

Catching the Drift:

What the Specifications of Your RH Monitoring System May not Specify

Introduction

Understanding how relative humidity measuring devices function and how their product specifications can be misrepresented in product datasheets can mean the difference between purchasing an expensive system with inherent measurement flaws and extra costs, and getting a system you can count on between calibrations. Knowing what to look for in product specs will allow you scrutinize the information and find the system that fits your needs. Basic knowledge of how these devices function will prove that often, critical information that is not on a product's datasheet can be more revealing than what is.

Validating/Mapping Humidity: How hard can it be?

One of the hardest parameters to accurately measure, relative humidity is a pivotal factor across a broad spectrum of industries and often entails the potential to impact critical applications and public safety. In calibration, stability testing, or quality assurance processes, the intrinsic uncertainty of humidity measurement can be a major source of unnecessary cost, skewed data, and lost revenues.

The Inevitable Drift of Humidity Sensors

It's an immutable law of RH measurement: humidity sensors drift. They do so for the simple reason that they're "air breathers." Unlike temperature sensors, the humidity sensor must be in direct contact with the environment. Because the air is constantly changing temperature and contains countless airborne contaminants and because the internal structure of the sensor is has no protection from those elements, the sensor's ability to accurately measure RH degrades over time. This is why, even if the calibration process were perfect (it isn't), once exposed to the real world, the measurement accuracy inevitably decreases until its next calibration.

A tale of two calibrations (Initial vs. One Year Later)

There are two key accuracy values that must be considered when looking at any RH measuring device's product specifications. The first is initial accuracy, when the device is first deployed, the other is one-year accuracy, or the accuracy when you go to calibrate the device (six months to one year is standard).

However, not all initial accuracies are created equal. Initial accuracy, the device's accuracy when first deployed, should factor in all known uncertainties, including:

- Calibration Uncertainty
- Temperature Effect & Mathematical Fit
- Hysteresis
- Measurement Resolution

If you don't see these variables on a product's specifications, you cannot be certain that they have been included in calculating that device's accuracy.

One Year Later: How long has your RH data been wrong and by how much?

Although a critical value, one-year accuracy (the accuracy of the device after a year of normal use), is rarely included on product specifications for humidity measuring instruments. However, this percentage is actually more important than initial accuracy because *all data gathered since the last calibration is based solely on its accuracy upon re-calibration.*

For example, if your RH measurement device is found out-of-spec when you go to re-calibrate, you will be faced with some hard questions. What products or tests were affected and to what extent?

Knowing what to look for in product specs

You may be able to find specs on the accuracy of an RH measuring device after a year of typical use and over a wide temperature range, but first you'll have to know what to look for and second, look at a lot of product spec sheets. As a last ditch effort, you may have to just ask the sales representative. However, this comes with a proviso; the manufacturer should provide documentation that shows the accuracy values of their devices at the end of the calibration cycle, *before* re-calibrating.

The question is: why is the inclusion of these values on product specifications so rare within the industry? To answer, it's vital to understand the three main elements that determine sensor accuracy:

- Sensor characteristics
- Calibration
- Sensor Measurement System (Electronics)

A device may have the best RH sensor available; however, as already stated, *all RH sensors drift.* To maximize overall accuracy, it is crucial to reduce errors that occur during the calibration process and within the Sensor Measurement System. These elements, well controlled, will create a bit of room for the device to drift, and still maintain a reasonable amount of accuracy.

In other words, to anticipate the drift of a device, you must achieve optimal accuracy in the calibration and the Sensor Measurement System. In effect, you need to reduce or virtually eliminate all other sources of error in the manufacture and maintenance of the device.

Sources of Error:

Calibration Uncertainty

All humidity calibration chambers have an associated uncertainty, a major source of which is temperature non-uniformity, which must be factored into a measuring

device's accuracy specification.

Before humidity calibration, manufacturers of humidity data recorders must perform a high-accuracy temperature calibration. Each recorder's measured temperature is then able to compensate for chamber non-uniformity during RH calibration — greatly reducing this source of error.

In addition, the location of the temperature and RH sensors inside a data logger can have an effect. Inside some of the best available data recording devices, the temperature sensor is placed right beside the RH sensor. Proximity allows both sensors to read the same environment, eliminating any discrepancies (however small) between their measurements.

Temperature Effect & Mathematical Fit

Most RH measuring devices are calibrated to measure at one specific temperature (typically 25°C). But, unless the device will only measure humidity at that temperature, there can be significant temperature-related inaccuracies.

To solve this, a manufacturer could include tables that correlate humidity measurement over a wide range of calibrated temperatures in the memory of the device. Ideally, no two data recorders have the same set of tables because each set is calibrated to the unique components of every recorder.

This creates an “intelligent” device, because the tables contain explicit information on how to measure humidity over a wide temperature range. This is particularly important in the case of ICH (stability) applications.

Hysteresis

Hysteresis is the tendency of measuring devices to not return completely to their original state after a change has been measured. It's also a major source of error. Unfortunately, despite its ubiquity, too few data sheets include hysteresis as a factor in their accuracy values. If it appears at all, it's often de-emphasized by being placed far apart from the total accuracy specification. Hysteresis unmentioned or disconnected textually from an accuracy value could be considered product misrepresentation to a discerning purchaser.

Measurement Resolution

Resolution is simply the smallest measurable increment that the device can detect. A good device will feature a 12-bit high-resolution system that detects changes of as small as 0.05%RH.

Electronics

A significant element that affects a device's accuracy is its electronic components. Electronics systems are greatly impacted by temperature, which in turn affects overall accuracy. One challenge that manufacturers face is trying to get the electronic system to remain stable over wide temperature ranges.

For example, Veriteq Instruments, a manufacturer of high-end data loggers and integrated software, found that a synchronous bridge measurement system features low power and superior stability. (1) This unique combination greatly reduced the electronics-associated error in humidity measurement.

Product specifications, often one of the key pieces of information decision makers use to select a suitable system, must be explicit, easy-to-understand, and straightforward. All of the known influences and sources of error — calibration uncertainty, temperature effect, measurement resolution, and hysteresis — should be included in the accuracy value stated on any data sheet.

If these values are not mentioned on a product data sheet, the consumer is left to ask: have they been included in that product's stated accuracy? Until those who equip laboratories are better informed on other factors that contribute to inaccuracy in humidity measuring devices, manufacturers confronted with their own out-of-spec devices upon re-calibration, can always blame drift.

1 For an in-depth description of Humidity Sensors, see “Methods of Accurately Measuring Capacitive RH Sensors” at:
<http://www.veriteq.com/download/Methods-of-Accurately-Measuring-Capacitive-RH-Sensors.pdf>

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