Improving Gas Analysis

Comparison of Accuracies between Laser Systems and Other Techniques

Fig. 1

Experienced users of moisture analysers know how difficult it can be to maintain the accuracy of on-line systems. Natural gas presents additional problems, with some analysers being influenced by methanol injection and glycol and aimine carry-over. Sensors are regularly returned for re-calibration or re-coating, in some cases as frequently as every 3 or 4 weeks.

A new technique, using a tunable diode laser (TDL) (*Fig. 1*), has proved to be not only a highly accurate method of on-line analysis, but can also maintain that higher accuracy without frequent calibration or servicing. The SS2000 from SpectraSensors uses a new laser-based device for water vapour and carbon dioxide measurement and offers significant advantages in terms of speed of response and maintenance requirements, resulting in greater cost efficiencies and improved safety for many process control applications. This bulletin discusses and compares moisture analysis techniques and highlights the reasons for higher accuracy obtainable from TDL techniques.

Principles of Measurement

What is a TDL?

Water vapour (and some other gas molecules) will vibrate when hit by infrared light at certain, precise, wavelengths. This induced vibration absorbs energy and the instrument (*Fig. 2*) simply measures how much light is returned, after passing through the flow cell. The amount of light absorbed by the gas space is proportional to the concentration of the target gas present.

This technique measures a fundamental physical property, and as different gases have different absorption wavelengths, it is possible to select individual gas species by careful control of the specific wavelength emitted by the laser.

Both the laser and the detector are mounted behind a window, meaning the measurement devices do not come into contact with the sample gas. A non-contact system such as the SS2000 offers many benefits for the user over "surface" sensor techniques such as aluminium oxide, phosphorous pentoxide, quartz crystal or chilled mirror systems. The quality of measurement of all surface techniques can rapidly degrade when exposed to the various contaminants commonly present in process gases (see Technical Bulletin 124 for more details).

Broadband infrared-based analysers operate in a similar manner and have been around for a number of years, but the difference with TDL based systems lies in the narrow wavelength of the light emitted by the laser. The narrower the line width, the more specific the absorption of light is to the target gas. With broadband infrared systems a light source emits a wide band of wavelengths which are then filtered to block those that are either higher or lower than the target wavelength. This technique allows a line width of around 40 nanometers to pass through the gas space to

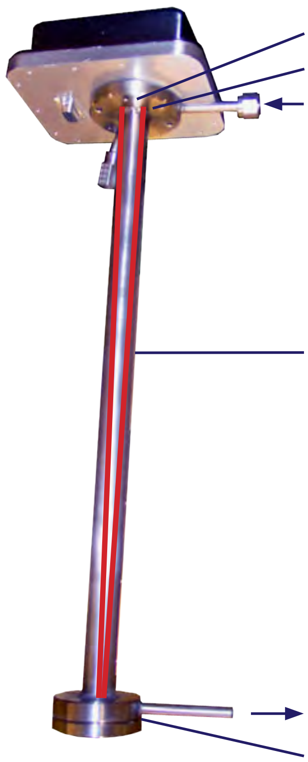

Fig. 2

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What is a TDL?

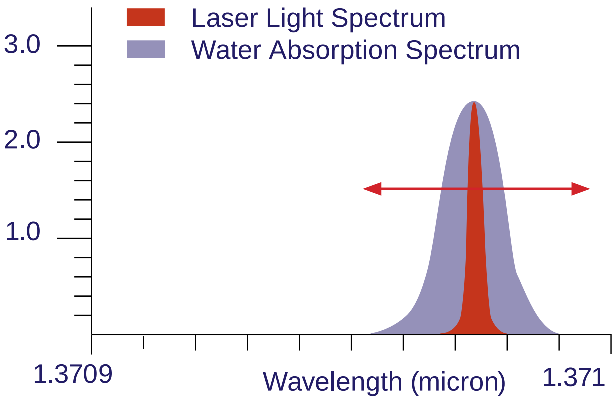

Fig. 3 Narrow spectral width improves specificity

be measured. The line width of the TDL SS2000 system is only 2 picometers. This is the equivalent of comparing a width of 2 mm to 40 meters and this improvement of resolution allows better accuracy and higher specificity. In fact the line width of the laser is smaller than the line width of the water vapour absorption line and the shape of the absorption line can be seen as the laser wavelength is swept, or tuned, through the target wavelength as can be seen in *Fig. 3.*

Accuracy Comparison

The accuracy of the SS2000 is 2% of reading or 2 PPM_V (whichever the greater). This compares very favourably with all other on-line techniques.

A comparison of published accuracy statements is shown in *Fig. 4* for different techniques. These statements relate to new or freshly calibrated systems and, with conventional techniques, actual on-line accuracy is unlikely to be maintained at these levels due to sensor contamination and inherent drift. It is not uncommon for errors on some sensors returned for calibration to be 10 °C or even 15 °C Dewpoint in error.

Normally there is a hierarchy of calibration for any instrumentation with higher accuracy devices calibrating lower accuracy systems. Automated chilled mirror systems with an accuracy of +/- 0.1°C Dp are the only devices suitable for use as a calibration reference for the SS2000. Chilled mirror systems, although highly accurate, can be susceptible to contamination and therefore are not be suitable for long-term on-line use in natural gas, or other gas streams with contamination. Normal practice with the SS2000 is to verify the on-line system with periodic cross checks with the portable CR-4 chilled mirror device, or calibration gas from a certified cylinder.

Because the laser is a non contact method contamination will not effect precision, and accuracy can be maintained. If the mirrors or other optical components were exposed to contamination there would be a decrease in total power returned to the detector. As the system normalizes the signal to laser power by comparing light levels over a range of wavelengths, up to 80% of reflectivity may be lost before effecting accuracy. Systems have been operational for many continuous months, with simple membrane filters to remove liquid carry-over.

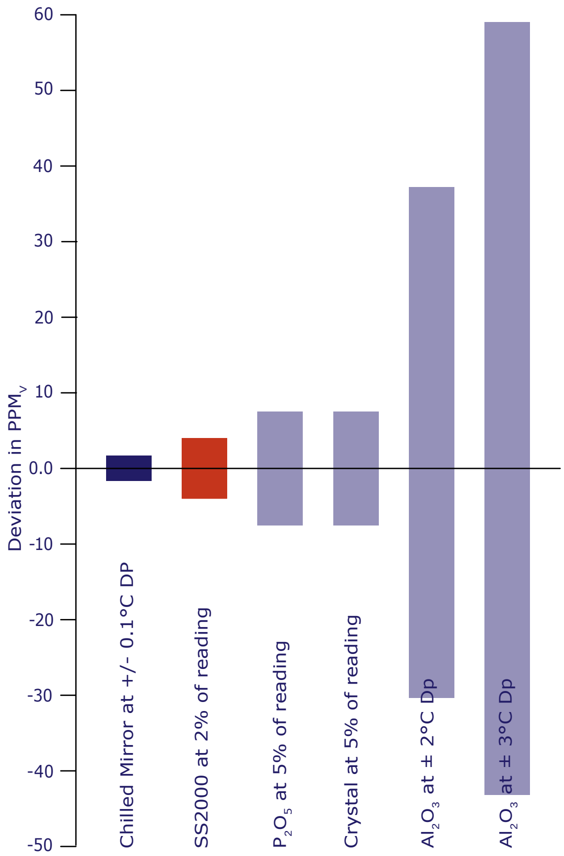

Fig. 4 Deviations from ideal measurement for different moisture analysis techniques at 150 PPM_V