Technical Note 1-001

Verification of Moisture Readings in the Field

Key Points

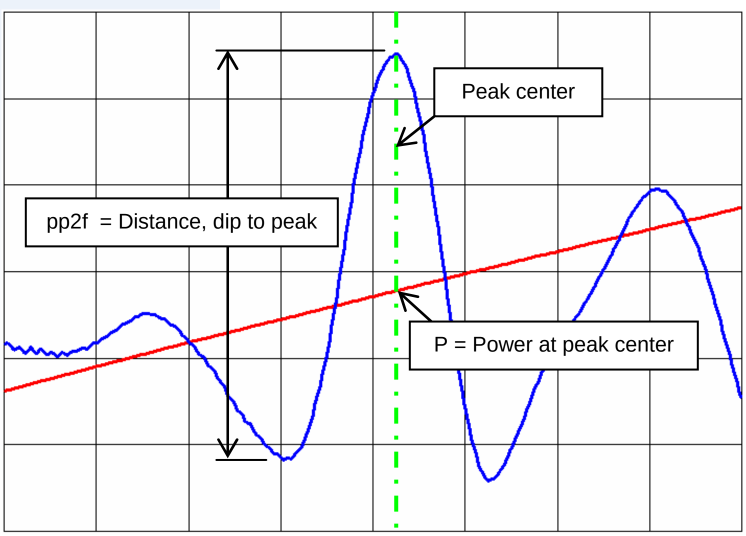
- *Mirror contamination does not affect the calibration*
- *Calibration Frequency is measured in years ("Recertification" includes inspection, cleaning, recalibration, & software upgrade)*
- *System performs a self-check during every reading*
- *Measurement validations can be performed with portable unit because instrument to instrument repeatability is high*

Introduction: Occasionally, users of SpectraSensors moisture analyzers ask the question "How do I know its working?" Sometimes the question comes up after months of operation when the user feels that "it should need frequent maintenance" because that's what they are accustomed to. Other times, a potential customer asks prior to purchasing the unit. This is especially true in streams that contain high levels of contamination. The fact is that contamination in the chamber does not affect the calibration (the laser and detector do not come into contact with the gas). In general, when something is wrong, an error message will appear.

The recommended calibration frequency is measured in years and depends on the criticality of the application and the level of certainty required – i.e. it depends on the application. For example, in natural gas applications, the average calibration frequency is every 3-4 years.

This document provides information about how the analyzer self checks, and how customers can validate the measurement results.

Self Check:
During every reading update (typically once per second), the SpectraSensors analyzer generates a graph with two lines as shown in the figure. The X-axis represents the spectral wavelength and the Y-axis represents power. The seemingly straight line is the power given by the optical detector over the wavelength scan. The wavy line is an amplified version (second derivative) of the straight line which shows the spectral absorbance of the gas. The tallest bump is the water peak.



The software in the analyzer does two main things, 1) determines the center of the water peak, 2) measures the ratio of the distance between the dip to peak divided by the power at the peak center wavelength (pp2f/P). This ratio is proportional to amount of water in the gas (with some corrections for changes in temperature and pressure). The measurement does not drift because the ratio remains the same even as the mirror becomes partially blocked. As long as a strong enough signal is returned to the detector and the software can determine where the peak is, the analyzer will stay calibrated.

Every time the analyzer updates the display it does a self-check. The checks include verification that: pressure and temperature are in the compensated range for the instrument, the laser power reads close to zero when the laser is turned off, laser power reflected back to the detector is sufficient for a good reading, and the peaks and dips detected in the spectrum are consistent with a valid measurement. If any of these tests are not passed, an error message is displayed on the display. The message will remain as long as the error condition persists. The presence of an error condition is indicated on the current loop output by forcing the output to either zero or full scale (user selectable).

