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WET GAS SAMPLING

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The quality of gas has changed drastically in the past few years. Most gas is wet with hydrocarbons, water, and heavier contaminants that tend to condense if not handled properly. If a gas stream is contaminated with condensables, the sampling of that stream must be done in a manner that will ensure all of the components in the stream are introduced into the sample container as the composite.

The sampling and handling of wet gas is extremely difficult under ideal conditions. There are no ideal conditions in the real world. The problems related to offshore operations and other wet gas systems, as well as the transportation of the sample, are additional problems that must be overcome if the analysis is to mean anything to the producer and gatherer.

The sampling of wet gas systems is decidedly more difficult than sampling conventional dry gas systems.

Wet gas systems were generally going to result in the measurement of one heating value at the inlet of the pipe and a drastic reduction in the heating value of the gas at the outlet end of the system. This is caused by the fallout or accumulation of the heavier products that, at the inlet, may be in the vapor state in the pipeline; hence, the high gravity and high BTU. But, in fact, because of pressure and temperature variances, these liquids condense and form a liquid that is actually running down the pipe as a stream or is accumulated in drips to be blown from the system.

Gas is an extremely fragile product.

Everything that is done to it will affect its quality. This paper will cover the important aspects of collecting, transporting, and analyzing a representative gas sample. It will begin with where to take the sample and why, the sample probe and its design, sampling equipment and its design and operation, spot and composite sampling, right and wrong ways the industry uses sampling equipment. The transportation and analysis is an integral part of the final result. Your decisions are only as good as your samples. This paper will be the definitive word on wet gas sampling. The techniques and systems outlined will not only ensure a representative sample, but will ensure repeatability and a defensible system when followed to the letter.

With the advent of payment for natural gas by BTU, the popular concept is that, if liquid hydrocarbons are pushed into a pipeline, these liquid hydrocarbons can increase the BTU of the stream, and the gas will be worth more to the seller. This concept is not necessarily true, and free liquids will cause many more problems than we admit.

What is wet natural gas? A gas stream that contains hydrocarbons, water, or other liquid contaminants that will condense when the pressure or temperature change, is considered wet natural gas.

Where do these liquids come from?

Retrograde condensate is the most common liquid found in gas pipeline systems. This liquid comes from production of wet gas and/or condensate reservoirs. Retrograde condensation also comes from inadequate field processing and inadequate retention time in production separators. These liquids and others exacerbate measurement errors, change specific gravity, and create BTU problems.

Other liquids that present serious problems in the analysis, specific gravity, and BTU determination are liquids that end up in the pipeline because of operations abnormalities.

Methanol, odorant, corrosion inhibitors, and compressor oil, to name a few, create havoc in downstream systems. The most serious culprits, however, are compressor oil and valve grease & oil. These contaminants can and will end up in your sampling system and sample cylinders.

Liquids in gas pipeline systems create measurement errors, corrosion problems, as well as hydrate and pulsation problems.

With the obvious problems created by the liquids addressed, but not solved, how do you collect a representative gas sample from this flowing stream?

Wet gas, however, is always going to have aerosols entrained in the stream, and these aerosols must be taken as part of the products flowing down the line.

Since wet gas samples are going to contain aerosols, the location where the sample is taken must be chosen or built to ensure all of the components, both liquid and gas, are mixed in the line directly upstream of the sample probe.

The location of the sample probe must be directly downstream of the area where the contents of the line are mixed. This mixing is accomplished with special Komax static mixers.

Samples from wet gas systems taken downstream of Komax static mixers may be taken in horizontal or vertical lines.

A static mixer should be designed to create the dispersion and distribution desired without creating excessive pressure drop. The properly designed static mixer will do this over ranges from 1.5 feet per second and above.

The sampler spool will have the mixer installed with the sample point two pipe diameters downstream of the mixer. The sampler will be installed in a horizontal plane, so the products will flow down and out to the sample container.

Isokinetic Sample Pump

The sample pump must be designed specifically for the purpose of "grabbing" the sample and pumping that sample from the line regardless of flowing conditions (pressure or temperature) or product properties (viscosity, particulate content, or vapor pressure).

The isokinetic sample probe is designed specifically to trap a sample from the flowing stream and pump that sample into the container.

