

Semester Thesis

Start: As soon as possible

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- ☒ theoretical
- ☒ numerical
- ☐ experimental
- ☐ constructional

Development of a Numerical Entropy Wave Conversion Benchmark in OpenFOAM

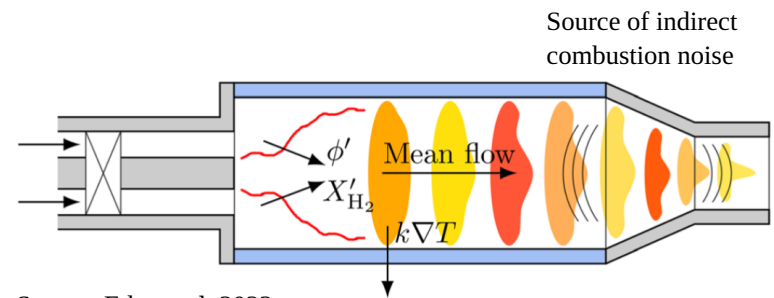
Thermoacoustic instabilities are highly undesirable phenomena caused by constructive feedback between acoustic oscillations and the flame's fluctuating heat release rate in combustion chambers. These instabilities reduce performance and make the safe operation of combustion systems very difficult.

Besides the classical direct mechanism of sound generation, there is another - indirect - mechanism. This mechanism is based on the acceleration of entropy waves in a constriction downstream of the combustion chamber. This acceleration leads to the emission of a sound wave towards the flame, thereby closing the thermoacoustic feedback loop. Despite growing interest in investigating the role of entropy waves in the thermoacoustic mechanism and in developing models that include them in predicting thermoacoustic instability, no definitive configuration exists against which such models may be validated.

This work aims to close this gap by developing a compressible CFD setup in OpenFOAM to benchmark the performance of entropy-acoustic conversion in reduced-order modeling approaches.

Planned work packages are:

- Literature research on acoustics, thermoacoustics and interaction with convective phenomena
- Familiarization with the compressible OpenFOAM solver and characteristic boundary conditions (CB-SBC).
- Conceptualization and implementation of a test case where the phenomenon of accelerated entropy waves and their interaction with acoustics can be tested.
- Results of eigenmodes/scattering matrices are compared with stability predictions from hand calculations or network models.
- Optional: Comparison of results with an LRF/CAA solver should be performed.



Source: Eder et al. 2023

Requirements:

Good grasp of thermo- and fluid dynamics
 Familiarity with CFD
 Knowledge of OpenFOAM is beneficial

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