

**ABSTRACT SUBMISSION****Title: Model-based diagnostics and control of liquid water in a PEM fuel cell****Abstract No.** 0096**Title** Model-based diagnostics and control of liquid water in a PEM fuel cell**Abstract**

Liquid water management in a PEM fuel cell is critical to its performance. Particularly, cell flooding caused by water generation, electro-osmotic drag or back-diffusion is a major issue observed when operating PEM fuel cell stacks under high load cycles where rate of water generation is considerable, or when certain disadvantageous environmental conditions are present such as low temperatures and high relative humidity. In the presence of liquid water, the load across the cell re-distributes onto available active sites of the catalyst layer. However, when water coverage reaches a certain limit, the load distribution of the cell becomes critically uneven (flooded cell) and cell performance is compromised unbalancing the whole stack. In this work, a model-based control strategy has been developed to trigger the activation of available actuators to prevent cell flooding. A 1D validated single cell model is used to estimate the percentage of liquid water coverage on the active area of the catalysts layers on both sides of the polymer electrolyte membrane. The water activity levels are observed using this model with continuous verification of the estimated outputs against the respective real-time load current profile (observer results confirmation). Liquid water coverage is calculated from observed water activity levels and a simple droplet distribution analysis. Depending on the stack conditions, the control strategy is able to trigger purges, change reactant humidification levels, modify stack temperature setpoint to evaporate liquid water, or even request a cathode channel blowdown action, if allowed, to prevent cell flooding. Overall, the strategy achieves a trade-off to maintain an acceptable level of liquid water coverage on the catalyst layers with appropriate actuators effort or frequency of control events. This control strategy helps to avoid system level shutdown because of single cell flooding in a stack, a situation that deteriorates fuel cell system reliability.

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