Simulative spatial behavior analysis for enhanced fuel cell system control

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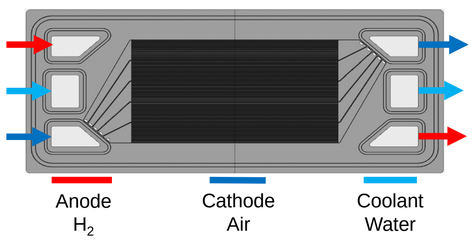
Objective

Understand the impact of operating parameters on local conditions within a fuel cell to develop a better informed operating strategy

Setup

Simulation conditions:

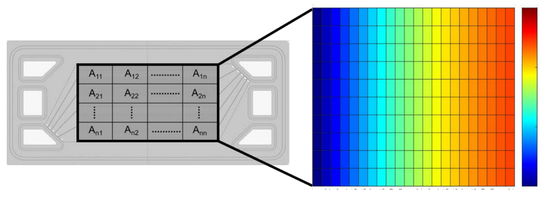
- Co-flow configuration
- Straight flow channels
- Coolant flow set to maintain a temperature difference of 5 K



Parameter	Anode	Cathode
Stoichiometry [λ]	1.5/2.5	1.5/2.5
Inlet Pressure (bara)	2/3	2/3
Inlet Relative Humidity [RH] (%)	50	50
Current Density (A/cm²)	1	

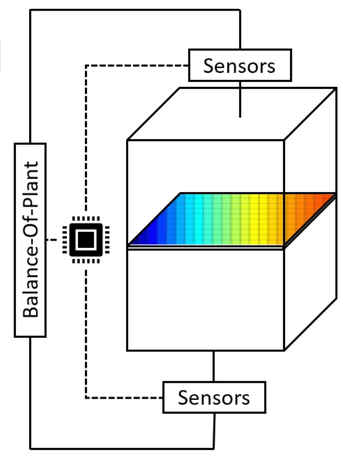
Source: Feierabend, L. (2023). PEM Fuel Cell Stack Model (Version v1.0.0) [Computer software]. https://doi.org/10.5281/zenodo.7611662

