ME Seminar

Study and control of non-acoustic combustion driven oscillations in gas turbine combustors

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ABSTRACT

Lean premixed, pre-vaporized combustion systems are prone to large amplitude self-sustained detrimental oscillations, termed as combustion instability. Traditionally, combustion instability is understood to be caused by a positive feedback loop between unsteady combustion and acoustic field of the combustion chamber. This essentially leads to the amplification of combustor acoustic modes. Recent investigations indicate that non-acoustic driven feedback mechanisms do lead to instability. The configurations, where these mechanisms occur have good relevance to practical combustor configurations. In my talk, I will focus on our investigations performed in two lab-scale combustors. The downstream end of combustion chambers in most practical systems is usually connected to additional components such as tailpipes, turbine blades, etc., which effectively reduce the exit area. Therefore, the exit of our first combustor is terminated by an area-contraction (nozzle), so as to have a phenomenological representation of the actual configuration. This contraction, leads to a reduction in the acoustic reflection coefficient. Intrinsic thermoacoustic feedback loop, which is a non-acoustic mechanism is found to drive instability. Systematic experimental investigation, along with theoretical stability analysis allow us to explore the characteristics of instability. Active control by low frequency fuel flow modulation is found to reduce instability amplitude. In afterburners of jet engines, flame is aerodynamically stabilized in the recirculation zone created by a bluff body. This flow field supports vortex shedding. Additionally, the acoustic field of the combustor possesses another frequency. The dynamics of the total system, comprising of the two frequencies due to vortex shedding and acoustic field, make the study intriguing in the context of lock-in. We explore the above by performing investigations in a bluff body-stabilized combustor.

ABOUT THE SPEAKER

Sathesh Mariappan is currently serving as an Associate Professor at the Department of Aerospace Engineering in Indian Institute of Technology Kanpur. He completed his Bachelors at Madras Institute of Technology, 2007 and obtained his direct Ph. D., Indian Institute of Technology Madras, 2012, both in Aerospace Engineering. Before joining IIT Kanpur, he worked in the Department of Helicopters, German Aerospace Center, Goettingen as an Alexander von Humboldt Post-Doctoral fellow. He is a recipient of INAE Young Engineer Award, IEI Young Engineer Award (Aerospace division), International Exchanges award (co-applicant) from The Royal Society London. He works in the broad areas of combustion driven oscillations in aerospace engines, optical flow diagnostics and rotorcraft aerodynamics. He conducts both theoretical and experimental investigations to understand the underlying fundamental processes and their relevance to practical scenarios.

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