NONLINEAR IDENTIFICATION OF THE FLAME DESCRIBING FUNCTION OF A LAMINAR PREMIXED FLAME

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The linear CFD/System Identification (SI) approach is a useful and well known tool to derive reduced order models (ROM) from a CFD simulation. Unfortunately, it is often hard to tell, how well the identified model describes transfer behavior of the underlying CFD model. Therefore we present some techniques from system identification that give a measure for the quality of the ROM.

The ROMs, determined with the linear CFD/SI approach, can be used together with network models to perform a linear stability analysis. In case the system is linearly unstable the oscillation amplitudes grow and the assumption of linearity becomes false. Nonlinear dissipative effects come into play, which lead to limit cycle oscillations.

The flame describing function (FDF) is used to predict the amplitude of these limit cycle oscillations. Thereby the nonlinear flame response is modeled with an amplitude dependent flame transfer function. The determination of the FDF is usually done by harmonically excited experiments or CFD simulations. This procedure is very expensive and time-consuming. Therefore, we propose to extend the CFD/SI approach to the nonlinear regime. A broadband input signal is applied to a CFD simulation of a laminar flame and the resulting disturbance in heat release is measured as the output signal. We use neural networks and Hammerstein-Wiener-models to derive the FDF from time series collected with a single CFD run.

References

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