Motivation

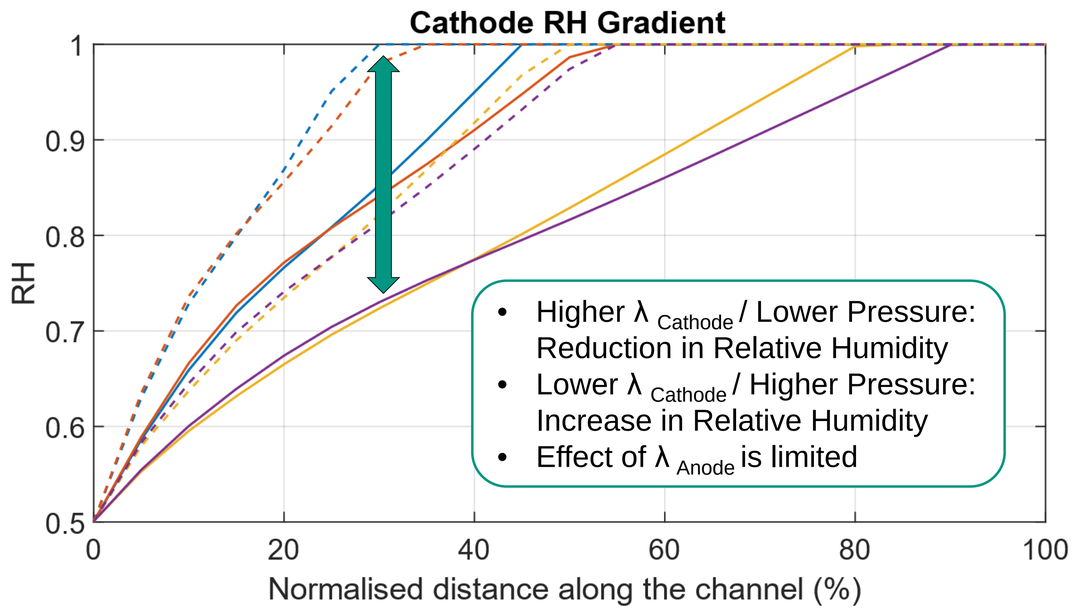


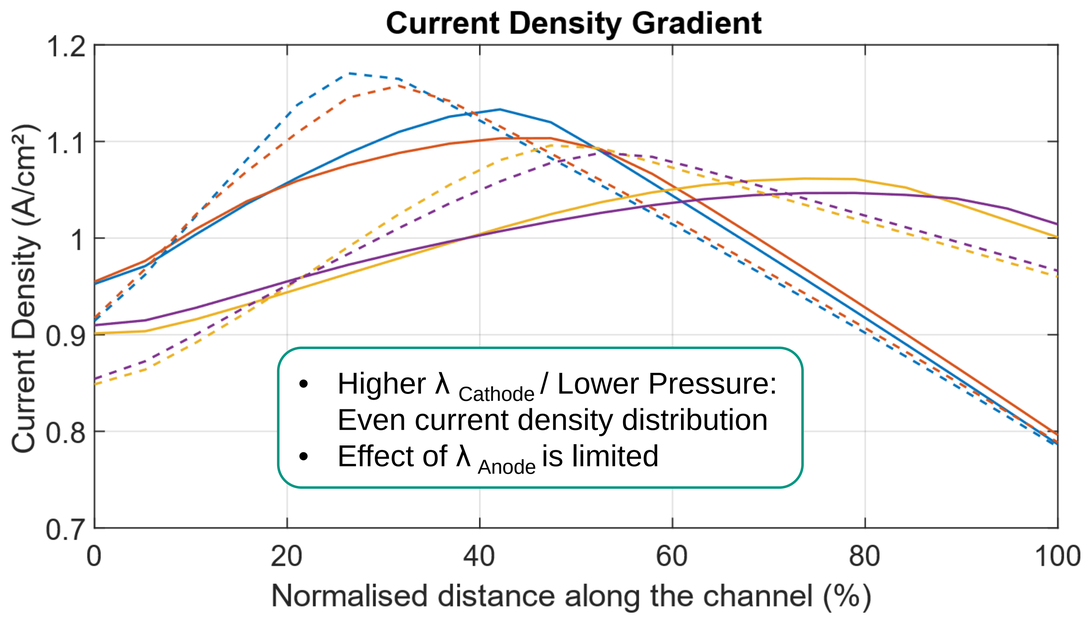
Gradients exist along the fuel cell bipolar plate: Temperature, humidity, concentration, liquid water etc.

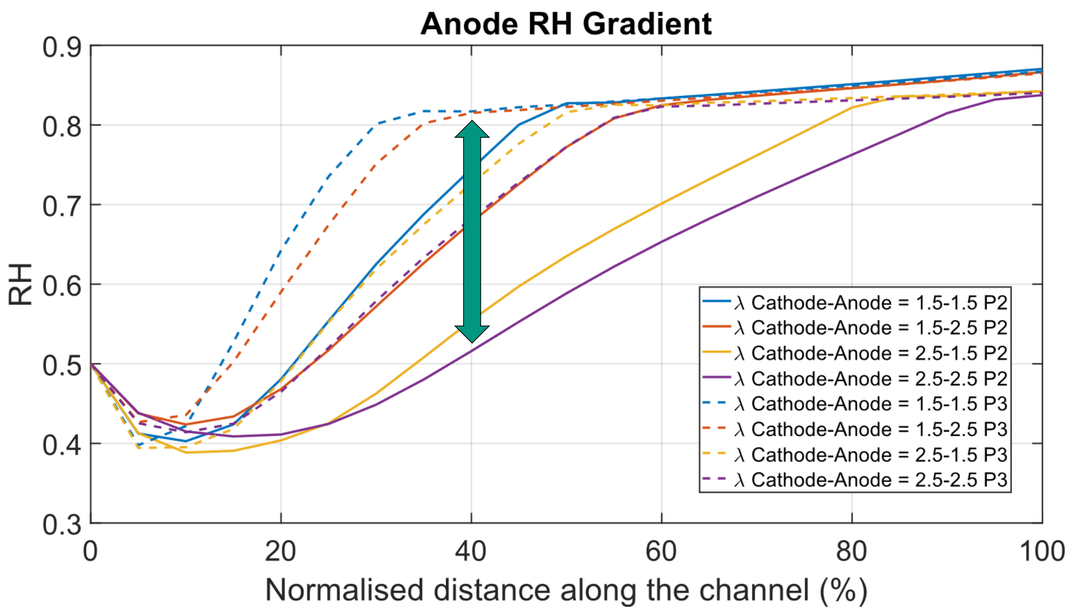
- Current fuel cell systems measure inlet and outlet conditions for the fuel cell control.
- Understanding the local effects of operating strategies can help in avoiding ‚localised' critical states.
- Spatially aware operating strategies can help in better utilisation of the fuel cell system making them more efficient.