The inlet to the sample collection head should be large enough to inhibit the diversion of sample droplets. The sample head should be self-purging between strokes.

In order for this to be true, the sampling system must be installed properly, maintained in working order, and the sample must be subsequently handled properly.

The object of the composite sampling system is to gather representative "bites" or grabs of the gas moving by the sample point and inject those "bites" unchanged into a sample container for storage and transportation to an analyzing device.

The composite sampling system consists of the following items:

- Stream Conditioning (Komax static mixers)
- Isokinetic Sampling Pump
- Sample Timing System or Electronic Interface
- Sample Container

The composite sampler is normally used as a practical alternative to an on-line analyzer such as a calorimeter, therm titrator, or chromatograph. If instantaneous information is required, the on-line analyzer is the mechanism to use. If, however, the analysis and BTU can be sent from a lab at a later date, the composite sampler will provide as accurate, if not more accurate, information than the on-line analyzer.

It is understood that liquids cannot be removed from flowing gas streams; therefore, the sample will contain liquids or droplets that will condense. The sample that contains these condensables will be representative of the flowing stream. Two phase samples will not produce repeatable results in standard cylinders because the phases of the sample cannot

be controlled. The piston cylinder is the only container that can be used to ensure an accurate analysis of the collected sample. The sample may be kept in equilibrium in the piston cylinder.

Liquids in natural gas transmission and distribution systems are being ignored.

Because of economic considerations, or lack of knowledge, the liquids that are being generated at the wellhead are not being adequately removed to be able to move a clean, dry gas for transportation in the pipeline. Because of this, both the producer and gatherer experience losses and unaccounteds.

Is the sampling technique suitable to find liquids in the gas stream?

Liquid fallout – some hydrocarbons and water vapor may drop out under certain conditions of temperature and pressure. This liquid is equivalent to gaseous volume that is not accounted for. Water, CO_2, and liquid hydrocarbons knocked out at conditioning, treating, or processing plants should be properly accounted for.

The liquids in the metering and pipeline system create problems of lost efficiency, inaccurate measurement, hydrate problems, and inaccurate chart integration.

The study showed the increase in the specific gravity and BTU was not appreciable. The problems created by the liquids, however, were ever-present.

The removal of the liquids from the systems would have created increased revenues far greater than the BTU increase for the producer. The removal of the liquids from the system was found to be of a great benefit to the pipeline company in improved operations and measurement.

This wet gas problem is further compounded by the variation of cylinder pressures. It is important to note the pressure in the sample cylinder at the time the sample is taken. This pressure needs to be the same when the sample is run on the analytical device.

Excessive bleed during purge cycle is a means by which the BTU is also drastically affected. This excessive bleed or purge using gas from a standard cylinder will lower the pressure and allow heavies in the liquid state to vaporize and, therefore, affect the BTU by driving it up. The amount the BTU will be affected will be determined by the heavies in the cylinder and the decrease in pressure in the cylinder.

The sampler should be designed to pump all of the trapped sample into the container. Any product retained in the collection head because of clearances from pistons or inlet check valves will most certainly be heavier contaminants, such as water or natural gasoline, and oil.

Proportional-To-Flow Timing System

The wet gas sampling system, as with all multi-phase sampling systems, must be actuated proportional to the flowing stream. In order for the components in the sample container to be related to a specific volume of total products moving through the pipeline, the sampling system must be interfaced with the flow.

Sample Containers

The method of storing the collected sample is to employ a container that has a sliding piston. The use of the constant pressure sample container allows the sample to be stored and mixed without changing phase.

Since the sample container is normally going to have pressure higher than pipeline pressure on the piston above the product, the sampler must work independently of any associated conditions (pipeline pressure, ambient temperature, or precharge pressure on the cylinder).

To retain a collected sample in the same phase as it is in the pipeline, the light ends must be kept as part of the sample. If the light ends are retained, the BTU and specific gravity will not change. With proper pre-conditioning, the compositional analysis can be accurately determined.

To use the Constant Pressure Product Container (CPPC) as the sample container, the sampler will be required to capture the sample and pump that collected bite through the tubing and into the cylinder. The cylinder has a precharge gas on the back side of the piston to keep the sample in a single phase. The precharge gas is 50 to 100 psi above the pipeline pressure.

