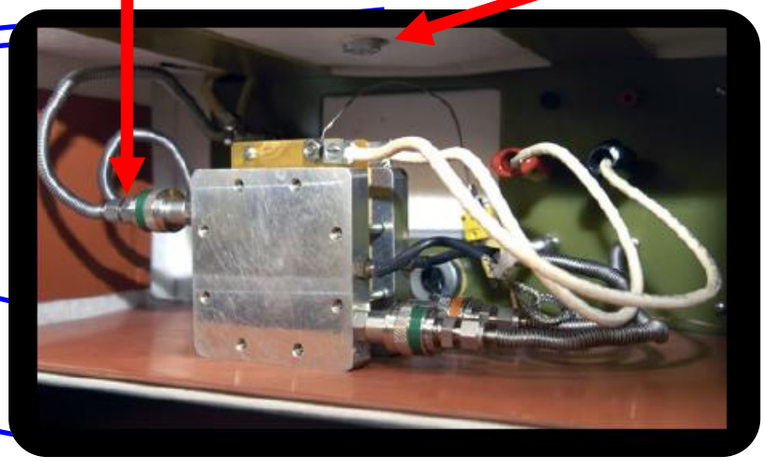
# MT571 Fuel Cell Tester

- Automated polarization curve and EIS at constant stoic
- Unprecedented control of  test parameters
- Comprehensive test configuration and data acquisition automation
- Wide variety of modules for custom configuration
- High level of safety