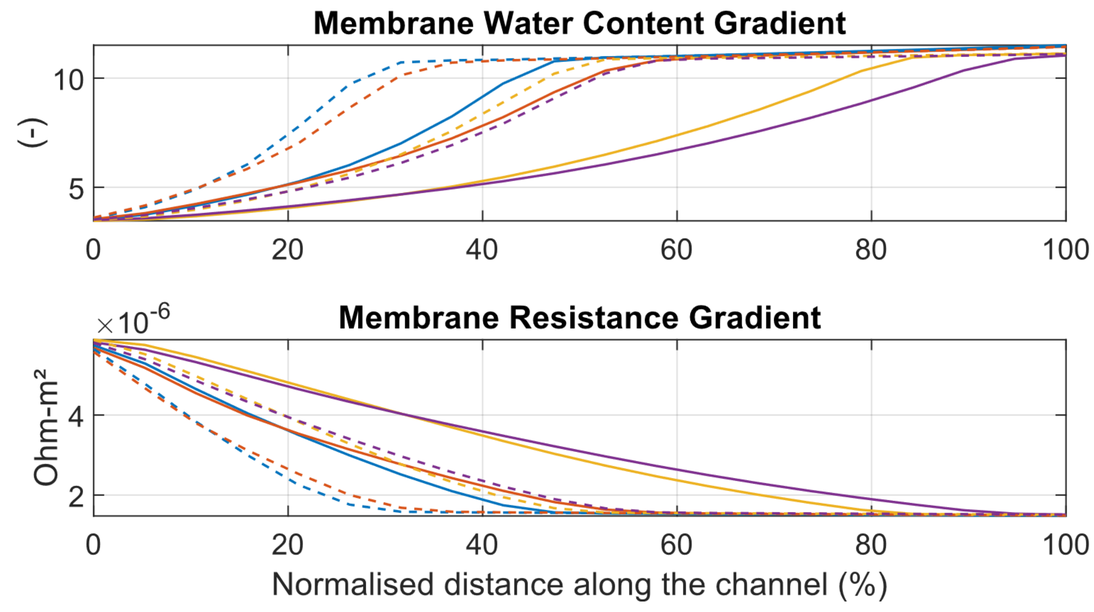


Results & Conclusions









Control Strategy:

To reduce RH : **increase λ $_{Cathode}$** and **decrease** Pressure → Reduces membrane water content and increases resistence.

To increase RH : **decrease λ $_{Cathode}$** and **increase** Pressure → Increases membrane water content and decreases resistence.

Acknowledgements

The authors would like to thank the Ministry of Science, Research and Arts of the Federal State of Baden-Württemberg for the financial support of the junior research group Sensor Based Fuel Cell Development (SensE2B) within the InnovationCampus Future Mobility.

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