Analyzers Enhance Plant Efficiencies

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HOUSTON–Processing raw natural gas to remove contaminants such as moisture and hydrogen sulfide, and recovering natural gas liquids includes many steps, including using cryogenic fractionation to separate the various hydrocarbons. This cryogenic process demands bone-dry gas, with moisture levels below 100 parts per billion.

To remove moisture down to such a low level, processing plants pass the gas through vessels containing molecular sieve desiccants, which selectively adsorb the water. Molecular sieves are the solution of choice in many gas processing applications, including the deep dehydration required by natural gas liquid and liquefied natural gas facilities.

Molecular sieve dehydration systems typically consist of multiple adsorption beds filled with solid desiccant. The beds are cycled among adsorption, regeneration once the desiccants become saturated (the desiccant bed is heated with hot gas to drive the water off so the molecular sieve is back in its original state and the adsorption process), and cooling.

Proper operation of the molecular sieve dehydration system is critical to operating any natural gas processing or LNG plant. In theory, it all works fine. But the whole process hinges on one key element: the analyzer that tests the desiccant dryer outlet gas for moisture content. If a bad measurement of the outlet gas is made, it can become a major economic blow or even shut down the entire plant. And there are lots of ways to make poor operational choices with bad information.

Simply stated, cryogenic plants are allergic to moisture. When moisture is not managed properly, it causes a loss of efficiency and earnings. Given of the criticality of moisture measurements at the desiccant dryer outlet, advanced solutions such as online tunable diode laser (TDL) analyzers are being applied to improve measurement accuracy and help take mistakes out of the process.

TDL absorption spectroscopy provides natural gas processing plant managers with fast, accurate and cost-effective measurements of moisture levels in the presence of methanol. The technology also can measure carbon dioxide, hydrogen sulfide, ammonia, acetylene, oxygen and other components. It uses an electrically pumped semiconductor laser to measure concentrations of water vapor and other components, and can achieve very low detection limits for quantitative assessments of gaseous mixtures.

Minimizing Maintenance

Traditionally, electrochemical probes such as aluminum oxide capacitance or quartz crystal microbalance (QCM, or vibrating quartz crystal) were used in gas processing to measure moisture content in the desiccant dryer outlets. But these methodologies have inherent problems and costs. For instance, trace hydrocarbons and other impurities (methanol, glycols, and amines) present in the stream can easily contaminate the measurement sensor, resulting in drift and the ultimate loss of analyzer response.

That leaves processing plant operators with three solutions: maintenance, maintenance and more maintenance, driving the total cost of ownership ever-higher and occupying the time of processing plant staff who otherwise could be engaged in more value-adding tasks. Meanwhile, operators are left operating plants without meaningful data at desiccant dryer outlets.

QCMs also suffer from sensitivity to vapor impurities, resulting in false readings. And both types of probes are slow in reporting data; they simply need too much time to react. That can translate into wet gas passing through the outlets undetected for an hour or more.

All of these drawbacks have led many plant managers to turn to TDL trace moisture analyzers as the answer for fast, accurate readings with virtually no maintenance costs.

NASA scientists developed tunable diode laser-based technology in the 1990s to look for moisture on Mars. Since a laser beam is used, there is no physical contact between the gas stream and the sensor. The result is fast, accurate measurement from an analyzer that is nearly maintenance-free through many years of operation.

There is a built-in verification system that generates an accurate level of moisture for field validation purposes. Coupled with a high efficiency dryer, this validation system solves the long-standing problem of a lack of accurate field references for trace moisture analyzers.

Operating Economics

While the initial purchase price for a TDL system is somewhat higher than

On-line TDL trace moisture analyzers utilizing spectral subtraction allow plant operators to protect cryogenic units and enhance operational efficiencies by optimizing molecular sieve bed regeneration, minimizing fuel consumption, extending molecular sieve life, lowering maintenance and operational costs, and eliminating upsets and freeze-ups.

surface-based gas sensors, even the most conservative evaluation of this technology indicates that maintenance savings alone (e.g., calibration, replacing sensor heads, service labor, etc.) will provide a return on investment within a relatively short period.

