COMBUSTION WEBINAR

Hydrodynamic instabilities in gas turbine combustor flows and their passive control

Speaker: Santosh Hemchandra, India Institute of Science

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Biography: Santosh Hemchandra is an associate professor in the Department of Aerospace Engineering, Indian Institute of Science (IISc), Bangalore, India. His research group primarily focuses on modelling the dynamics of reacting flows in gas turbines and rockets. They explore these phenomena using modelling approaches ranging from hydrodynamic and thermoacoustic stability analysis and Large eddy simulation (LES) of chemically reacting flows with support from key industry OEMs and govt. agencies in these areas. Santosh's group received a large HPC compute time award from the National Supercomputing Mission, Govt. of India for LES studies on the impact of H2 addition on flame dynamics. His research other research interests are towards understanding fundamental mechanisms of jet noise and turbulent boundary layer flow in the transitional transonic regime.

Abstract: Coupling between acoustic pressure and heat release oscillations in combustors can potentially result in high amplitude pressure oscillations that limit the operability envelope of Gas turbines for power generation. A key physical process that controls the unsteady characteristics of heat release oscillations is the response of the combustor flow field due to imposed acoustic perturbations. This response is driven by the characteristics of the hydrodynamic instabilities of the combustor flow and how they interact with the flame. In this talk, I will present an overview of how hydrodynamic instabilities and acoustic pressure oscillations can interact in combustors. Then, I will describe in some detail the mechanism of a common self-excited instability in swirl flows known as the precessing vortex core (PVC), from our recent non-linear stability analysis of a swirled turbulent jet. Next, I will show examples from prior experiments from other research groups that show how the PVC can both promote or suppress combustion instability in swirl stabilized combustors. I will present an overview of a theoretical analysis that suggests mechanisms by which this is possible, and a description of ongoing research aimed at clarifying these mechanisms. The ideas that will be discussed in this talk will provide insights into how hydrodynamic phenomena influence heat release oscillations and formal computational methods that can be used to design combustor nozzles in a manner that suppresses their receptivity to acoustic forcing and thereby, the occurrence of these heat release oscillations.

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