*"Think inside the box"*

%RH  IS MEASURED HERE AT UUT

2 INTEGRATED $H_2$ SENSORS FOR SAFETY



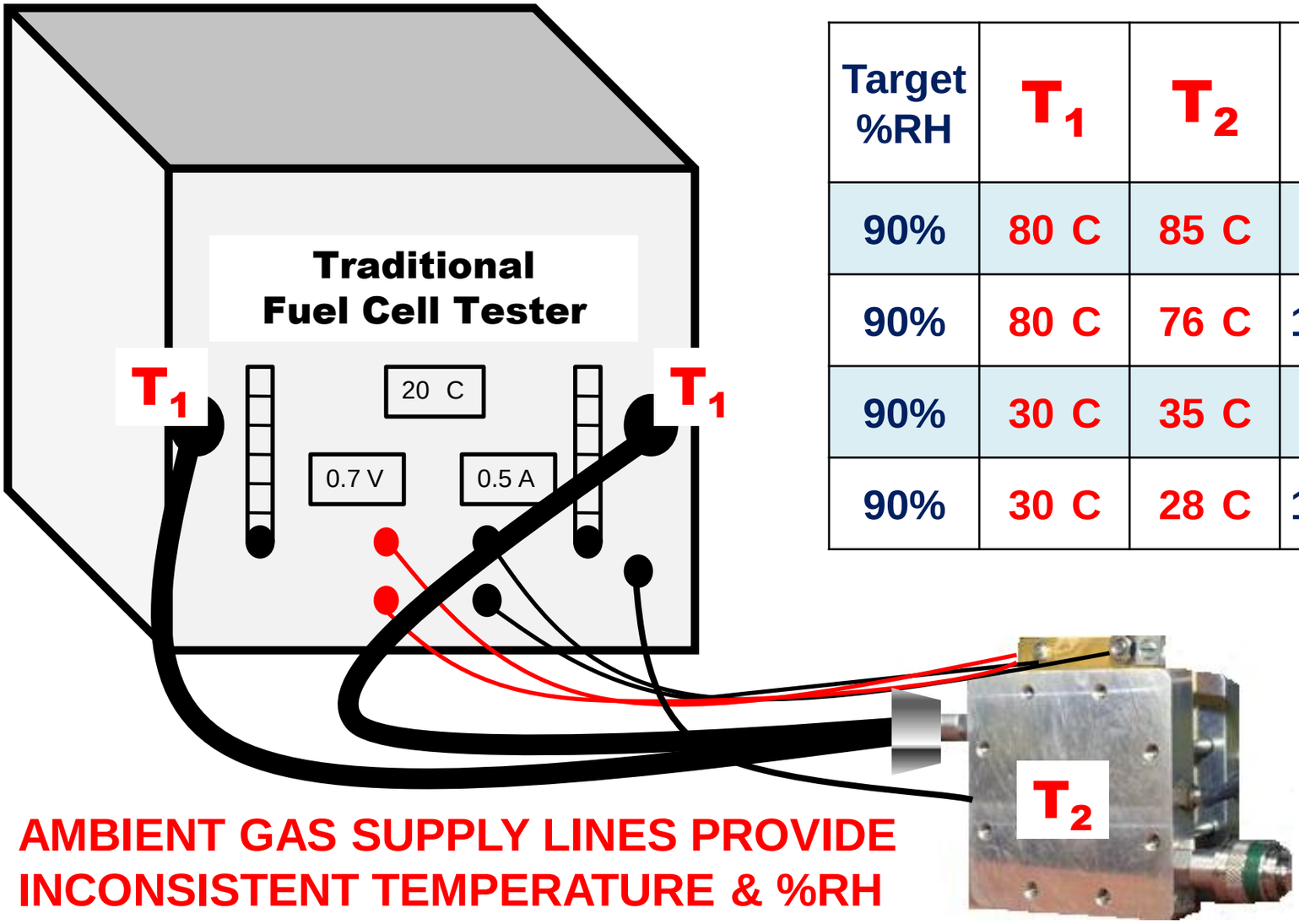
PATENTED THERMAL CHAMBER MAINTAINS EQUAL GAS AND UUT TEMPERATURE

ALL GAS & ELECTRICAL CONNECTIONS  ARE CONVENIENT AND QUICK

# Traditional Fuel Cell Testing

## Humidification Errors Due to Lack of Temperature Control

***This loss of temperature control can result in condensation**




| Target %RH | $T_1$ | $T_2$ | UUT %RH | RH Error |
|---|---|---|---|---|
| 90% | 80 C | 85 C | 77% | 17% |
| 90% | 80 C | 76 C | 100%+ | 12%* |
| 90% | 30 C | 35 C | 69% | 30% |
| 90% | 30 C | 28 C | 100%+ | 10%* |

**AMBIENT GAS SUPPLY LINES PROVIDE INCONSISTENT TEMPERATURE & %RH**

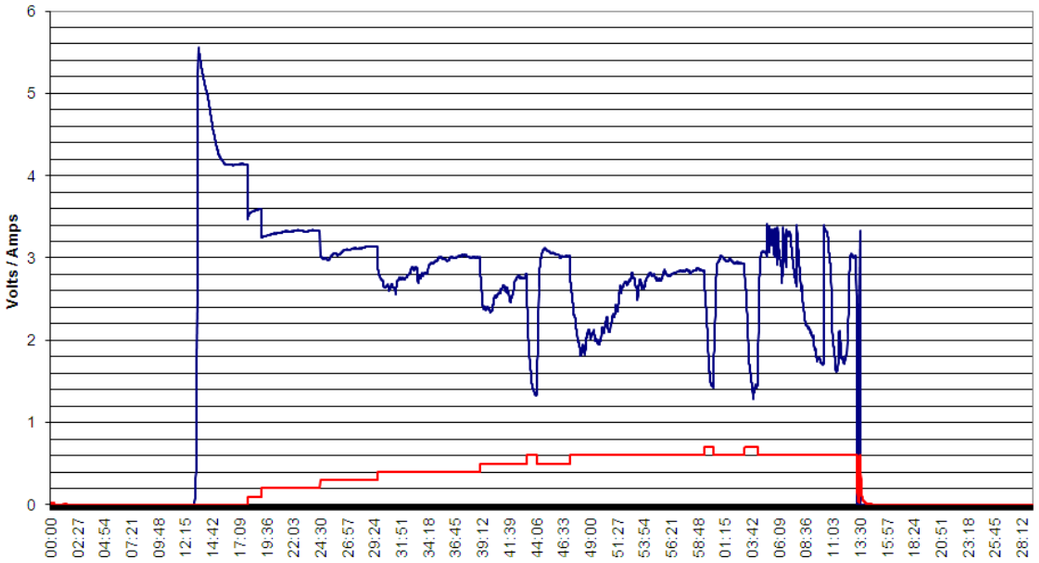
# Problems with Traditional Test Configurations

