

Measuring Humidity in High Humidity Environments



Making measurements in environments with high relative humidity (over 90%) is always a challenge because it is so close to saturation. Vaisala has developed warmed probe and sensor heating technologies to handle these demanding conditions. Warmed probe technology enables reliable and accurate humidity measurement, even in environments with 100% relative humidity (RH) where wet humidity sensors are unable to measure.

In high relative humidity (over 90% RH) all objects, including humidity sensors, are likely to be at a temperature close to saturation. In such an environment the vapor pressure gradient is insufficient for effective evaporation of liquid water from the sensor surface. The sensor may stay wet for a few minutes or more, causing a prolonged measurement outage even after the environment is no longer saturated. Consider an environmental chamber at 23°C and 90% RH. The corresponding dewpoint temperature is 22.2°C. This means that water

vapor will condense on any object that is at a temperature equal to or less than 22.2°C.

Ideally, the humidity probe containing the sensor is in equilibrium at 23°C. In reality, there is only a margin of 0.8°C before condensation occurs. For example, problems arise when:

- The chamber's conditions are adjusted to rapidly change from a lower temperature and relative humidity to a higher temperature and relative humidity. The humidity probe has thermal mass so its

temperature lags behind that of the environment, potentially causing condensation on the probe.

- The chamber's humidity controls overshoot the intended settings, resulting in saturation and condensation on the probe.
- The probe is installed in such a way as to lose heat from the chamber to the outside environment. This makes the probe cooler than the chamber interior, potentially creating condensation if it cools enough to meet the chamber's dew point temperature.

Variations of these problems occur in other high humidity applications. For example, outdoor measurements are corrupted by fog, mist, rain, or heavy dew. Or process measurements in high humidity are disturbed when process pressure spikes, raising the dewpoint of the process gas to the point of condensation. The challenge is to obtain valid measurement data and maximum sensor uptime, even if the environment is at or close to saturation.

Warmed Probe Technology - How It Works

The warmed probe technology is available in Vaisala HUMICAP® Humidity and Temperature Transmitter HMT337 that features a composite humidity sensor with a bonded temperature sensor. With this composite sensor, the relative humidity and the temperature of the sensor are known at all times.

The humidity probe containing the composite sensor is equipped with a heating element. Heating keeps not only the sensor but the whole probe, including the filter, at a temperature several degrees above the ambient. This ensures that water will not condense on the sensor, even when the measurement environment is at the dewpoint temperature (100% RH).

The dew point temperature of the composite sensor can be calculated using the measured relative humidity and temperature values, and can be directly used as the output parameter. If relative humidity or

another humidity parameter output is preferred, the transmitter needs to be equipped with a separate temperature probe installed in the same measurement environment as the humidity probe. This is necessary as relative humidity is a temperature-dependent parameter and probe heating disturbs the relative humidity measurement. Relative humidity can be reliably calculated using the dew point value and the temperature value from the additional temperature probe.

XHEAT Sensor Heating - How It Works

XHEAT is another type of heating function available in selected Vaisala humidity transmitters. By default, XHEAT rapidly heats the sensor to 100°C for about 30 seconds, but users can define the heating temperature, as well as the duration of the heating period.

Unlike the warmed probe, the heating in XHEAT is achieved by directly warming the temperature sensor bonded to the humidity sensor. This is much faster than heating the whole probe, but it also takes the measurement offline until the sensor is heated and cooled back down to its operating temperature. This typically takes about 60 seconds. During that time the last valid measurement is held in the output and display of the transmitter.

Users can configure XHEAT to activate automatically at a specified humidity level. Maximum protection from condensation can be achieved

by using XHEAT with the warmed probe. XHEAT can be considered a defense mechanism against rapidly increasing humidity levels that might wet the sensor. It also speeds up the recovery from condensation.

Warmed Probe Technology and XHEAT in Vaisala Humidity Products

Warmed probe technology is available in the Vaisala HUMICAP® Humidity and Temperature Transmitter HMT337.

XHEAT sensor heating is available in the following Vaisala humidity products:

- Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT330
- Vaisala HUMICAP® Humidity and Temperature Transmitter Series HMT310
- Vaisala HUMICAP® Humidity and Temperature Probe HMP155

In conclusion, condensation can pose problems in a variety of applications. Humidity measurements are compromised when condensation forms on the humidity sensor. Warmed probe technology can improve humidity measurement performance in close-to-saturation environments.

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