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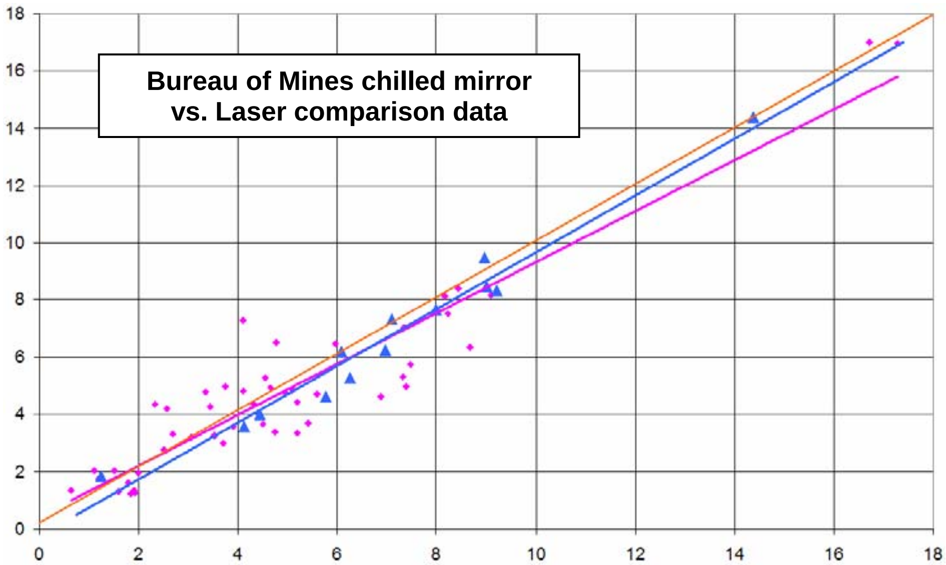
Analyzer to Analyzer Comparisons:

The most common method of validating measurements in the field is to use a portable moisture analyzer to check the permanently installed units. The analyzer-to-analyzer repeatability of the laser system is very good, so it is a sound way to determine if there is a problem. Bureau of Mines (B.O.M.) chilled mirrors are also commonly used; however, they are subject to error from hydrocarbon, glycol, or methanol condensation and are less precise. They must be relied upon only when the purity of the gas sample is assured and the person operating the instrument is a highly trained expert. In the scatter plot below, the diamond and triangle points are chilled mirror data which are compared to the laser factory calibration. As you can see, the average results are highly correlated, but the data exhibits a high degree of variation. More information on the details of this experiment is available upon request.



***Validation*:**

Three methods are available to validate the reading of the moisture analyzer. The first method is the quickest and easiest. As described above, the SpectraSensors analyzer generates a graph during each update. This graph can be downloaded onto a PC through the serial port on the instrument and can be viewed on PC software. A visual examination of the profile (shape) of the graph, can serve as a simple validation that the unit is working properly (the shape will depend on the target and background gases). Since the shape of the graph represents physical properties of the target gas, it cannot be created in error. See manual for instructions.

In the second method, a natural gas stream is put through a drier to reduce the moisture level to less than 0.1 lb/mmscf. The dried gas stream is fed around a temperature controlled permeation tube that adds a very precise amount of water to the surrounding gas. If the gas flow and temperature around the permeation tube is known accurately, the water vapor concentration can be calculated. This gas can be fed back into the moisture analyzer and the concentration read. The main drawback of this method is that the various errors in this process can contribute to an overall error of about 10%. However, it is a good way to make sure with certainty that the moisture analyzer is in the right neighborhood. Additionally, the method is straightforward, making it a useful tool in situations where laser technology or dew scopes are under scrutiny.

The third method uses a pre-mixed standard gas. Because the laser calibration is sensitive to the background gas species, it is important that the analyzer be checked with a water vapor in natural gas or methane standard (methane-CO_2 mix similar to the pipeline composition) must be used (rather than air or nitrogen).

Variations in moisture in such standards can vary over time and with flow-rate and cylinder pressure. Air Liquide has developed a cylinder that they claim can maintain a stable moisture level in methane over long periods of time. We are currently conducting a long-term test of this cylinder (using a standard with approximately 100ppmv moisture). Initially, our instrument measured 2.4ppmv higher that their stated concentration and so far, the results indicate that over an 18-month period, the concentration has been stable to within the uncertainty of our instruments (±4ppmv). During this time, the cylinder pressure was constant at 800 psig, read on a gauge with an uncertainty of about +/-30psig and the temperature of the cylinder has remained constant within a few degrees. Under the conditions described above (for at least 6-months), a gas standard can be used effectively. Drastic changes in temperature (weather), pressures lower than 600psi, and rough handling (e.g. back of truck) of the cylinders could effect the results; however further testing is needed to quantify the effects, if any.

Please keep in mind that the validation methods described above will not test the sample system, only the analyzer. To ensure that the analyzer reading is representative of the pipeline gas, one should periodically compare the continuous laser reading to a Bureau of Mines chilled mirror at pipeline pressure. Some consider this the only way to verify the laser for two reasons: first, the gas custody transfer contracts sometimes specify that the B.O.M. chilled mirror is the legal standard (despite the questionable accuracy and repeatability). Second, the largest errors in the analyzer reading are most likely caused by problems with the sampling system. More information about appropriate sample system design is available upon request.