**Traditional test system configurations can provide erroneous data:**

- ❑ **Temperature gradients in transport of heated and humidified gases**
  - **Actual %RH at Unit Under Test (UUT) is uncertain**
  - **Potential for condensation and flooding**
- ❑ **UUT %RH control point is not generally measured at UUT**
- ❑ **Temperature of UUT is uncertain due to self heating and ambient conditions**
- ❑ **Gas composition changes due to partial pressure of water vapor**

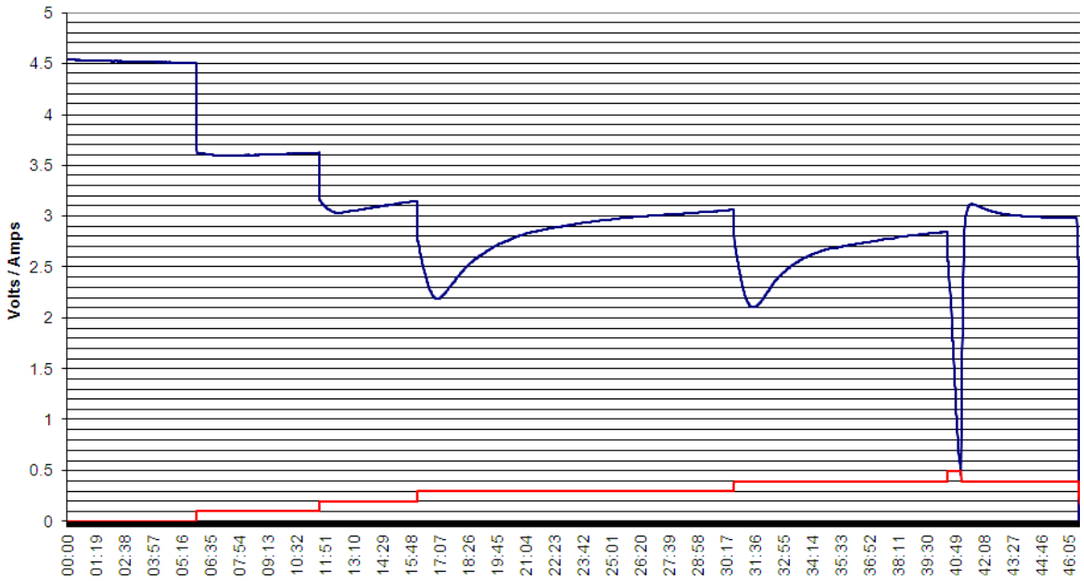
**Polarization data taken with air breathing test stack on bench (Traditional Method)**

- **As more current was drawn from the stack, the voltage output naturally decreases.**
- **The data is not stable due to variable conditions.**
- **Identifying the corresponding voltage level for a given current is difficult.**

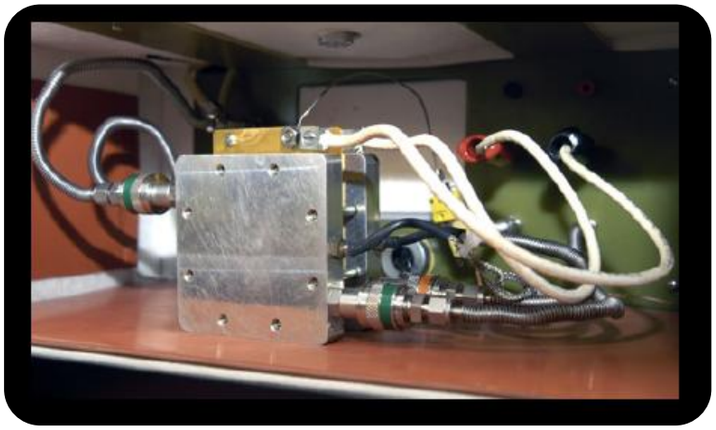


# Test the Component, Not the Ambient Conditions

**Compared with the previous Traditional Method data graph, the data produced by the MT571, with same stack is much more stable as conditions were accurately controlled during the test.**




