Abstract:

In this project, our target is to numerically determine the flame transfer function of a conical flame, analyze the flame dynamics in response to the acoustic perturbations and try to find the connection between them. We start by introducing the thermo-acoustic systems as a simple model of several elements and briefly describe the flame transfer function. An analytical representation of the FTF is also represented. Regarding the flame dynamics we introduce the fundamental theories of laminar premixed flames. Moreover, we explain the flame instability and introduce two analytical models describing its growth rate. We then review some literature include experimental determination of the Darrieus-Landau instability of V-Flames. We briefly describe our numerical setup before showing the results. In the results, we start by introducing two excitation approaches, velocity and base temperature, and verify their similarity according to the flame heat release response. We then discuss the gain and phase of the FTF where the gain appears to reach a maximum value of higher than unity at around 80 Hz. We switch afterwards to looking at
the flame front behavior for different harmonic frequencies and analyze the one with highest
instability also at around 80 Hz. Results from the simulation are compared to theoretical relations
from literature to verify the growth rates at different harmonics. We then try to find the reason
for this instability using an impulsive excitation test, with an attempt to draw a conclusion from
the observed unusual behavior of the FTF and the flame dynamics. The impulsive excitation
produces a secondary wrinkle that lags the primary one with a time lag that is equivalent to 83
Hz. Further observations are then made with respect to the flame tip response which shows
that the wrinkles are propagated with the convection velocity along the flame front. Another
analysis in this chapter includes comparing results from the simulation to one of the analytical
models describing the flame position to show that the model does not predict the Darreius
Landau instability.

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