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technology.



# Condition Monitoring

## on Fuel Cell Test Benches





# Humidity and Temperature Measurement for Fuel Cells on Test Benches

Following the clear commitment to climate protection in Europe, and the global trend to decarbonisation, the expansion of alternative energy generation systems is shifting into the action focus. Hydrogen plays a major role here. As it does not cause any direct pollutant or greenhouse gas emissions, hydrogen has become one of the most important renewable energy sources for the transition to a zero-emission economy. The fuel cell is a highly efficient method of generating electricity with hydrogen. The HTS801 humidity and temperature sensor and the intrinsically safe EE300Ex see E+E Elektronik contribute towards industrialising this technology, boosting the efficiency of the units and keeping the systems fail-safe.

The fuel cell's operating principle is based on converting the reactive chemical energy of a continuously supplied fuel (H<sub>2</sub>) and an oxidant (O<sub>2</sub>) into electrical energy. The polymer electrolyte membrane (PEM) fuel cell is one of the most common types of fuel cell – forward looking in both mobile and stationary applications.

Each fuel cell system contains the central core component, the single or monocell. To boost performance, multiple cells are combined to form a stack. The system also requires subcomponents such as pumps, heat exchangers or humidifiers, also known as BoP (Balance-of-Plant) components.

## Efficiency of Fuel Cells

Some of the key mechanisms affecting fuel cell efficiency depend on the environmental conditions within the cell. If the temperature and humidity balance are not appropriately controlled, the catalyst and membrane age more quickly. The proton conductivity of the membrane and, in turn, the performance and lifetime of a fuel cell increase proportionally with the water content of the polymer membrane. This is why the water content needs to be constantly monitored and appropriately adapted with the help of a humidifier.

## Fuel Cell Test Benches

In a fuel cell system, the hydrogen and oxygen inflow and outflow conditions, and the electrical output, need to be closely monitored. To optimise and enhance fuel cell efficiency, test benches are designed to integrate monitoring of the process parameters such as flow and pressure, but also the humidity and temperature of the gas flows and their interaction within the process. The range of test benches extends from testing monocells to testing fuel cell stacks and complete systems.

Fuel cell test benches are built for different systems and purposes:

- Environmental and service life simulation
- Testing Balance-of-Plant components and membrane activation
- Leakage checks and electrical safety
- Quality control and factory acceptance testing

## Strict Requirements for the Measuring Technology

The moisture content of the fuel gas flows used in the process is an essential factor regarding to the quality, service life and efficiency of the PEMs. This makes it all the more important to monitor and control the humidity and temperature on highest accurate value. The greatest challenge for the measuring devices is the very humid environment with > 85% relative humidity at relatively high temperatures of up to 90 °C. Condensation on the sensor additionally influences the reliability and stability of the measurement and leads to incorrect measurement results.

In this respect, installing the sensor correctly plays an important role. Measurements are taken at up to 4 measuring points: both in the supply air (wet-in), in the water discharge (wet-out), and in the hydrogen supply and recirculation. Measuring at the inlet provides information about the operating status of the fuel cell humidifier, while measuring at the outlet reveals the efficiency of the entire process. The sensor needs to be protected against excessive water exposure, especially at the wet-out, by installing baffle plates. Apart of the correct installation, the sensors

themselves need specific properties, such as high humidity resistance, short response times or protection against corrosion and chemical contamination.

### The HTS801 - the Solution from E+E Elektronik

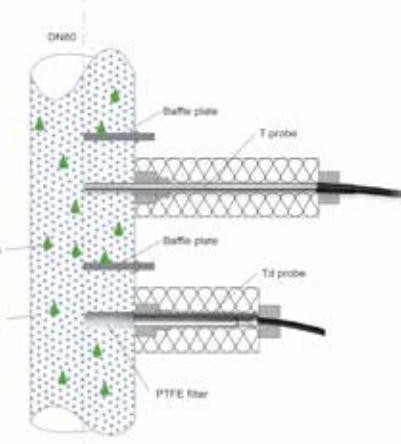
In the form of the HTS801, E+E Elektronik has developed a sensor for the strictest requirements in terms of stable and highly precise measurement of relative humidity (rH) and temperature (T) under the most difficult conditions. In addition to a condensation monitor, the sensor features a High Humidity Guard (H2G), which prevents condensation on the measuring elements through continuous, controlled heating

of the sensor element and the sensor body (dual heating system). This means that accurate humidity measurement is possible even in conditions with persistently high humidity and condensation. Equipped with a PTFE filter cap, the sensor enables long-term stable measurement even in chemically demanding environments.

