Innovative Measurement Solutions

Application Notes

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MOISTURE MEASUREMENT OF GASES

"Moisture and humidity are significant factors affecting us directly and indirectly through their meteorological aspects, their contribution to the quality and cost of natural and synthetic products, their influence on the chemical, electrical, physical and parasitic life support characteristics of most manufactured and processed goods, their relationship with storage life, energy cost and conservation, material degradation, etc."

The amount of water vapor in air and many different gases is vital to a wide variety ofindustrial processes--especially the manufacture of electronic components, and is one of the variables in most fields of research which must be accurately measured and controlled.

Until the age of modern electronics there was no alternative to the wet-and-dry bulbhygrometer for measurement of relative humidity and this simple device remains as one of the cheapest and most accurate forms of measurement. Making measurements when the moisture content is drier than about 20% relative humidity is a very different matter.

The development of the aluminum oxide sensor drastically changed the science of moisture measurement. The invention of the capacitance sensor opened up such\ possibilities that new applications for the technique were discovered almost on a daily\ basis--indeed new applications are still being found for this highly versatile sensing device forty years later.

The sensor is a variable capacitor with an ultra high purity aluminum core and porous gold film outer electrode with a special dielectric layer between. It rapidly comes into equilibrium with the surrounding atmosphere, and the capacitance of the sensor varies in direct proportions to the water vapor content.

Cosa Sensors are manufactured in a variety of measuring ranges to meet the needs of applications as varied as making sure that periscope prisms remain clear, medical gases in hospitals are not contaminated, plastic bottles for carbonated drinks don't burst, and that the highly specified gases used in VLSI (very large scale integration) silicon chip manufacture are within specification.

With such a large market it is natural that many other manufacturers have tried to develop aluminum oxide sensors. However, none have come anywhere near the performance of the Cosa product for these very good reasons:

1) Accuracy: Xentaur XTR-100 sensors are produced in a robotized manufacturing system and vigorous QC procedures assure high uniformity. One curve correction function fits all sensors, making sensors freely interchangeable.

2) Capacitance Change: The capacitance change of a XTR-100 sensor over the full measuring range is about 60 times larger than that of a conventional Al2O3 sensor. In addition, the capacitance change per 1°C change of dewpoint at the dry end is approximately 500 times larger. The much larger signal change makes it easier to handle the sensors signal electronically. The result is more stable and accurate readings, which are less prone to other influences such as drift, temperature and electrical noise.

3) Automatic Calibration: Any measuring system needs to have its calibration checked from time to time. With the Xentaur sensor it takes about one minute and needs no other equipment or operator skill. The XTR-100 sensors flatten out at the top and saturate at a predesigned level above +20°C. With other types the sensor (or even the complete instrument) must be returned to the manufacturer, or the user has to buy extremely expensive calibration equipment.

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4) Speed: The XTR-100 sensor responds significantly faster to a change in water vapor content than conventional sensors. Xentaur sensors dry down from -40°C to -60°C in 90 seconds. In dry to wet change conditions response speed is virtually instantaneous.

5) Temperature Coefficient: Xentaur sensors have a small and uniform temperature coefficient. Conventional sensors exhibit a substantial coefficient (i.e. readings vary significantly with temperature changes). Some other manufacturers supply their sensors in thermostatically controlled chambers in order to obtain a stable reading.

OTHER PRICIPLES OF OPERATION

The capacitance sensor is not, of course, the only way of measuring small amounts of water vapor in air and other gases, but it is certainly the easiest, most reliable, and usually the cheapest.

1) Chilled Mirror Instruments: Generally accepted as the standard to which other instruments are measured against. This is a very simple instrument in principle, although complicated and expensive in practice. The air or gas passes over a very small mirror on which shines a light source. The mirror is chilled, usually by using a Peltier device, until its temperature is below the sample dewpoint temperature. Condensation or frost forms on the mirror, scattering the light beam and detection of the scattered light is used to control the mirror temperature. Cosa offers the MBW line of chilled mirror hygrometers. These analyzers are laboratory grade instruments, extremely accurate and very expensive. Normally used as standards, these analyzers are not well suited to industrial applications.

2) Electrolytical Instruments: These have a cell which is coated with Phosphorus

Pentoxide. The theory is that the sample gas passes through the cell at a closely controlled flow rate and all the moisture is absorbed into the desiccant. Platinum wires embedded in the desiccant carry a current which electrolyzes this water into hydrogen and oxygen and Faraday's law is used to convert the required current into a moisture measurement. Fine so far--but did you spot the deliberate mistake? The desiccant absorbs ALL the moisture: clearly impossible, and the reason for quite large errors when measuring at 10 parts per million moisture content and drier. The other disadvantages are the need to accurately control sample flow rate, the very limited cell life, and the several days it takes to obtain stable readings from a new cell.

3) Oscillating Crystal Instruments: These are very high-tech devices which use a tuned crystal coated with a hygroscopic polymer. The sample gas passes over the crystal, the polymer absorbs the moisture and the resonant frequency between the two gases is used to measure the sample moisture content. (In some versions two crystals are used to give a differential measurement). Not only do these instruments assume near total absorption of the sample's moisture but they also rely on their own reference gas having an absolutely constant known moisture content close to zero--both being equally unlikely. These are impressive instruments--extremely expensive--but having questionable reliability when measuring very dry samples.

The type of hygrometer chosen by the user to perform a particular process measurement of control function depends to a great extent on the compatibility of the moisture measurement technique of the hygrometer type with the process of interest. Xentaur aluminum oxide sensor technology is certainly the easiest, most reliable, and usually the least expensive method of measurement for the vast majority of applications measuring moisture. Specify Cosa dewpoint sensors for all your hygrometer requirements.

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