Control Scenarios for an SOFC system unit

Motivation & Objectives
To operate sustainably under optimal conditions, it is essential that the temperature at the core of a Solid Oxide Fuel Cell (SOFC) unit be as constant and as homogeneous as possible. A temperature of around 1023 K (750°C) is to be maintained for the stack to function optimally.

The purpose of this project is to devise a model predictive control algorithm that can meet these goals.

Reference System
The target system is a 0.5-1kW SOFC HoTbox module produced by HTceramix. A gPROMS numerical model written at LENI simulates the system.

A thermocouple reads the temperature of the gas at the cathode inlet. The temperature reading is biased by conduction and radiation. The discrepant reading is corrected using a Kalman filter.

Controller Design
Model Predictive Control was used to stabilize the temperature of the unit.

The system consists of:
- an MPC controller with bias feedback
- a Kalman filter
- a gPROMS pant simulation

Results
The controller maintains the temperature of the stack close to 1023 K under widely changing loads. The Kalman filter gives a close estimate of the real temperature of the unit based on the thermocouple reading.

Model Predictive Control proved successful for regulating the temperature of an SOFC system, in spite of the thermocouple’s discrepant reading. This is chiefly important in the context of SOFCs, as thermal stress is a major factor in the degradation of their performance over time.