*"Think inside the box"*



**Polarization data taken with same test stack via MoundTech MT571 with patent pending thermal management technology and same TDI electronic load**

**Identical test protocol and measurement instruments were used in both cases**

**The difference between the scenarios is the ability to control the temperature, gas humidification, and ambient conditions of the unit under test.**

**As more current was drawn from the stack, the voltage output naturally decreases. The data from the MoundTech MT571 with Thermal Control Module is more stable and identification of voltage levels is relatively easy.**

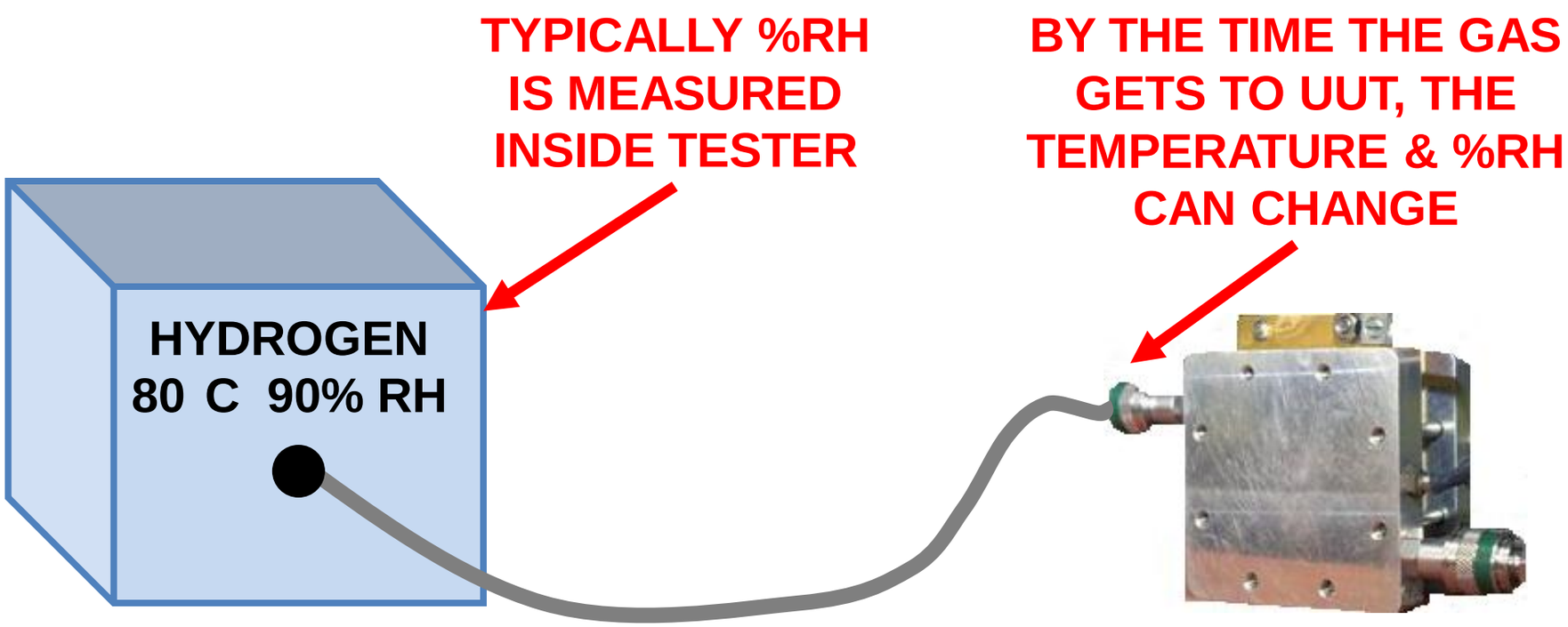
# Location Location Location

**Another source of error related to humidification measurement and control is the <u>location</u> of the RH measurement.**

