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Study on the Impact of Power Fluctuation, Hydrogen Utilization, and Fuel Cell Stack Orientation on the Performance Sensitivity of PEM Fuel Cell

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Abstract : The performance of proton exchange membrane (PEM) fuel cells is sensitive to several factors, including power fluctuations, hydrogen utilization, and the quality orientation of the fuel cell stack. In this study, we investigate the impact of these factors on the performance of a PEM fuel cell. We start by analyzing the power fluctuations that are typical in renewable energy systems and their effects on the 50 Watt fuel cell's performance. Next, we examine the hydrogen utilization rate (0-1000 mL/min) and its impact on the cell's efficiency and durability. Finally, we investigate the quality orientation (three different positions) of the fuel cell stack, which can significantly affect the cell's lifetime and overall performance. The basis of our analysis is the utilization of experimental results, which have been further validated by comparing them with simulations and manufacturer results. Our results indicate that power fluctuations can cause significant variations in the fuel cell's voltage and current, leading to a reduction in its performance. Moreover, we show that increasing the hydrogen utilization rate beyond a certain threshold can lead to a decrease in the fuel cell's efficiency. Finally, our analysis demonstrates that the orientation of the fuel cell stack can affect its performance and lifetime due to non-uniform distribution of reactants and products. In summary, our study highlights the importance of considering power fluctuations, hydrogen utilization, and quality orientation in designing and optimizing PEM fuel cell systems. The findings of this study can be useful for researchers and engineers working on the development of fuel cell systems for various applications, including transportation, stationary power generation, and portable devices.

Keywords : fuel cell, proton exchange membrane, renewable energy, power fluctuation, experimental
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