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# TECHNIQUES OF GAS SPOT SAMPLING

Class # 5290

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## Introduction

This paper will discuss the various approved methods used for spot sampling in the natural gas industry. Proper sampling technique is extremely important because it impacts both the quantity and quality of the gas being measured. Up until 1978 when congress passed the Natural Gas Policy Act, natural gas was sold based on volume. The Natural Gas Policy Act implemented selling of natural gas based on the energy available in the gas being sold. Consequently, the importance of sampling to determine the BTU content of the natural gas sold became much more important. The energy available in a gas stream is the product of the volume and the BTU content of the gas sold. In order to determine the BTU content of the gas, a sample must be captured and analyzed by a gas chromatograph or calorimeter. Typically, the industry utilizes gas chromatographs to make this determination. The sampling method is frequently a function of the volume of gas sold over the period. If the volume sold is small the technique used is usually the spot sampling method, which is the method covered in this paper. In spot sampling, the sample is obtained and transported to a laboratory for analysis by a gas chromatograph. If significant volume is transferred over the period, a composite sample might be utilized and analyzed. This method is more expensive and thus requires more volume. When very large volumes are measured, an online gas chromatograph is justified. Today, an online gas chromatograph can provide a complete C6+ analysis in approximately four minutes. However, the cost of the system is high, which is why it is only utilized at significant volume locations.

This paper will only look at the spot sampling method. Other papers presented will cover the other methodologies. Spot sampling techniques rely on the product stream being relatively constant in BTU content over the sampling period, in order to be representative. There are various spot sampling techniques covered in industry standards such as Gas Processors Association, GPA, standard 2166 and American Petroleum Industry, API Manual of Petroleum Measurement Chapter 14 Natural Gas Fluids Method Section 1 Collecting and Handling of Natural Gas Samples for Custody Transfer. These various sampling techniques will be discussed in this paper.

Ideally the sample will be collected well above the hydrocarbon dew point of the gas. If the sample conditions are close to the hydrocarbon dew point, a small change in either temperature or pressure can cause liquids to drop out of the gas if the dew point line is crossed. Consequently, one must know the hydrocarbon dew-point in order to obtain a valid sample. Each composition of gas will have a slightly different phase envelope. All of the sampling system must be kept above the hydrocarbon dew point in order to have a valid sample to be analyzed.

There are several methods for determining the hydrocarbon dew-point temperature of the natural gas stream in question. The preferred method is to use ASTM D 1142, Standard Test Methods for Water Vapor Content of Gaseous Fuels by Measurement of Dew-Point Temperature. The next best method is to use a constant pressure method to catch the sample and then run an extended analysis. Once this is accomplished the hydrocarbon dew-point temperature can be calculated. It is extremely important to keep the sample temperature above the flowing gas temperature for this method to be applicable.

Representative samples are extremely difficult if not impossible to obtain if sampling at or below the hydrocarbon dew-point temperature. Therefore, the designers of a gas measurement system should be cognizant of the issues; anticipated flow rate and gas quality, ambient temperature extremes expected, availability of power, intended sample collection methods and time between collection and analysis, and finally cleanliness. Proper system design can help mitigate sampling issues. For example, if any of the inerts in the gas stream are used as the carrier gas typically used in the gas chromatograph, the carrier gas used by the chromatograph must be changed.

## Sample Point

In order to obtain a representative sample the selection of the proper sampling point is critical. It is imperative to avoid sampling from a dead end line, manifolds, or close to any flow disturbance in the piping system. Flow disturbances typically encountered include orifice plates, elbows, tees, control valves, thermo-wells, or any other obstruction in the line. The general rule of thumb is to place the sample point at least five pipe diameters downstream of any known disturbance. For example, if a six inch meter tube is utilized the sample point would need to be at least 30 inches away from any disturbance, (5 pipe diameters times 6 inch pipe). The reason for the five pipe diameter rule of thumb is to prevent or minimize the presence of aerosols entering into the sample cylinder if liquids are present the line. The sample point should be at the top of a horizontal section of pipe.

## Sampling Components

**Probe -** The sample should be taken with a sample probe inserted in the top of a horizontal section of the metering system at the desired sample point. The sample probe should extend into the middle third of the pipe, unless the pipe is very large diameter. The maximum length of the sample probe should be ten inches, otherwise vortices caused by the probe at high gas velocities (vortex shedding) may cause the probe to fail over time. The probe may be beveled at a 45 degree angle (preferred over square cut), be square cut or even a filter probe if liquids are anticipated.

**Valves –** Valves associated with the sampling system should not be restrictive, otherwise the restriction will cause the Joules-Thompson effect to come into play. As a rule of thumb, for every 100 lbs of pressure drop there will be a corresponding 7 degree Fahrenheit temperature drop. This temperature drop might be sufficient to cause condensation of liquids in the gas stream which would result in a questionable sample.

Valves with soft seats providing positive shut-off should be utilized. If the valves leak, the sample is seriously compromised and the composition obtained by the gas chromatograph suspect. The light ends will be lost first if a valve leaks, leaving the remaining sample non representative. Some form of pressure relief valve or rupture disk should also be included to prevent an overpressure situation with the sample cylinder. These devices relieve some or all of the sample contents if a thermal expansion or overpressure occurs. Obviously, if the sample is released at all, the sample has been compromised and should not be analyzed.