**Generally the RH sensor is located at the source of humidification.**

**From the source, the gas can be exposed to lengths of tubing and potentially different temperatures.**

**This typically results in an RH at the unit under test that is significantly different than that measured at the source.**



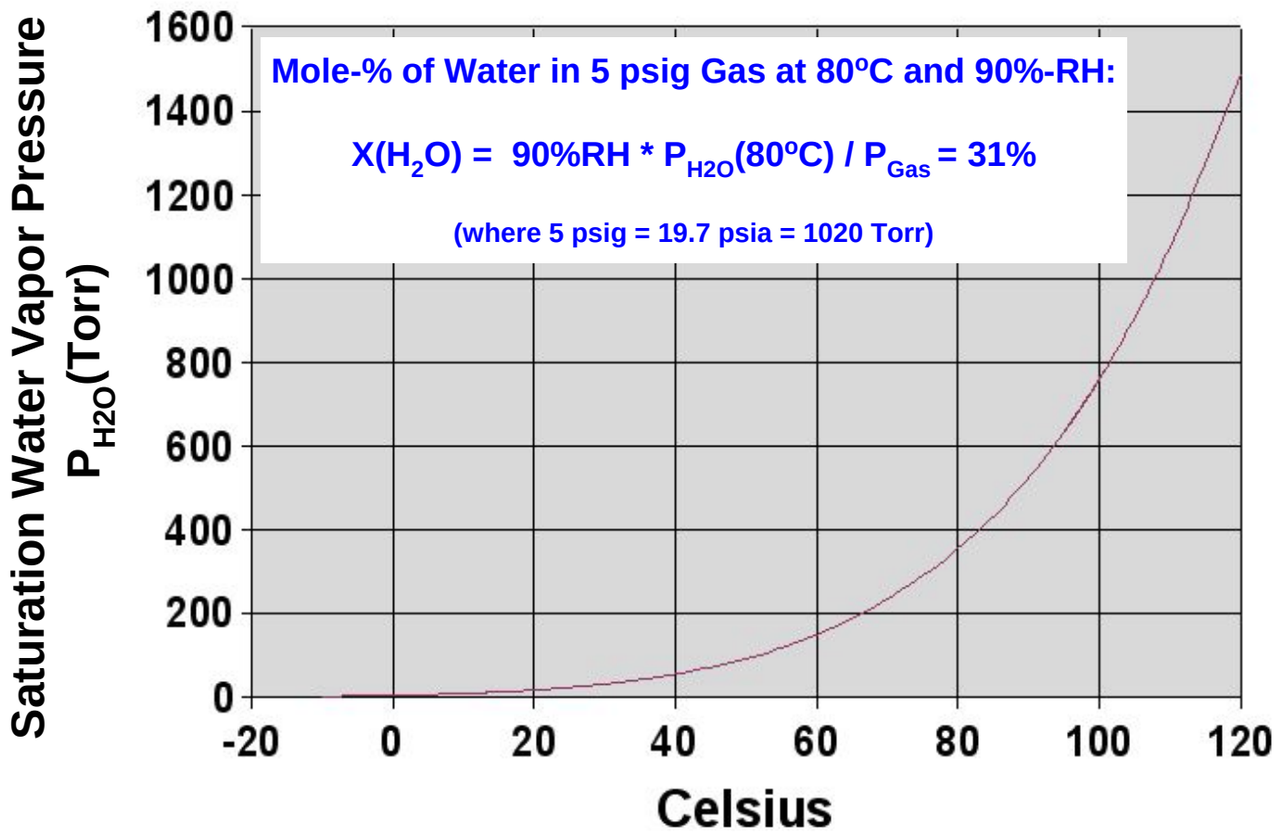
# Gas Composition and %RH

**At 80°C and 90% R.H., the water vapor mole fraction in the fuel or oxidant gas is significantly higher than at 25°C and 90% R.H.**

**At 80°C and 90% R.H., the water vapor partial pressure is 0.42 atmospheres present within the total pressure of the humidified fuel or oxidant gas.**

**If both fuel and oxidant are equally humidified, this is generally not problematic. However, if they are at different levels of humidification, the ratio of fuel to oxidant is not what is intended.**

