NATURAL GAS MOISTURE MEASUREMENT APPLICATION NOTE FOR PHYMETRIX ANALYZERS

REASONS FOR MEASURING THE MOISTURE CONTENT IN NATURAL GAS

1. Natural Gas must often be dried before it can be distributed to its end users. The drying is necessary to prevent hydrate formation and liquid water deposition in the pipelines and/or condensation in the compressors; all of which would either cause damage or poor performance of the equipment. This drying is often accomplished by dehydration utilizing Tri-ethylene Glycol (TEG) contactors, which are very effective but introduce a TEG residue carryover into the Natural Gas. The drying process has a high cost associated with it, therefore it is important to dry the gas but not spend excessive resources to over dry it. Thus it becomes important to perform moisture content measurements on the Natural Gas after it has passed thought the dehydration equipment. Not dry enough and there may be failures – while too dry and there is a waste of resources.

2. When Liquefied Natural Gas (LNG) is "re-gassed" for pipeline transmission/distribution, it is passed through heat exchangers which are prone to leakage thus can introduce unwanted moisture into the very dry gas. Therefore it is important to monitor the moisture content after the heat exchangers for leak detection and quality control.

3. The custody transfer of Natural Gas often requires monitoring of the moisture content of the gas as a quality control.

4. The gas must be sufficiently dry as not to form ice, after cooling from pressure drops.

CHALLENGES IN MEASURING THE MOISTURE CONTENT IN NATURAL GAS

Natural Gas is mostly Methane; however contaminants are almost always present in one form or another. The contaminants which are most widely encountered are Glycol (TEG), Ethanol, Natural Gas Liquids (NGL), H_2S, a variety of particulates as well as other contaminants depending on the gas source. The gas can be at pressures of 700 psig to 1,400 psig. These operating conditions are taxing on the typical moisture analyzer, in most cases requiring complex cleaning procedures such as an elaborate rinse/wash procedures, detested by maintenance crews but needed to keep the typical sensor running reliably.

H_2S vapor combined with water becomes a corrosive acid; unlikely at low moisture levels. Natural Gas is typically dried to 7 pounds of water per million standard cubic feet (LBS/MMSCF), this water vapor density corresponds to approximately -40°F dewpoint or 143PPMv of moisture content. Even though this is not a very high moisture level, it is not what would be considered very dry; therefore it is expected that some corrosives will form and thus have an effect on the equipment being used for measuring.

The presence of TEG carryover can cause interference for two major reasons:

1. slowing down the measurement because of its highly hygroscopic nature
2. shorting the sensor because of its electrical conductivity (0.002mhos/cm @ 20°C for pure TEG, and significantly higher in the presence of ionic contaminants).

The use of TEG filters actually makes the measurement even slower because the filters buildup much more TEG than the sensing devices would have without any filtration. Since the gas being measured passes through the filters, it equilibrates with the TEG and slows down the measurement.

To understand the importance of the effect of TEG's electrical conductivity in moisture measuring apparatus, one needs to look at the construction of the moisture sensors. All of the moisture sensors that use the impedance method of measurement e.g. aluminum oxide, ceramic, polymer etc. have a moisture dependant capacitor. In all models from all manufacturers except PhyMetrix, both contacts of the capacitor plates are exposed to the gas under measurement. Normally this does not present a problem as the gasses being measured are insulators at the low excitation voltages that are used to measure the capacitance of the sensor. However when the sensor is coated with a TEG film which is electrically conductive, the currents conducted through the TEG film (from one plate of the sensor capacitor to the other plate) cause the measuring electronics to misread the sensor measurement. PhyMetrix has designed its sensor construction such that only one of the capacitor plates are exposed to the gas under measurement (the other plate is completely isolated), thus a coating from an electrically conductive film does not effect the measurement. This is a unique feature present only in the PhyMetrix sensor design. A similar problem is encountered when there is mercury vapor in the gas being measured, where it forms a conductive film and shorts out the sensors of all other manufacturer's, while the PhyMetrix sensor is not effected by any kind of conductive coating.

The presence of particulates may cause abrasive harm to the measuring equipment, thus there should be a particulate filter to remove them.

Of course the desirability of Natural Gas is its energy content, however this property also poses an incendiary hazard; thus the measuring equipment must be certified by appropriate agencies for use in hazardous areas.

THE BEST CHOICE FOR MEASURING IN NATURAL GAS MOISTURE CONTENT

The PhyMetrix Nanotechnology based moisture sensor combined with the unique PhyMetrix instrument design and the Sampling Systems provide a much needed solution for Moisture Measurement in the Natural Gas industry.

