Dry as a bone - hot as a house on fire

Confirm the dryness in high temperature processes

Jan Grönblad
Product Line Manager
Vaisala
Helsinki, Finland

In many drying applications the temperature can be very high. Typically, the humidity level is also very low, especially at the end of the drying cycle. In such conditions, traditional humidity instruments may come up against their accuracy limits. On the other hand, the humidity level can be relatively high at the beginning of the drying process, making it difficult to take samples from the measured process air. In these situations, the new Vaisala DRYCAP® Dewpoint Transmitters provide unbeaten accuracy in direct installations in high temperature applications.

Direct humidity measurement in high temperature applications can be a challenging task. When the process temperature rises above 100 °C (212 °F), the relative accuracy of a traditional humidity instrument is acceptable if the amount of moisture in the air is high. But as the humidity level drops, the measurement accuracy suffers. In high temperature applications the humidity is typically low due to the fact that, as the temperature increases, the relative humidity level decreases rapidly. Figure 1 illustrates the maximum relative humidity in the temperature range 90...200 °C (194...392 °F). The humidity value is always below the blue saturation curve, which starts to drop fast when the process temperature exceeds the boiling point of water.

Advantages of direct measurement

A sampling system is one way to get around the accuracy problem resulting from high temperature. Sampling the process air into cooler conditions outside the process is one way to keep the humidity reading at a level where the accuracy is good with traditional technologies. This works in very dry applications, where the process humidity does not condense in the sampling system. Examples of such applications are heat treatment applications where a dry shield gas is used. But typical drying applications (e.g. foodstuffs or pharmaceuticals) use heated air with a rather high humidity, and not shield gas.

The drying process tries to remove the moisture of the dried product as effectively as possible. The dewpoint temperature (humidity) of the process is typically – for at least part of the drying cycle, if not during the whole drying cycle – higher than the outside temperature. This results in saturation in the sampling system. Direct measurement should therefore always be preferred when possible to avoid the risk of the sampling system being filled with water.

Dry end accuracy is important

Measuring the humidity of exhaust air in a drying process is typically a very good indication of the material moisture of the dried product and, when suitable, a

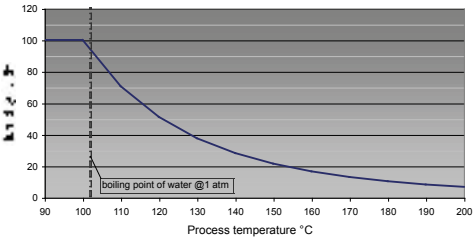

Figure 1. The maximum humidity (%RH) in a high temperature process at 1 atm.

High temperature humidity measurement is problematic in practice because, when the temperature increases above 100 °C, the maximum relative humidity level drops drastically as shown in Figure 1. The 100 °C boiling point of water limits the process humidity in terms of the dewpoint temperature 100 °C Td. When the difference between the process temperature T and the process dewpoint Td increases, the accuracy of humidity measurement typically decreases. To increase the accuracy of humidity measurement at high temperatures, Vaisala's advanced DRYCAP® technology is recommended.

very reliable online measurement. The key issue in drying applications is to measure whether the dried product is dry enough. However, the product should not be over-dried either, in order to optimize product composition or minimize energy consumption. The more accurate the measurement is, the narrower a window for the end product's moisture can be achieved. If accuracy higher than traditional humidity measurement accuracy with ±1 or 2 %RH is required, and if a rugged and long-term stable measurement is preferred, Vaisala's latest DRYCAP® Dewpoint Transmitters are the right solution.

New unbeaten measurement performance

The new Vaisala DRYCAP® Dewpoint Transmitters DMT345 and DMT346 offer unbeaten measurement performance in direct installations in hot and dry processes, thanks to the updated auto-calibration function that now also operates in high temperature processes. The process temperature range for direct installation can be as high as +350 °C (660 °F).

Both models incorporate the auto-calibration method that has been used in low humidity applications in low temperatures for years with great customer satisfaction. The patented technology offers very good accuracy and simultaneously maintains excellent long-term stability. For the user, this means not only reliable measurement values, but also reliable process control with low maintenance costs.

Passive cooling for extreme temperatures

The difference between the two new dewpoint transmitter models is the so-called passive cooling method, which enables the DMT346 to be installed directly in temperatures of up to +350 °C (660 °F). Regardless of the extreme temperatures, passive cooling keeps the sensor temperature within a range that will not burn the sensor.

Passive cooling has the advantage of not requiring any external power to generate the cooling, and the sensor is protected even in power loss situations. The mechanics conduct heat out from the sensor to the outside of the hot process. Not only is the sensor protected against extreme temperatures, but also the measurement accuracy can be improved when the temperature around the sensor is lower than in the actual process. The reason for this is that when the temperature drops, the humidity the sensor detects increases to a more sensitive range. Together with the auto-calibration, this allows measurement in a very wide range with excellent accuracy.

To avoid getting wet in situations where the process humidity is high, the sensor also has an integrated heater that automatically switches on when the risk of saturation is present. This can happen, for example, during process changes or the start-up of the drying phase. When conditions in the process normalize, the heater is automatically switched off. The visibility of this operation is minimized, making the instrument fully automatic and very easy to operate.

Many instruments to choose from

Many instruments have specifications for humidity measurement in high temperatures. Figure 3. provides guidance on selecting the most suitable instrument. It shows that in applications where humidity is low and temperature is high the new DRYCAP® transmitters DMT345 and DMT346 provide the best accuracy. If the temperature is lower and the humidity likewise low, the basic Vaisala DRYCAP® Dewpoint and Temperature Transmitter DMT340 series is recommended. And if there is no need to measure accurately at low humidity, the Vaisala HUMICAP® Humidity and Temperature Transmitter HMT330 is the most suitable choice.

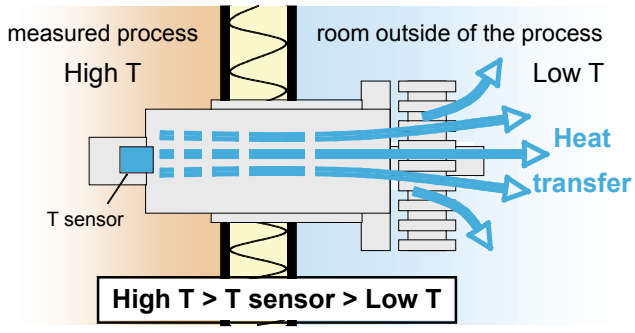

Figure 2. The passive cooling of DMT346 keeps the sensor cooled by means of the lower temperature outside the process.

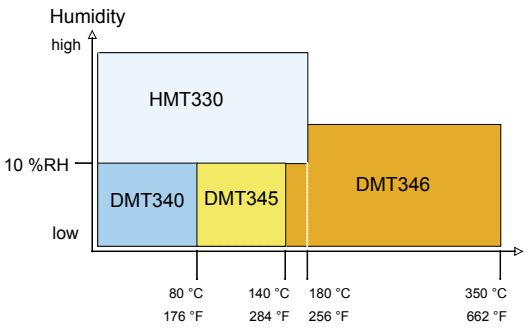

Figure 3. The new Vaisala DRYCAP® Dewpoint Transmitters DMT345 and DMT346 are made for low humidity measurements in high temperatures.