Measuring Humidity (and Why it's Important)

Most people are all too aware of the effects humidity can have on human comfort and health, especially when combined with high temperatures. Perhaps less well known is how humidity can impact electrical systems. For example, high humidity can cause droplets of liquid water to condense on circuits, producing problems such as shorting and corrosion.

Many geographic regions are prone to humid conditions, particularly the tropics. But even in relatively temperate climates, high humidity can occur depending on altitude, proximity to bodies of water, and seasonal effects. In addition, the "microclimate" inside and immediately around an electrical cabinet can result in condensation-related issues. As a result, standards bodies such as the InterNational Electrical Testing Association (NETA) often require that humidity data be included in test reports.

Absolute vs Relative
Simply stated, humidity is the amount of water vapor in the air. This is commonly measured either of two ways:

- ***Absolute humidity (AH)*** is the mass of water vapor present in a given volume of air. This is usually expressed in grams per cubic meter (g/m^3) and changes as the volume of air changes.

- ***Relative humidity (RH)*** is the ratio of water vapor density (mass per unit volume) to the water vapor density at the saturation vapor pressure (the point at which the air can hold no more water vapor and liquid droplets begin to precipitate out; this is also known as the ***dew point***). This is typically expressed as a percentage, and changes with air pressure and temperature.

In this Application Note, humidity will be expressed as RH.

Humidity and People
Maintaining an appropriate level of humidity is important for ensuring a comfortable and healthy indoor environment. Excessive humidity can make working difficult, especially if physical activity is involved. Less directly (but equally important), high humidity promotes the growth of mold that can cause respiratory issues. It can also cause peeling paint, rust on iron objects, and slippery surfaces slick with condensation. These and other factors can significantly affect your health and safety.

In general, a humidity level between 30 and 40% is considered ideal for maximum comfort. To ensure the humidity remains within this range, facilities employ a variety of HVAC systems, including air conditioning, controlled mechanical ventilation, and dehumidifiers. To test their efficiency, it is important to periodically check the humidity level with hygrometers and other moisture measuring instruments. In many cases, it also can be useful to monitor humidity continuously over an extended interval, to identify potential trends and spikes.

Electronics

As noted at the beginning of this article, humidity can have a detrimental effect on electrical systems and components. The most obvious issue is condensation, which results when RH reaches 100%. For example, droplets of water forming on a heatsink can wick into the housings of power modules. In live conductors, liquid can compromise insulation. The damage may remain even after the RH falls and the droplets evaporate, making it very difficult to troubleshoot and identify the cause of the problem.

A number of factors can cause RH to reach the saturation point. One of the more common is temperature disparity. As air cools, the amount of water vapor it can hold decreases. Thus a sudden cooling causes RH to rise rapidly.

For instance, an electrical system can be warmed by the waste heat of its components. A sudden change in operating state (for instance a power failure) can cause the system to cool. Components such as the heatsink may cool far more rapidly than the air temperature in the enclosure, creating a condition where the heatsink temperature falls below the dew point. Therefore it is critical to be aware of any changes from operation from full to reduced power, such as equipment entering standby mode or an unexpected downtime.

Changes in air temperature can also cause internal condensation in electrical systems. Many heatsinks are cooled by outside ambient air. As the inlet air temperature drops in the evening the heatsink may be cooled to below the dew point. We therefore recommend monitoring both the interior and exterior RH over a period of days or weeks to understand how weather and system operation interact.

In addition to electrical conductance, humidity can also have a corrosive effect on many materials. Corrosion progresses rapidly when humidity exceeds 60%. And since corrosion also progresses as temperature increases, facilities in high humidity locations must carefully monitor (and prepare countermeasures for) the amount of water vapor in the air.

Organic components

A recent trend is to fabricate electronic components from organic materials, due to their reduced costs and ease of manufacture. Unfortunately, these materials present special humidity-related issues. This is due to the fact that they tend to be water-permeable, slowly absorbing moisture until its internal water concentration matches the ambient air.

Excessive levels of moisture in organic materials can severely impact performance and reliability. One obvious example is so-called “popcorn” cracking, caused when saturated organic materials are suddenly heated to a high temperature. Other longer-term effects include swelling of components, which can compromise electrical connections.

AEMC Thermo-Hygrometer Data Logger Model 1246

To help you monitor humidity in your facility, AEMC provides the Thermo-Hygrometer Data Logger Model 1246. This is a portable, compact digital meter designed for simplicity and one-hand operation. The instrument enables you to perform a variety of recording tasks with easy and intuitive setup from a computer using supplied DataView® software. The meter uses an NTC as the temperature sensor, providing excellent response time to changes in temperature, good repeatability and accurate readings. The Model 1246 also utilizes a thin film polymer capacitive type relative humidity sensor, offering excellent recovery from 100% moisture, and fast response time and durability.

Features include:

- Monitor and record temperature, humidity, and dew point
- Dual line display toggles between any two measurements
- User selectable temperature units (°F, °C)
- Built in sensor with removable protective cap
- Min and Max measurements stored
- Hold function freezes the display
- Spot or continuous recording up to 1 million measurements
- Blue luminescent backlit display
- Programmable alarms for temperature and humidity through software
- USB and Bluetooth communication
- Magnetic mount
- Battery or USB powered
- DataView® graphing and analysis software included

The Model 1246 can store up to 1,000,000 measurements on each channel (4MB). Recorded data is stored in non-volatile memory and will be retained even if the battery is removed. The instrument can measure from 3 to 98% RH, with an accuracy of ± 2% RH + 1 count when measuring between 10 to 90% RH.

For more information about the Model 1246, see https://www.aemc.com/products/environmental-testers/environmental-thermohygrometer-1246.