MECHANICAL ENGINEERING STUDENT SEMINAR

Wednesday, July 31 2024 at 13:30, D. Dan and Betty Kahn Building, Room 217.
Online: https://technion.zoom.us/j/99699290184

Performance Analysis of Solid-Oxide Fuel Cells Operating with Different Sustainable Fuel Reformates Derived from Methanol and Ammonia

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The Technion Internal Combustion Engines Lab has previously developed a Combined Electro-Thermo-Chemical Cycle (CETC), which is an innovative hybrid propulsion cycle comprising a solid-oxide fuel cell (SOFC), an internal combustion engine (ICE), and a reformer for thermochemical recuperation of waste heat and onboard production of hydrogen-rich reformate. SOFCs are recognized for their outstanding fuel flexibility and high efficiency in converting fuel chemical energy into electrical work. In this research, both numerical simulations and experimental research were conducted to characterize the performance of the SOFC and the reformer aiming at CETC characteristics improvement. To achieve this, model-based simulations were performed to improve fuel conversion within the reformer and to make better use of the engine exhaust gases' waste heat. Furthermore, the simulations allow predicting the SOFC performance when fed with different fuels and at different temperatures. The research involves experiments with the anode-supported and electrolyte-supported SOFCs fed with humidified hydrogen and hydrogen-rich gaseous reformates derived from methanol and ammonia: methanol steam reforming (MSR), methanol decomposition (MD), and ammonia decomposition (AD) at 700 – 850 °C. MD-reformate was found to yield the highest cell performance, with the least disparity in power density from humidified hydrogen, followed by AD- and MSR- reformates. The research introduces the concept of critical power density to evaluate fuel utilization across SOFC. Scanning Electron Microscopy imaging and Energy-Dispersive X-ray Spectroscopy analyses confirmed the viability of CO as a fuel, with no carbon deposits on the anodes when using MD-reformate. The experimental findings demonstrate the suitability of using methanol- and ammonia- decomposition products in SOFCs and their compatibility with hybrid power generation cycles. We suggest that the SOFC has the potential to be successfully integrated into methanol- and ammonia- based power-generating cycles with the external thermochemical recovery of waste heat.

Note: The seminar will be conducted in Hebrew but can be conducted in English if necessary.

Seminars Coordinator: Assoc. Prof. Shmuel Gal