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Fuzzy Controller for Stabilizing Fuel Cell Systems

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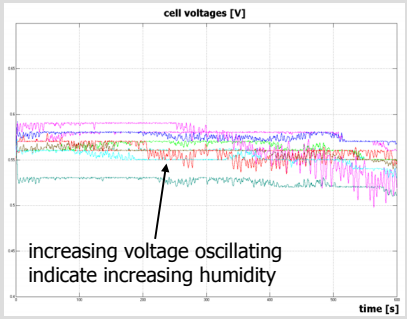
Abstract

- PEM-FCs have a dynamic and nonlinear behavior
- Fluctuations of media pressure, temperature and humidity can lead to instability
- Classical controller fail to stabilize stacks under such conditions
- EUtech developed a fuzzy controller which allows complete automated operation of PEM-FCs, even under difficult and adverse conditions

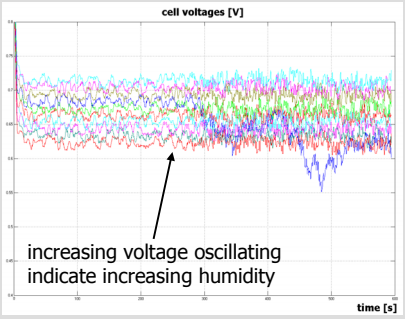
Task

- PEM-FC system with gas generator
- Gas generator reforms CH_4 to H_2
- Fluctuating quality of H_2 (pressure, temperature and humidity)
- Task: Development of a controller which stabilizes the stack operation

Measurement at real stack (9 cells)
Stack gets humid after 200 seconds



Simulation of stack with 10 cells
Stack gets humid after 200 seconds

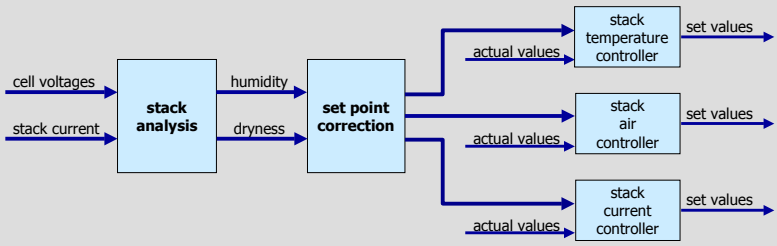


Fuzzy Controller

The fuzzy controller is divided into two blocks:

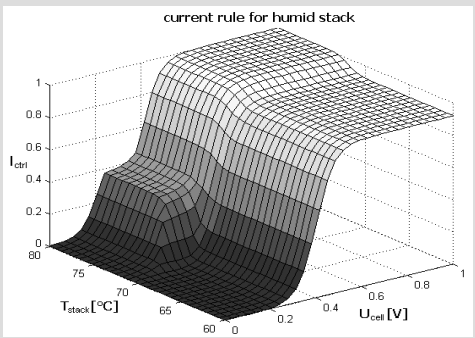
- Stack analysis
  - Signal analysis (stack voltages & current)
  - Fuzzy rule base to identify stack condition
- Set point correction
  Fuzzy rule base to select and induce counter measures (correction of set points)

Block diagram

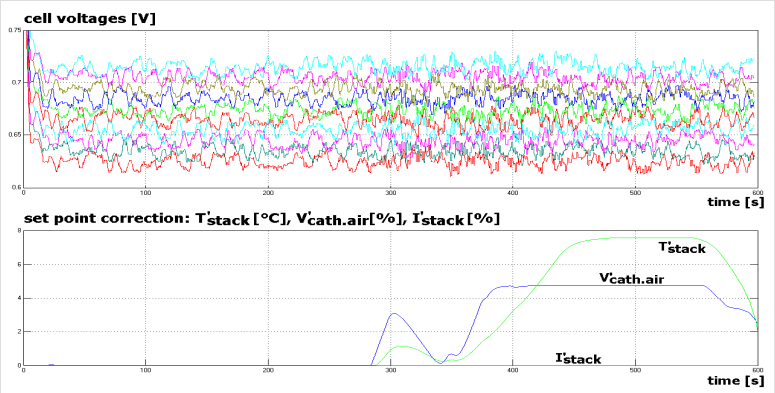


Example: *Current rule for a humid stack*

The more the smallest cell voltage is less than 0.25 V
OR
the more the smallest cell voltage is less than 0.4 V
AND the stack temperature is less than 72 °C
the more the stack current has to be reduced.



Example: Simulation run of 10 cell stack and fuzzy controller



Humidity is detected at approx. 280 sec. and counter measures are induced:
- increase of cathode air (up to 4.8%) and stack temperature (up to 7.6°C)
- stack current is not decreased since cell voltage is above 0.6 V