Lehrstuhl Flug-Triebwerksdesign

Brandenburgische Technische Universität Cottbus

Research: Fuel Cell Modelling

This study focuses on the numerical modeling and characterization of proton-exchange membrane (PEM) fuel cells using MATLAB. The aim is to predict voltage–current behavior, heat/water balances, and degradation-relevant stressors as functions of operating conditions, materials, and geometry. The outcomes will support design and control of systems with optimized efficiency, durability, and thermal–water management.

1. **Software / Analysis:**
   1.1. Develop 0D/1D MATLAB models for PEM fuel cells (lumped or through-plane), including activation/Ohmic/concentration losses, charge and mass transport, and two-phase water management.
   1.2. Implement parametric polarization and efficiency maps versus temperature, pressure, stoichiometry, RH, membrane thickness, and GDL/CL properties; include thermal and water balances (evap/cond, membrane hydration).
   1.3. Perform sensitivity/uncertainty studies (DoE), parameter identification against polarization/EIS data, and generate performance envelopes for different operating strategies.
2. **Miscellaneous Points:**
   2.1. Develop and refine MATLAB scripts/functions for sub-models (membrane conductivity vs. λ, gas diffusion, two-phase flooding limits, kinetics T-dependence via Arrhenius), with clean APIs and unit tests.
   2.2. Produce automated plots: polarization & power curves, efficiency, heat rejection, species fluxes, water content profiles, and operating maps; export figures/tables for reports.
   2.3. Assist in preparing papers/presentations on model validation, parametric insights (e.g., RH/stoichiometry trade-offs), and design/control implications for stack and balance-of-plant.
3. **Possible Extension to Study Project after initial model development**
   3.1 Add a MATLAB/Simulink balance-of-plant (compressor, blower, humidifier, coolant loop); implement simple supervisory control (stoichiometry/RH/temperature tracking).
   3.2 Extend to degradations (e.g., high-frequency resistance drift, voltage decay) via empirical sub-models; or couple to a 1D along-channel model for spatial effects.
4. **Requirements:**
   4.1. Bachelor's/Master's in Mechanical, Chemical, Electrical, or Energy Engineering.
   4.2. Understanding of electrochemistry, transport phenomena, and heat/mass transfer.
   4.3. Familiarity with fuel-cell fundamentals (Tafel/Butler–Volmer, Nernst, membrane hydration) preferred.
   4.4. Proficiency in MATLAB (scripting, functions, optimization/curve-fit, plotting); Simulink a plus.
   4.5. Strong analytical/problem-solving skills and interest in energy systems and model validation.

➢ **Are you interested or do you know someone who likes this?**
Please send the below documents to Mr. Akilan Mathi, akilanmathi.btu@gmail.com:

- CV
- A short description (max. 600 words) explaining (1) your skill set relevant to the research (2) and a technical problem (ideally related to above description but not mandatory) you have worked in the past.