הטכניון מכון טכנולוגי לישראל TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING SEMINAR

Monday, December 04, 2023 at 14:30, D. Dan and Betty Kahn Building, Room 217

Online (optional zoom): **https://technion.zoom.us/j/93272303961**

Particle Formation in Hydrogen Combustion

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Hydrogen is globally considered as a most promising sustainable fuel. However, we have discovered the unknown earlier counter-intuitive phenomenon of elevated particle formation in the non-premixed combustion of carbon-free hydrogen and hydrogen-rich reformates in an ICE, which is substantially higher than in combustion of carbon-containing fossil fuels like gasoline or methane. This discovery contradicts all previously published data on particle formation in hydrogen combustion.

We have accomplished the interlinked series of fundamental and engine-based experiments which allowed us understanding and describing the physics behind the observed peculiarities in particle formation. Optical imaging techniques, as high-speed Schlieren and Particle Image Velocimetry, were employed to characterize the flow field of an underexpanded impinging transient gaseous jet in a confined engine-like environment. A laboratory research engine was used for detailed combustion and particle emission analysis.

The gained results showed that non-premixed hydrogen combustion in ICE enhances particle formation, which is substantially more intensive compared to hydrocarbon fuel combustion. This phenomenon is a result of a combined influence of the hydrogen's low flame quenching distance that intensifies lubricant evaporation, and the interaction between the lubricant vapor formed near the cylinder surface with the gaseous fuel jet. The obtained experimental data showed that gaseous fuel vortex evolved after jet impingement subsequently climbs over the liner wall, thereby sweeping away the lubricant vapor into the combustion chamber bulk. This entrainment mechanism was found to be stronger compared with the lubricant entrainment in the free-jet region. The excessive entrainment of lubricant vapor into the chamber bulk with its subsequent involvement in the combustion process results in the elevated particle formation. Notably, this breakthrough finding paves the way to future development of engineering solutions aimed at mitigation of particle formation in hydrogen-fed ICEs.

Seminars Coordinator: Assoc. Prof. Gal Shmuel .