerical tools available and widely used by OEMs.

This program is accessed through a graphical user interface (GUI) where OEM engineers can select options

The software/code necessities to be thoroughly verified and validated against other simulations and measurements.

Methods and Materials

There were two software packages required to implement Stanford's flamelet model:

1) the thermochemical and transport pretabulator and
2) the flamelet software.

The development of these software packages was completed with the following tools:

-Twenty eight core Windows computer is utilized for software coding, development, and testing.

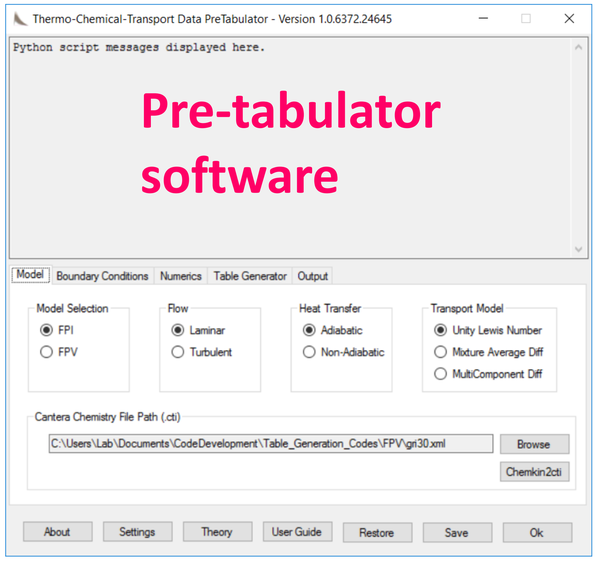
-Four hundred and eight core Cray supercomputer is utilized for testing LES version.

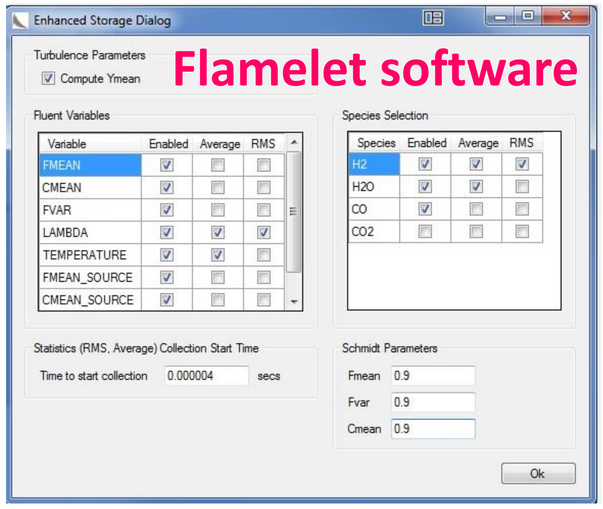
-Computer languages: Python, Cython, C, C++, C#, Scheme, and MPI.

-Open source: Cantera v2.3. This code was enhanced to accommodate Stanford flamelet model.

Summary

- The Graphical User Interface (GUI) and software have been developed.
- The software has been validated against laminar and turbulent standard flames (e.g. Sandia D flame).
- OEMs have begun to use and test the software.





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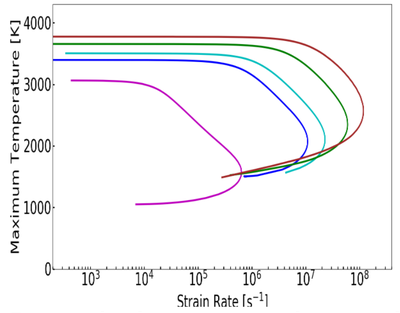
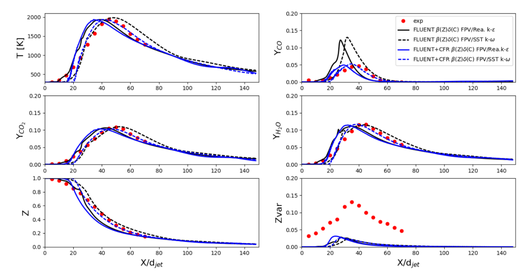
Results and Discussion





Pre-tabulator sample results are in excellent agreement with results reported in the literature.

Comparison of measurements and CFR/RANS/FPV predictions (Sandia D Flame).

Sandia D Flame; LES/FPV simulation

Conclusions and Next Steps

Conclusions:

The pretabulator for this task has been proven to work well for both laminar and turbulent configurations as well as both premixed and non-premixed flamelets.

The flamelet software has no bugs, but further numerical improvements can be added to better handle the exit boundary condition-induced disturbances.

Next Steps:

Add numerical techniques to better handle boundary induced disturbances.

The combustion model is to be tested on the Referee Rig combustor that couples the flamelet model with the spray model.

Additional CFR models are being discussed and down-selected.

September 26, 2017

This work was funded by the US Federal Aviation Administration (FAA) Office of Environment and Energy as a part of ASCENT Project 34 under FAA Award Number: 13-C-AJFE-UD-13. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the FAA or other ASCENT Sponsors.