In order for the sample to be accurately analyzed, it must be kept in the same phase during collection and storage as in the pipeline.

The sample must be collected, stored, and transported in containers specifically designed for this function.

The transportable Constant Pressure (CP) sample container that is used must be capable of the phase control and must have the mixing capability to re-mix the contents of the container to a completely homogeneous mixture, and be D.O.T. Approved.

With gas, water, and hydrocarbon mixtures, the continued mixing of the contents during sample transfer from stationary container to transportation container or container into analytical devices or glassware cannot be stressed enough.

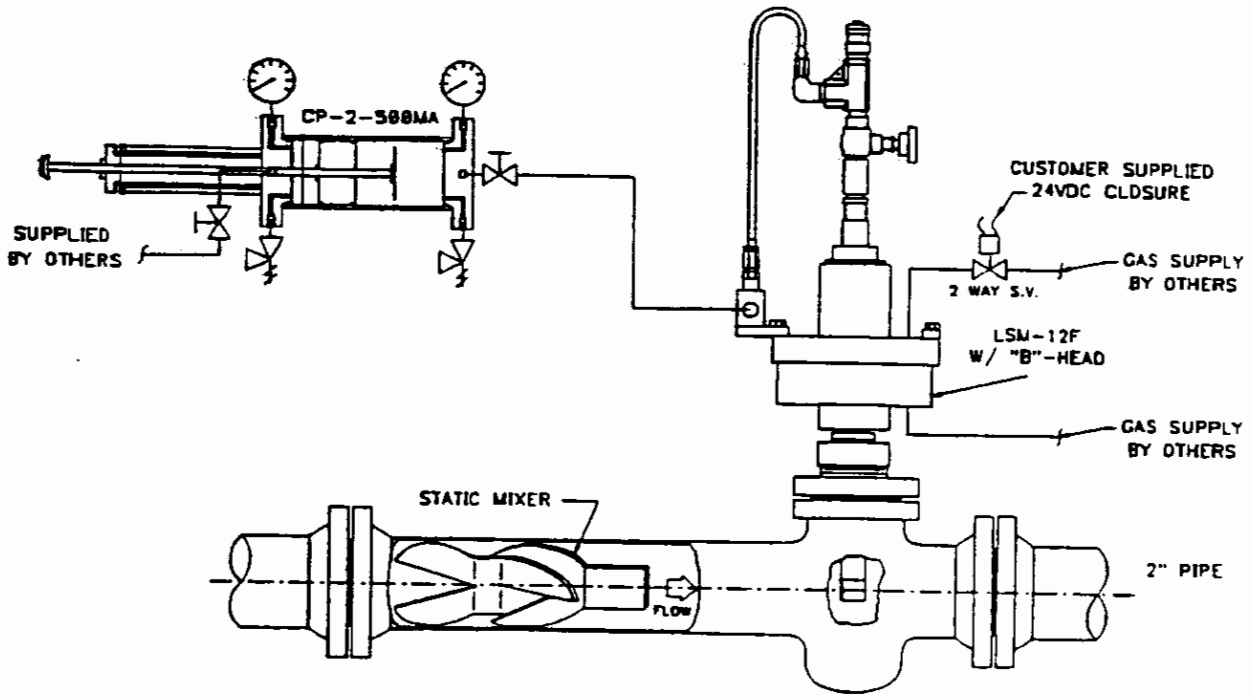
The sampling technique in spot sampling of wet gas is more sophisticated than normal dry gas.

Spot sampling wet gas should be done using the phase observation sight glass and piston cylinders with the phase control bleed plug in the precharge valve of the sample cylinder.

The sliding piston sample container should always be used in wet gas sampling.

By using the piston cylinder, the drawing of gas from the pipeline ensures the phase of the sample is always under control.

The piston cylinder also allows control of the gas as it is pushed into the analyzer. After the gas analysis has been done, the liquid phase can be measured and removed for further analysis.



References

[1] Paper presented at the North Sea Flow Measurement Workshop, a workshop arranged by NFOGM & TUV-NEL

Note that this reference was not part of the original paper, but has been added subsequently to make the paper searchable in Google Scholar.