MECHANICAL ENGINEERING PhD SEMINAR

Monday, August 25, 2025 at 14:30, D. Dan and Betty Kahn Building, Room 217

Establishing scaling rules and material guidelines for the desalination fuel cell

Salman Abdalla

Advisers: Asst. Prof. Michael Patrascu, Assoc. Prof. Matthew Suss, Assoc. Prof. Alon Wolf.

The desalination fuel cell (DFC) is an innovative technology that simultaneously addresses water desalination and electricity production through redox reactions, offering an alternative to traditional energy-intensive desalination methods. This research explores the possibilities of DFC technology, emphasizing critical obstacles to improve its scalability and overall performance. The initial focus of this work delineates significant voltage losses inside the system by presenting experimental analyses of voltage losses at the electrodes and across the membranes in a custom-engineered DFC. The cell was evaluated in both near-neutral pH aqueous streams and in a pH gradient configuration. This study enabled us to identify major sources of voltage losses and provide critical insights for the advancement of DFC materials and optimization. In the subsequent study, we investigate a scaling strategy for DFCs by integrating alternating anion and cation exchange membrane pairs. This technique relies on prior data indicating that potential losses across membranes are insignificant. We analyze and contrast three distinct cell configurations - single, double, and triple membrane pairs, illustrating that additional membrane pairs maintain desalination efficacy while only slightly diminishing power density. This has also enabled the flexibility in selecting anolyte and catholyte solutions, as they are no longer the principal brine channels. We next present an integrated Methanol Reformer (MR)-DFC system and experimentally examine its performance. Specifically, the effect of CO2 and CO intake directly to the DFC's anode from the MR exit stream. The results indicate a reduction in power density when employing the MR outlet as a feed, while the desalination process remains unaffected. Finally, we developed the first computational model that has been used to provide a theoretical basis for the hydrogen-oxygen DFC. This model utilizes the Nernst–Planck equations for ion flux and charge transport through diffusion, electric migration, and convection.

This body of work presents a unified research that systematically evaluates, quantifies, and conceptualizes the DFC, establishing a definitive path for its future development as a sustainable water-energy solution.

Note: the seminar will be given in English

Seminars Coordinator: Assoc. Prof. Shmuel Gal.