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Chilled Mirror vs. Capacitive Sensor
Understanding the methods of measuring humidity

Many methods exist for measuring Humidity. No single method is Ideal for the manifest ways that humidity can present in the environment of interest. In this article, we will explore two widely used methods: The optical chilled mirror hygrometer, which provides a fundamental (primary) measurement of dew point, and the capacitive polymer sensor, which provides a non-fundamental (secondary) measurement of Relative Humidity.

A Fundamental measurement is such that the parameter being measured, is the same as the Standard International definition of that parameter. In the case of the Chilled Mirror Hygrometer, that measurement is the temperature of the mirror surface covered by a water layer that is in equilibrium between the liquid and gaseous phases of water. If that temperature measurement is accomplished by a platinum resistance thermometer, the measurement is equivalent to the definition of dew point. Tables constructed by NIST, notably by Wexler and Greenspan, establish the equivalence of dew point and the vapor pressure of water. Using this equivalence and a second, fundamental, temperature measurement, realizes the definition of Relative humidity: Vapor pressure of water/saturation vapor pressure (temperature) of the gas being measured, X100(%) i.e. %RH =100*P_{H2Ov}/P_{SAT}. Addition of a 3rd measurement, the pressure of the gas being sampled, allows measurement of almost every other humidity parameter. Some further unit examples: absolute Humidity (g_{H2Ov}/m^3), mixing ratio (g_{H2Ov} /kg_{DRY}), Parts per million ($P_{H2Ov}/(P_{Tot}-P_{H20})$), enthalpy(h), to name a few.

Chilled mirrors are used where accuracy, typically +-0.15 °C, is paramount. Also, Chilled mirrors work well due to their ruggedness, simple maintenance, and ability to accurately measure sample gasses remotely from process, i.e. ovens, dryers, furnaces, etc. Dew points above ambient can be measured by heating the chilled mirror and associated components. Chilled mirrors can be, and are, constructed as an insertion probe, provided the temperature of the process is < ~95 °C.

Applications where low cost, relative to a chilled mirror, can be satisfied most times using a lower cost product. A good choice is a capacitive RH Sensor. Price ranges widely, cost drivers being a NIST traceable factory calibration, all stainless-steel construction, high-pressure rated, being major cost contributors. Even so, a capacitive sensor-based transmitter with these features' ranges from about 1/5 to 1/2 the cost of similarly employed chilled mirror.

Other advantages of a capacitive-based sensor are their small size, low power consumption, and an extended high-end temperature range. Many 4-20ma. loop powered versions are available, lowering installation cost. The measurement needs just 2 wires, typically terminated to a PLC Probes of this type are very popular for measurement in compressed air lines, mainly to monitor the dryness of the air, and

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to guard against condensation of water in the system, avoiding a usually costly problem. A properly designed probe can measure at temperatures up to ~200 °C. Here, much greater cost savings is realized compared to a heated chilled Mirror and associated sampling system.

Downsides of capacitive-based measuring are significant. The need for periodic re-calibration, due to the secondary nature of the measurement, is strongly recommended, as capacitance has no part in defining humidity. This non-primary technique, in all cases, requires calibration of the correlation of the change in capacitance vs. change in humidity. Humidity is only one of many contributors to the measured capacitance, which can be affected by exposure to condensation, aging, exposure to certain chemicals, etc. This is where chilled mirrors perform best, providing high confidence in the measurement result, requiring only an occasional cleaning of the mirror surface. A chilled mirror can be designed to have just stainless steel and sapphire as wetted materials, making the measuring cavity inert to most industrial chemicals. Many companies use a combination of the two technologies, allowing “spot checks” of the capacitive probes, and the capability to calibrate humidity probes using a chilled mirror, as a calibration standard.

In closing, choosing the correct technology to measure humidity for your application can be perplexing. Identify your needs and know your application. So, as an example, if budget, speed of response, elevated temperature above 100C and a need for a vast number of units to measure a daily environmental application, then, a polymer based (capacitive) sensor would most likely be the choice. If precision accuracy, stability, repeatability, product life, simple maintenance and its inertness to aggressive gases, then, chilled mirror should be the choice.

The Dewtran uses chilled mirror technology.

The RO120 uses capacitive sensor technology

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