Fuzzy Controller for Stabilizing Fuel Cell Systems

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 CH₄ to H₂
- Fluctuating quality of H₂ (pressure, temperature and humidity)
- Task: Development of a controller which stabilizes the stack operation

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)

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