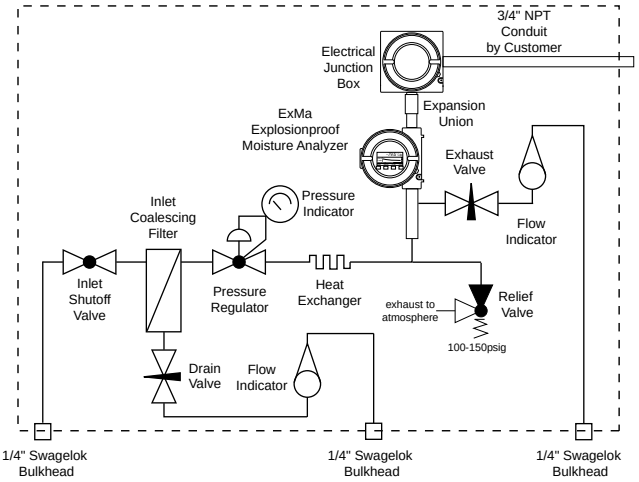
The NanoTechnology Sensor: The PhyMetrix moisture analyzers utilize a proprietary Nanotechnology based metal oxide sensor. The NanoPore structure allows for a quick response on wetting-up and drying-down, high accuracy and reproducibility. Nanoscience by its very nature allows us to bring change in the critical properties of materials and thus add a new dimension to their applications. Consequently, our technology allows accurate, reproducible and quick measurements in the range of -110°C dewpoint to +20°C dewpoint.

The Operating Pressure: The PhyMetrix instruments are designed for a wide variety of applications including gas pipelines (and specifically for methane), and high operating pressures up to 5,000 psig.

NATURAL GAS MOISTURE SAMPLING SYSTEM:

The PhyMetrix Sampling System consists of:

- An inlet shutoff valve for convenience and safety while servicing.
- A particulate / coalescing filter equipped with a drain valve and flow meter to allow a small flow through the drain as to eliminate any possibility of liquid carryover.
- A pressure regulator and indicator, for lowering the sample pressure to near atmospheric.
- A heat exchanger to compensate for Joule-Thomson cooling effects.
- A pressure relief valve for safety.
- PhyMetrix ExMa Explosion proof Moisture Analyzer with built-in sample cell.
- A metering valve and flow meter for flow control of the gas being measured.
- An explosion proof junction box for electrical connections.
- An environmentally sealed overall enclosure.



The PhyMetrix Sample System is designed to perform the measurement close to atmospheric pressure by regulating down the sample gas. This decreases the likelihood of liquid contaminants (they are vaporized) as well as it reduces the concentration of water vapor and of H_2S thus the likelihood of corrosives forming is also reduced and sensor life is prolonged.

Due to the unique design of the PhyMetrix sensor, Glycol filtration is not needed. The absence of a Glycol filter facilitates faster measurements.

HIGH RELIABILITY SAMPLING SYSTEM – AUTO VALIDATION / CALIBRATION

PhyMetrix offers a high reliability sampling system which utilizes a NIST traceable certified gas to validate / calibrate the analyzer, unattended in the field. The sampling system facilitates a programmable periodic switchover of the measurement to a NIST traceable certified bottle of Nitrogen. The analyzer can then either validate its measurement and report unacceptable drift, or

can recalibrate the sensor and continue operating. The gas can be chosen to have a moisture content of approximately 7 LBS/MMSCF thus assuring a NIST traceable measurement near that value. A single bottle of NIST traceable certified Nitrogen costs less than $500 and will last more than 1 year.

PORTABLE MOISTURE ANALYZER FOR NATURAL GAS

A portable moisture analyzer, such as the handheld model PPMa can be used to spot check measurements and determine if the on-line analyzer measurements are in agreement with the portable, which can be periodically sent to a lab for comparison to a NIST traceable chilled mirror standard.

The Portable analyzer exposes its sensor to the Natural Gas under measurement for a very short time (few minutes) thus contamination is minimal, in addition the sensor is stored in a desiccant chamber where the desiccant absorbs any of the contaminants that were accumulated on the surface of the sensor.

PHYMETRIX ADVANTAGES

The PhyMetrix product line is ideal for the moisture measurement needs in Natural Gas combining the on-line (ExMa) and hand-held (PPMa) analyzers with a Natural Gas specific Sampling System (PSS-NG) to result in:

- High Accuracy over a wide measuring range -110°C to +20°C dewpoint
- Speed of Response
- Eliminating unpleasant time consuming cleaning procedures
- Saving valuable service technician time
- Low Cost of Ownership
- Extremely Easy to Operate, with intuitive graphical user interface
- Resistant to Contaminants common in field measurements e.g. Glycol, Ethanol, NGL, H_2S
- Superior Reliability
- Hazardous area use approvals
- Portable analyzer available for spot checking:
    - Small, lightweight, rugged, weatherproof
    - Perfect for testing in tight spaces and above ground locations
    - Field analyzer designed for use outdoors
    - On screen graph indicates when measurement is stable
    - Powered by a rechargeable battery
    - Data logging (single point or continuous) with location/operator tags
    - USB interface for transferring logged data to MS-Excel® spreadsheet
- Expert prompt support from PhyMetrix engineers.
- Training software available for technicians to practice on the use of the analyzer at their convenience.