In addition to measuring in process environments, the intrinsically safe EE300Ex humidity and temperature sensor with ATEX approval is suitable for monitoring explosive testing environments.



HTS801-T17 with heated sensing probes



Installation of the sensing probes

## The Challenge.

- Fast and stable measurement in the long-term in the most adverse of conditions
- Strict demands on the robustness and durability of the sensors due to constantly high humidity and temperature
- Handling changing ambient conditions in the extended temperature range

## The Solution.

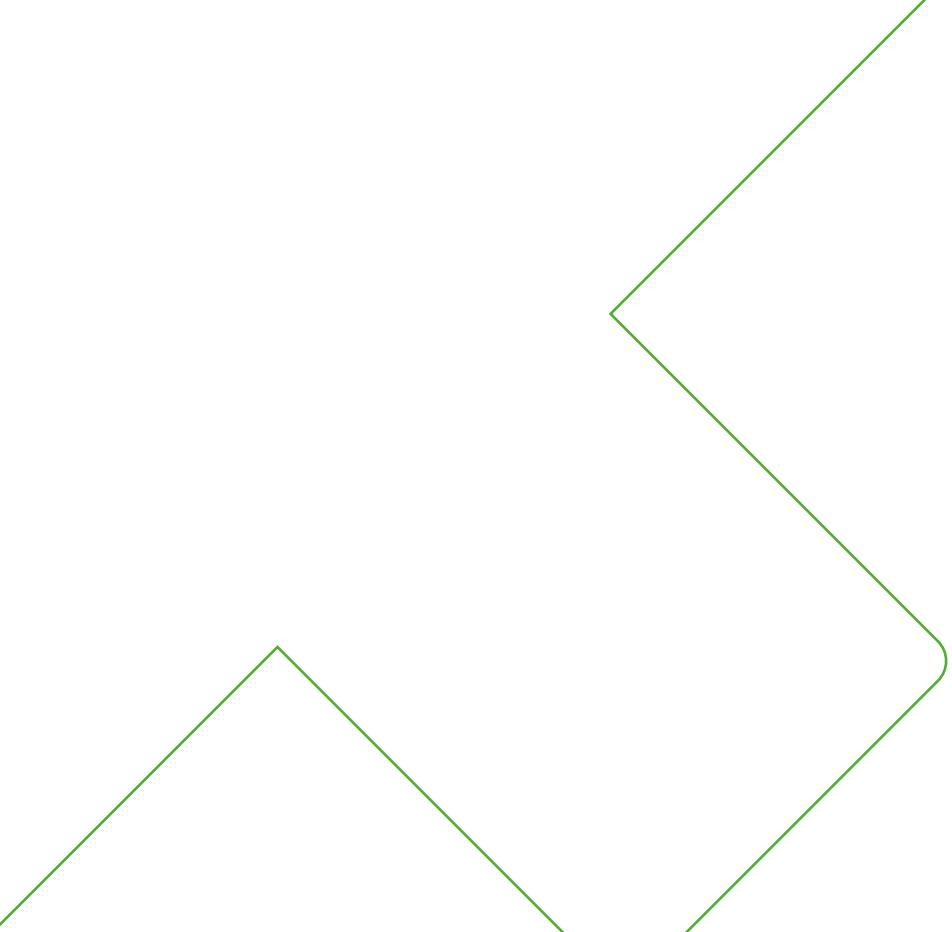
- HTS801 with H2G
- Controlled heating of the measuring cell
- Output of relative humidity, temperature and dew point
- Sensor protection features
- Customer-specific calibration also traceable in line with DIN ISO17025
- Interchangeable sensor probes

## Product Benefits.

- Long-term stability and highly accurate measurement
- Fast recovery after dewing
- Robust and insensitive to contamination
- Heating modes for temporary condensation, permanently high humidity and chemical load
- E+E proprietary sensor coating
- Reputation on the market
- Sensor Self Check

## Overall Value.

- Optimisation of PEM stacks and system humidifiers based on reliable humidity and temperature measuring results
- EOL and FAT operationally reliable and verifiable
- Repeatable values even in demanding climatic conditions
- Easy maintenance



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