**Tubing -** The tubing utilized should be as short as possible to minimize possible heat transfer caused by ambient conditions. The minimum tubing diameter used should be ¼ inch. If a purging method is utilized in the sample collection technique, a pigtail attached to the outlet of the sample cylinder should be utilized. The pigtail should consist of at least 3 feet of ¼ inch tubing and include a throttling device at the end. The throttling device will usually be either 1/16 or 1/8 inch in diameter. The purpose of the pigtail is to move the cooling which occurs at the throttling device well away from the sample cylinder. It should be noted however, if spot sampling is performed at a point in time when the ambient conditions are below the hydrocarbon dew point of the gas, the sample cylinder will cause condensation unless the sample cylinder is heated or insulated to keep the cylinder temperature above the hydrocarbon dew point.

**GPA Separator** – The research performed by the American Petroleum Institute indicates that the use of any sort of GPA separator or drip pots in the sampling system should be avoided. The GPA separator is now recognized by the Gas Processors Association to be very difficult to operate properly, and therefore they are cautioning the use of the separator in the latest version of GPA 2166-05.

**Sample Cylinders** – There are currently three main types of sample cylinders in use today. The most common cylinders in use today are the single cavity cylinder with a valve at each end. These cylinders are also known as constant volume and spun end cylinders. These cylinders are relatively easy to utilize in sample collection, however one drawback is difficulty in cleaning and inspecting the cylinders after use.

The constant pressure or floating piston cylinder is also utilized for spot sampling. Prior to use these cylinders have an internal piston with pressure on the piston away from the inlet. Pressure is added to the cylinder causing the piston to move, removing any air in the cylinder. Thus all of the air internal to the piston can be removed which eliminates the need to purge. Purging is considered one of the main sources of error in the sampling procedure. This type of cylinder is recommended when sampling near the hydrocarbon dew point or when sampling in cold ambient conditions. Issues with this type of cylinder include proper sealing around the piston, potential for contamination by the lubricant used around the piston seals, and the difficulty in properly cleaning the cylinder.

A relatively new type of cylinder utilizes a tedlar bag internal to the cylinder to capture the sample. This technique eliminates the contamination issues around the piston seals. The bag is disposable, and because it is only used one time, this technique also eliminates the cleaning issues. The way this cylinder works is somewhat like the floating piston cylinder mentioned above, except the bag is deflated prior to use by an inert gas providing a small back pressure. Like the floating piston cylinder, this cylinder is a good choice when sampling near the hydrocarbon dew point or in cold ambient conditions.

Typically the sample cylinders are constructed of stainless steel. However, if sampling a gas containing $H_2S$ special consideration should be made, since absorption of the $H_2S$ can occur by the stainless steel. Thus the sample may not be representative of the flowing gas.

## Sampling Methods

There are eight recognized spot sampling methods used in the industry. The following table summarizes the method, advantages, disadvantages, method description and the results obtained during the API tests.

| Method | Method Description | Advantage | Disadvantage | Results Obtained |
|---|---|---|---|---|
| Evacuated Cylinder | Dead-end filling of evacuated cylinder | Since the cylinder is evacuated no other fluids present | The integrity of the valves are critical to avoid air leaking into cylinder | +/- 0.14% of BTU |
| Reduced Pressure | Dead-end fill of evacuated cylinder to a reduced P | Problems associated with high P are reduced | Smaller sample quantity | +/- 0.12% of BTU |
| Helium Pop | Dead-end fill of Helium blanked cylinder | No air in cylinder to purge | Dilutes sample<br>Difficult to perform | +/- 0.15% of BTU |
| Floating Piston | Dead-end fill by moving floating piston | No air to purge<br>Constant pressure | Cylinder is difficult to clean and lubricate | +/- 0.14% of BTU |
| Water Displacement | Dead-end displacement of water | No air to purge<br>Constant pressure | Susceptible to contamination, possible absorption or desorption of $CO_2$ or $H_2S$ by the water | +/- 0.13% of BTU |
| Glycol Displacement | Dead-end displacement of glycol | No air to purge<br>Constant pressure | Uses 50/50 glycol water mix<br>Susceptible to contamination, possible absorption or desorption of | +/- 0.10% of BTU |

| | | | | |
|---|---|---|---|---|
| | | | $CO_2$ or $H_2S$ by the water | |
| Purging – Fill and Empty | Repeated dead-end filling and emptying to purge cylinder | Cleaning only inexpensive equipment | Residual contamination possible<br>Condensation possible<br>Number of purges required a function of the line pressure and is somewhat critical | +/- 0.12% of BTU |
| Purging - Controlled Rate | Cylinder valve used to regulate purge flow rate | Cleaning only inexpensive equipment | Residual contamination possible<br>Condensation possible<br>Inconsistent execution of method | +/- 0.18% of BTU |

**Summary**

Proper sampling requires the correct sampling equipment, technique and sufficient care during the sampling process to assure the sampling system is above the dew point temperature. Proper technique requires a good understanding of the available standard methods and detail following of the prescribed technique chosen. Proper sampling is imperative in as much as the results directly impact the bottom lines of both parties involved in the custody transfer location.