ME Seminar

Prechamber Assisted Combustion Thermochemistry and Gas Dynamics: In-situ Laser Diagnostics Methods

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ABSTRACT

The work explores prechamber-assisted combustion (PCC) technology, reportedly capable of simultaneously enabling significant upgrades for closed-cycle combustion systems. PCC works by enclosing conventional ignition sources like glow plugs, sparkplugs (plasma), microwaves, and laser igniters within a small volume. This volume is kept at thermochemical and fluid dynamic conditions suited for combustion initiation using these conventional ignition sources. The combustion within the small volume is then utilized in a cascade to ignite the main combustible mixture at harsher conditions (lean/high pressure). The interaction of PCC combustion with the mixture to ignite occurs through a nozzle with or without orifices.

This work describes the development and utilization of laser diagnostic techniques to examine the physics of turbulent reactive jets during PCC combustion in Heavy-duty optical engines, including mixing, quenching, and velocity, in various configurations. Traditional 10 Hz IC engine laser diagnostics provide only single snapshot images of the transient combustion process, which lasts between 3 to 10 msec in one revolution, and are unable to time-resolve the combustion process. The optical access to confined combustion chambers poses additional challenges for laser light delivery and imaging. However, advancements in lasers and scientific imaging have enabled the exploration of the thermochemistry and gas dynamics of the pre-combustion chamber, and this work presents implemented laser diagnostic systems to study the prechamber and a few other thermo-fluid systems.

ABOUT THE SPEAKER

Priybrat Sharma is a Postdoctoral Research Associate at Oak Ridge National Laboratory (ORNL), USA, focusing on combined heat and power systems and optical diagnostics for cryogenic cooling. Prior to joining ORNL, he was a Postdoctoral Fellow at King Abdullah University of Science and Technology (KAUST), Saudi Arabia, where he developed advanced laser diagnostics for combustion research. Dr. Sharma earned his Ph.D. (2023), specializing in planar laser-induced fluorescence and scattering techniques to study gas dynamics and thermochemistry in prechamber-assisted combustion. He holds an M.S. (Research) from IIT Mandi (2018), where he investigated hydrogen-fueled internal combustion engines, and a B.Tech. in Mechanical Engineering from JN Government Engineering College, Himachal Pradesh (2012). His research centers on developing optical diagnostics and experimental methods for reactive and non-reactive thermo-fluid systems, advancing clean energy and combustion technologies.

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