Electrochemical-sensor gas analyzers to monitor moisture use a coated surface. A higher electrical capacitance across the surface indicates higher water content. However, these capacitance sensors are susceptible to contamination by glycols or amines in the gas, which can cause exaggerated readings or a failure to detect. An erroneously high reading could force the plant operator to temporarily shut down operations, costing the company thousands of dollars.

TDL sensors offer high spectral purity. This enables the detection of specific gases, such as water, ammonia and carbon dioxide. Measurement intervals are as frequent as every two seconds, giving far more timely responses than the several-minute (sometimes hours) readings of quartz crystal and electrochemical sensors, which must be cleaned frequently and replaced.

Because a laser system never comes into contact with the contaminants present in natural gas, as with electrochemical and crystal gas sensors, laser-based gas analyzers practically eliminate maintenance and operational costs. Additionally, TDLs eliminate the costs and downtime incurred by having to either return an analyzer to the manufacturer for reconditioning or calibration, or having to inventory spare sensors as backup units

One of the first cost savings realized at the processing plant involves desiccant drying regeneration. Since a TDL analyzer provides near-instant and accurate information, plants have been able to extend time between regenerations by up to 20 percent. Fewer regeneration cycles mean less thermal cycling, less thermal damage to the sieve, and longer sieve life.

If a plant can eliminate even one extra recharge in 10 years, the savings could add to $100,000 in sieve replacement costs. And since the entire system is down for two days during each reload, the cost for that reload could reach $400,000 or more in lost revenue at today's natural gas price levels. For larger processing plants, it could even be much greater. There is also the added expense of loading contractors.

Self-validation is a major advantage of TDL analyzers. The data give plant operators the confidence to do their own breakthrough tests without having representatives from sieve companies on site. Plants with multiple beds equipped with a TDL analyzer on each outlet can test one bed while the others are in regeneration to ensure that processing operations are uninterrupted. That is important because a plant cannot make money if it isn't running.

Knowing more about how the desiccant dryers are operating means operators can avoid upsets and keep producing product. One processing plant manager using TDL technology reports that the analyzers are paying for themselves by preventing freeze-ups and accurately determining how much water is in the desiccant beds. The beds were only adsorbing an estimated 25 percent of their design capacity using the previous sensors. Once the TDL analyzers were installed, bed cycle times were lengthened, extending the time until the next sieve recharge.

Measurement Speed

Rather than requiring physical property changes to make measurements and taking an hour or more to report moisture levels changes, TDL analyzers measure the absorption of light and report a fresh reading every 16 seconds. The technology also has the advantage of reducing the potential for measurement interference. Because there is no contact with the gas, there is nothing to get saturated and fouled. As noted, this also means there is very little scheduled maintenance with TDL measurement.

The verification system on a TDL analyzer is designed for more than five years of service before the dryer and moisture emitter need to be replaced, which is a very simple procedure. However, aluminum oxide sensors, vibrating quartz crystal sensors, and other methods require regular recalibration and replacement of the measurement cells because of their sensitivity to the harsh environment and the direct contact with gas.

Daily validation is an important aspect of moisture measurement because it helps operators confirm the analyzer's performance on a regular basis. The consumables associated with the validation systems are minimalistic, at most.

If there are other types of chemicals present in the process (especially methanol or glycol), traditional measurement techniques can mistakenly read them as moisture, and could prompt unnecessary process changes or shut-ins. TDL analyzers provide superior sensitivity and the ability to accurately measure moisture at extremely low levels.

New plants and expansions, as well as processing facilities that have been operating for decades, can benefit from advanced automation and control strategies enabled by state-of-the-art on-line TDL analyzers. Trace water measurement at the desiccant dryer outlet is crucial for natural gas processing plants, and TDL trace moisture analyzers utilizing spectral subtraction are an effective, accurate and reliable analytical technique for processing plant applications because of the technology's sensitivity, operation reliability, fast response time, low maintenance, and immunity to vapor impurities.

The ability to more effectively monitor dryer bed performance using TDL trace moisture analyzer data allows plant operators to protect the cryogenic unit and optimize operational efficiency by determining the most effective frequency of dryer regeneration, minimizing fuel consumption, reducing the frequency of molecular sieve bed regeneration, extending the molecular sieve life, lowering maintenance and operational costs, and eliminating upsets and freeze-ups. ❐

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