

## SS2000 Tunable Diode Laser System Accuracy Comparison with Other Techniques



Experienced users of moisture analysers know how difficult it can be to maintain the accuracy of on-line moisture analysers. Natural gas in particular presents additional problems with some analysers being influenced by methanol injection or glycol and amine carry-over. Sensors are regularly returned for re-calibration or re-coating, in some cases this can be as frequent as every 3 or 4 weeks. A new technique, using a tunable diode laser, is proving to be a highly accurate method of on-line analysis and be able to maintain that higher accuracy without frequent calibration or servicing.

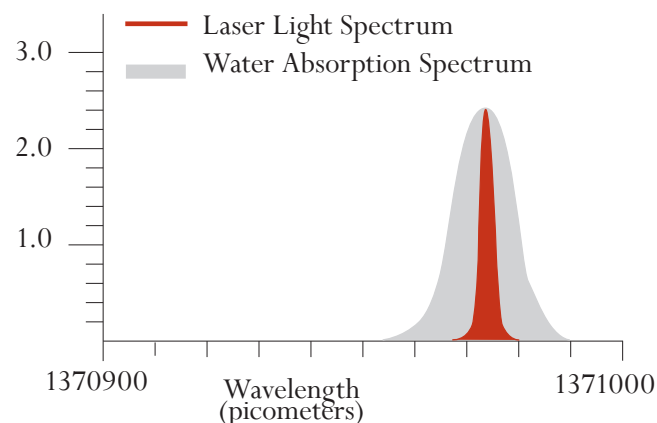
The SS2000 uses a new laser based measurement for water vapor and carbon dioxide measurement and offers significant advantages in terms of speed of response and maintenance requirements resulting in greater cost efficiencies and an improvement of safety for many process control applications. This bulletin discusses and compares moisture analysis techniques and highlights the reasons for higher accuracy obtainable from TDL techniques.

### Principle of Measurement

Water vapor (and some other gas molecules) will vibrate when hit by infrared light at certain, precise, wavelengths. This induced vibration absorbs energy and the instrument simply measures how much light is returned after passing through the sample environment, as a percentage of the total light that was sent into the environment. 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 species by careful control of the specific wavelength emitted by the laser.

As 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 systems such as the SS2000 offer 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 about contamination).

Broadband infrared light-based analysers operate in a similar manner and have been around for a number of years, but the difference with lasers lies in the narrow wavelength of the light emitted by the laser. The narrower the linewidth the more specific the absorption of light is to the target gas. With broadband infrared system a light source emits a wide band of wavelengths which are then filtered to block wavelengths that are either higher or lower than the target wavelength. This technique allows a linewidth of around 90 nanometers to pass through the gas space to be measured but the can be influenced by the presence of other gases that absorb energy in the same vicinity and therefore requires frequent calibration to “zero out” this effect. There are no filters in the laser system and the linewidth is only 2 picometers. This



*Narrow spectral width improves specificity*

result

is the equivalent of comparing a width of 2 mm to 90 meters (or 1/8" to 98 Yards) this improvement of resolution allows better accuracy and specificity. In fact the linewidth of the laser is smaller than the linewidth of the water vapor absorption line and the shape of the absorption line can be seen as the laser wavelength is swept through the target wavelength as can be seen

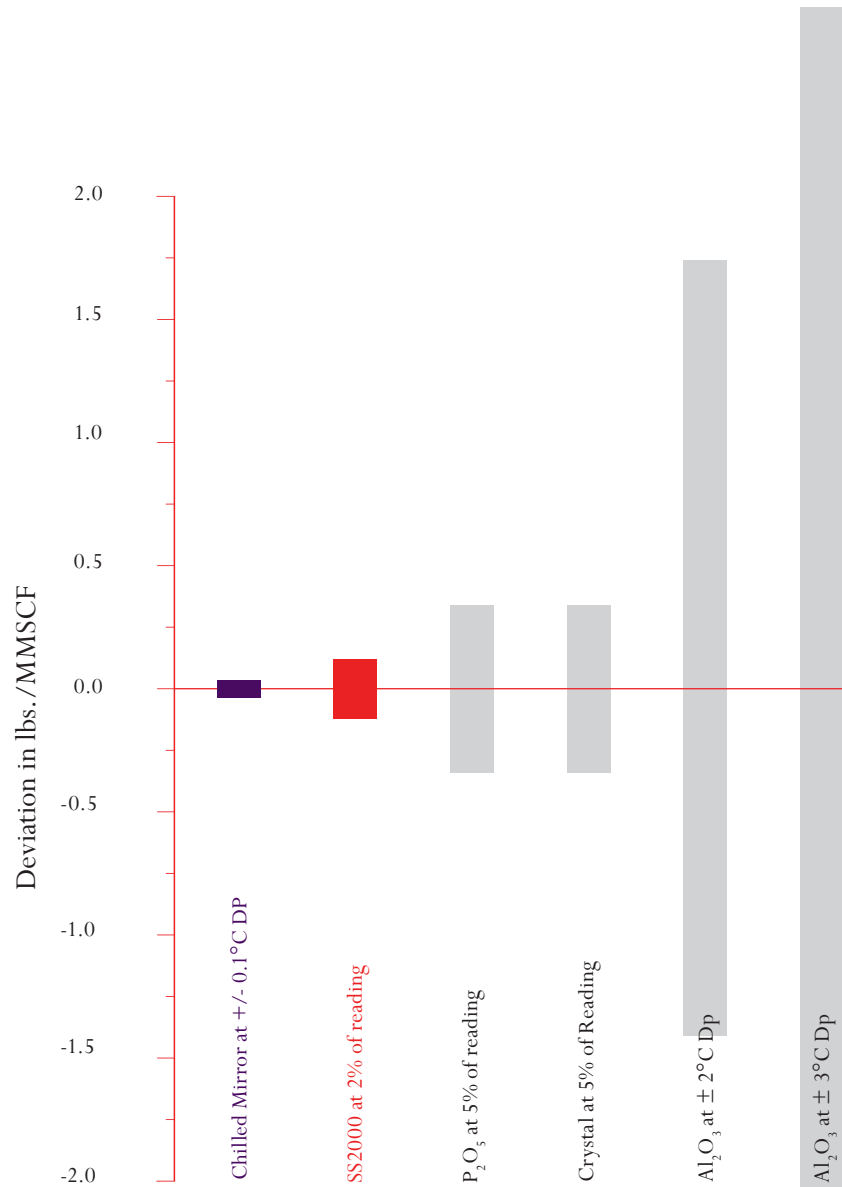
The accuracy of the SS2000 is 2% of reading or 2 PPMv (whichever the greater). This compares very favourable with all other on-line techniques.

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 device suitable to be used as a calibration reference for the SS2000. Chilled mirror systems, although highly accurate, can be susceptible to contamination and would therefore not be suitable for long term on-line use in natural gas and 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.

A comparison of published accuracy statements is shown here 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 systems returned for calibration to be 10 or even 15° C Dewpoint.

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 off-peak energy to on-peak energy up to 90% 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.



*Deviations from ideal measurement for different moisture analysis techniques at 7 lbs/MMSCF (approx 150 PPMv)*