MEASURING HUMIDITY: WHY IT'S IMPORTANT

BY JOHN OLOBRI, *AEMC Instruments*

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 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 HUMIDITY

Simply stated, humidity is the amount of water vapor in the air. Two ways are commonly used to measure humidity:

- **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. RH is typically expressed as a percentage and changes with air pressure and temperature.

In this article, humidity is 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 health and safety.

In general, a humidity level between 30 and 40 percent is considered ideal for maximum comfort. To ensure 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 can also be useful to monitor humidity continuously over an extended interval to identify potential trends and spikes.


Mold

ELECTRICAL EQUIPMENT

Humidity can have a detrimental effect on electrical systems and components. The most obvious issue is condensation, which results when RH reaches 100 percent. For example, droplets of water forming on a heatsink can wick into power module housings. 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, sudden cooling causes RH to rise rapidly.

For instance, an electrical system can be warmed by dissipation of heat from its components. A sudden change in operating state — for example, 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 in operation from full to reduced power, such as equipment entering standby mode or experiencing unexpected downtime.


Condensation

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. Therefore, it is recommended to monitor 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 have a corrosive effect on many materials. Corrosion progresses rapidly when humidity exceeds 60 percent. 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 cost 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 the 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.

MEASURING HUMIDITY

Many instruments on the market measure and, where necessary, record temperature, humidity, and dew point. On the low-cost end, a number of choices measure and display either humidity only or both temperature and humidity.

For more demanding applications where documented results are required, a data logging thermo-hygrometer is a better choice. These instruments are portable, compact digital meters designed for simplicity of operation. Most enable you to perform a variety of recording tasks with easy and intuitive setup from a computer or smart device app. These meters use a semiconductor as the temperature sensor, which provides excellent response time to changes in temperature, as well as good repeatability and accurate readings. Relative humidity is typically measured by a thin film polymer capacitive sensor, offering excellent recovery from 100 percent moisture and fast response time and durability.

A variety of common features includes:

- Ability to monitor and record temperature, humidity, and dew point
- User-selectable temperature units (Fahrenheit and Centigrade)
- Plug-in sensors with easy replacement capability
- The capability to store minimum, maximum, and average measurements time stamped for ease of analysis
- Spot or continuous recording of measurements
- Backlit display
- Programmable alarms for temperature, dew point, and humidity through software
- USB and Bluetooth communication
- Battery or USB power capability
- Graphing and analysis software to program the instrument, analyze the results, and print or transmit reports

CONCLUSION

Relative humidity is a common term most people can relate to. We know that when the humidity is high, the environment can be uncomfortable. When it is too low, static electric shocks are common when we touch something. As human beings, we like the relative humidity to be between 30 and 40 percent.

Electrical equipment is also affected by humidity. Condensation caused by high humidity can damage the operation and functionality of sensitive equipment that is not treated for humid conditions. Newer components made from organic materials are even more sensitive to high humidity, and corrosion progresses rapidly when humidity exceeds 60 percent with many materials.

It is a good practice to monitor the humidity in the work environment and in control rooms where critical electrical equipment resides to prevent costly down time or failure. There are many good choices of instruments available to monitor, control, and report temperature, humidity and dew point. It is an investment worth making to protect your assets.

John Olobri *has been Director of Sales and Marketing at AEMC Instruments for 20 years. He has been actively involved in the areas of insulation resistance, ground resistance testing, power quality testing, data logging, and environmental testing. John previously worked in instrumentation design and marketing for over 35 years, holding positions as Service Manager, Product Marketing Manager, and Sales Manager for several instrument manufacturers. He holds degrees in both electrical and industrial engineering and conducts accredited seminars on ground resistance testing across the country.*