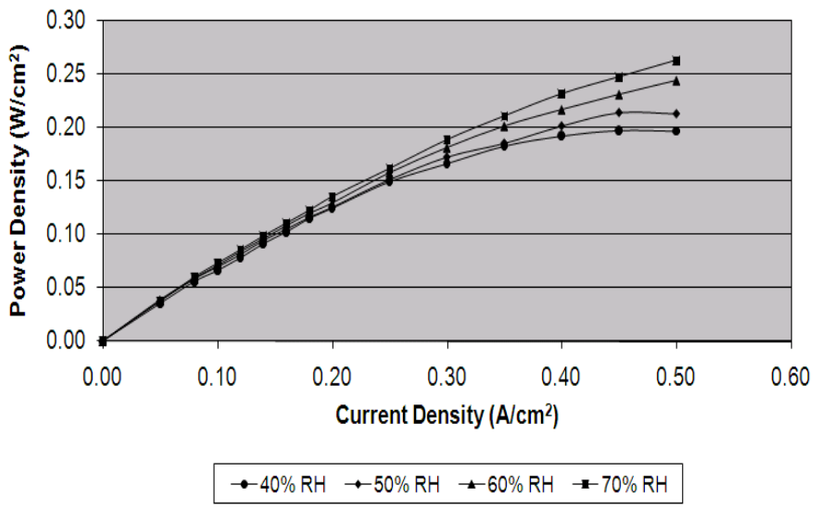
**Water Vapor vs Temperature**



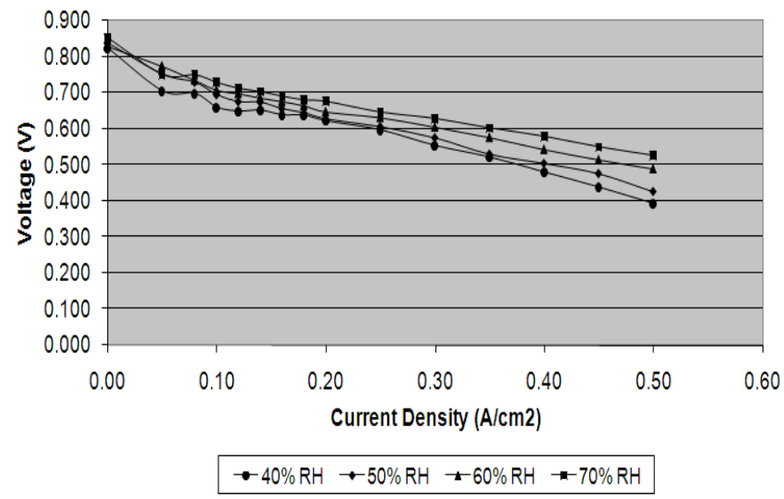
# Effects of %RH on Power Density

**Effects of fuel & oxidant humidification on cell power density and voltage while controlling all other parameters constant**

**Power density measurements at 40, 50, 60, and 70% RH**




**Voltage measurements at 40, 50, 60, and 70% RH**




**30% increase in power density between 40% RH and 70% RH**

**34% increase in voltage output between 40% RH and 70% RH**

**Easily seen when RH is controlled via RH measurement within the temperature controlled environment and directly at the unit under test. All features of the MoundTech MT571**

Data provided by University of Cincinnati

# Fuel Cell Testing Best Practices

- **Control Test Parameters**
  - Maintain uniform fuel, oxidant, and UUT temperatures
  - Measure %RH at UUT, not at source
  - Control, appropriately measure, and log all test parameters
- **Understand Test Conditions**
  - Set temperatures, flow rates, %RH within accurate control ranges
  - Note effect of %RH on fuel and oxidant composition and volume
  - Verify that test system is capable of accurate and precise control of desired test parameters:
    - Ensure that parameters are measured at appropriate location
    - Ensure set-point is within specified accurate control range
    - Ensure ambient conditions do not effect the UUT
- **Log measurements with a time base to enable data correlations**
  - Test data should include all operating parameters
  - Test configuration settings should be logged