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Testing the Membrane Electrode Assembly (MEA) for Polymer Electrolyte Membrane (PEM) Fuel Cells

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MEA testing seems relatively straightforward. In addition, the ability to collect data from an operating electrochemical system can be alluring. However, MEA testing can become downright unbearable with the realization of how difficult it is to achieve similar performance even on an identical sample. But, downright unbearable can be reduced to mildly frustrating if someone with significant fuel cell testing experience is involved.

Two Common Errors:

The Fuel Cell Stack Produces Valuable MEA Data

One common error is assuming that testing MEAs in a stack is more productive, because several MEAs can be tested at once. But, separating the issues related to the fuel cell stack from the issues related to the MEA can be difficult. MEA researchers may find that they are spending resources troubleshooting the fuel cell stack, rather than the MEA.

The root of this error is the assumption that a fuel cell stack provides an environment in which all cells are operating under identical conditions. A more productive assumption is that none of the cells within a stack is operating under identical conditions. A stack delivers gas to several cells, in parallel, which means test personnel can determine an average flow rate. But, test personnel cannot know an exact flow rate to each cell. In addition, the temperature within a stack can vary widely from cell to cell. Without knowing exact operating conditions, test personnel cannot make accurate statements about the MEA's performance.

Single cell testing allows more accurate control of the operating conditions. Because single cell testing allows specific control over humidity, reactant flow, and temperature, test personnel can be sure that the results they observe are MEA related. Single cell testing is never wasted. Test personnel can apply the lessons learned from single cell testing to stack testing.

Substantial single cell testing should be completed prior to stack testing. Knowing how the MEA operates under well-controlled conditions will lead to a better understanding of the operating conditions within a stack.

The Perfect Test Stand Produces Perfect Results

Another common error is assuming that a properly calibrated test stand, built by a reputable vendor, will produce data that can be interpreted at face value. Experienced test personnel know that the performance of an MEA is not only a function of its immediate operating conditions, but also a function of its short and long-term operating history.

For example, some MEAs can lose 100 mV in performance after being on a constant current hold for as little as 100 hours. This MEA behavior is well known among experienced test personnel. Performing a 5-minute refresh procedure and returning to the previous operating conditions recovers over 90 percent of the performance loss. This demonstrates that under identical operating conditions, and within 5 minutes, two very different data points are collected.

The error in assuming that a perfect test stand produces perfect results is compounded by the fact that there is no such thing as a perfect test stand. Equipment issues related to humidity control, flow control, and electrical noise also should be considered when comparing data.

Avoiding the Errors

Choosing to develop MEA testing experience over time, as opposed to hiring experienced personnel, can be a costly and time-consuming decision. The starting point for improved MEA performance is a thorough understanding of normal MEA performance. Avoid time-consuming issues by including someone with MEA testing experience on your team. Testing can appear deceptively straightforward. Don't be fooled.

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