Combining a Helmholtz solver with the Flame Describing Function to assess combustion instability in a premixed swirled combustor

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Abstract

Limit cycles of combustion instabilities can be estimated by studying the nonlinear behavior of flame dynamics. In the present study the flame describing function (FDF) framework is combined with a linear acoustic Helmholtz solver in order to estimate the growth rate of the acoustic perturbations in a swirled combustor. It is assumed that when this growth rate equals the inherent dissipation of the system, acoustic oscillation amplitudes cease to grow and a stationary state, i.e., limit cycle, is reached. In the same way, the FDF is combined with an analytical acoustic model for a quasi-1D version of the combustor. Numerical and analytical results are compared to experimental data and a reasonable agreement is obtained in terms of frequency, growth rate and amplitude of oscillations at the limit cycle.

Keywords: Combustion instabilities, Flame Describing Function (FDF), Helmholtz solver, limit cycle.

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