Gas storage: reduce risks and cut costs with optical moisture detection

Application background

International Energy Outlook (IEO2016) forecasts[1] that worldwide natural gas consumption will increase from 120 trillion cubic feet (Tcf) in 2012, to 203 Tcf by 2040. Natural gas remains an attractive fuel for industrial and power generating applications because it is relatively efficient and burns cleaner than both coal and petroleum products.

While gas production is relatively predictable, its consumption is marked by seasonal and daily weather variations. Energy companies compensate for variable demand by storing gas. Natural gas may be stored in several ways, but it is most commonly held underground under pressure, ideally close to where it is consumed. Energy companies reuse depleted hydrocarbon fields (oil and gas), aquifers and salt caverns to store natural gas inventory, which enables them to more easily meet peak loads.

Each method of storage has specific physical characteristics including porosity, permeability and retention capability. The store’s capacity and deliverability rate – the speed at which gas can be withdrawn – are particularly important because they impact the economics of the storage facility.

Why is measurement important?

One of the consequences of storing gas underground is that inevitably, it becomes impure. Pumping gas into what is essentially a ‘wet hole in the ground’ will increase its moisture content. It is well known that strict control of moisture concentration is essential for safe and efficient operation of the transmission network. To that end, energy companies require a fast, accurate and reliable means of measuring moisture which is made when gas is exported from storage. This is to judge if dehydration processing is required in order to fulfil the tariff limit/contractual specification for moisture content required by the transmission pipeline operator receiving the gas.

Energy companies measure moisture in natural gas using a range of techniques, each of which has its advantages and drawbacks in terms of accuracy, speed and cost of measurement. Technologies available for moisture measurement include impedance and capacitive sensors, chilled mirror, quartz crystal micro-balance and tunable diode laser spectroscopy.

If the analysis is inaccurate, there are two possible outcomes. The consequences depend on whether the analysis returns an over- or under-estimate of the true moisture content.

- Over-reading – when the analysis reports a pessimistic or higher-than-actual moisture content level – will increase costs and add delays as the operator performs more moisture removal processing than is necessary. Incremental processing costs can quickly become significant as gas volumes continue to increase.

- Under-reading – reporting lower moisture levels than reality – incurs the risk that the operator will not remove sufficient moisture from the gas. This could lead to hydrate formation in the downstream transmission pipeline with the potential for pipeline blockage and compressor damage. In the worst case, breaching contractual specifications or tariff limits can lead to shut-off of the transmission pipeline incurring commercial losses and fines, increased risk of pipeline corrosion and ultimately catatrophic pressure failure.

Measurement technique

Tunable diode laser absorption spectrometers (TDLAS) are especially suited to measuring moisture content in natural gas. Michell's OptiPEAK TDL600 is a next-generation analyzer that automates online measurement of moisture in variable compositions of natural gas and biomethane. It offers class-leading accuracy, with an operating range down to 1ppm$_v$ and a fast response time. Its low maintenance, simple installation and setup and built-in self verification ensures its low overall cost of ownership.

Real-world accuracy

TDLAS analyzers suffer from significant interference when interacting with methane, ethane, carbon dioxide and hydrogen sulphide; all of which are present in natural gas. The level of interference governs detection limits and accuracy but these errors can be mitigated by calibrating the analyzer for the gas composition in use. However, real-world natural gas composition varies dramatically, which results in errors outside of manufacturers' performance claims. A specified TDLAS performance limit of ±4ppm suggests a confidence band of approximately 2°C dew point. Realistically, this variation could be as high as 20ppm$_v$ and could occur at any point of measurement where the composition of natural gas is changing, such as transmission gas pipelines supplied from multiple gas wells, where fed with regassified LPG or downstream of non-conventional fuel gas injection, such as biomethane. This additional error increases the confidence band to around 14°C dew point.

The OptiPEAK TDL600 offers class-leading accuracy of ±1ppm$_v$ over real-world gas compositional ranges. This level of accuracy guards against both unnecessary process costs from over-drying and shut-off due to overly pessimistic measurements. We estimate that improving the accuracy to this level has the potential to deliver efficiency savings of up to 20% when processing real-world gas[2].

Non-contact measurement

The most common and cost-effective way to remove water from natural gas is to use glycol as a liquid dessicant within a glycol absorber or contactor process. Although this approach is well established, it does carry some risks. One potential issue is that excessive gas velocities can force glycol out of the top of the column along with the dry natural gas stream. Glycol has a high-dielectric constant, so any downstream moisture sensor that uses metal-oxide capacitive/impedance sensor technology will detect the glycol and return inaccurate or full-scale wet readings. The use of TDLAS technology, which is a non-contact measurement, is immune to the effects of glycol contamination.

Summary

As this sector continues to grow by extracting natural gas from new and diverse sources like shale, and injection of non-conventional fuel gas such as biomethane becomes more commonplace, operators need faster, more accurate and robust measurement technologies.

Existing TDLAS analyzers appear to offer a solution but often fail to deliver in the real-world as, in situations where gas composition changes, background interference can result in significant errors.

The OptiPEAK TDL600 is capable of quantifying natural gas contaminant concentrations such as moisture, carbon dioxide and hydrogen sulphide with single figure ppm_V precision. This level of accuracy can unlock potential efficiency savings of up to 20% when applied to the processing and removal of moisture from natural gas.

1: http://www.eia.gov/outlooks/ieo/nat_gas.cfm

2: http:/www.michell.com/uk/support/advances-online-moisture-analysis.htm

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