Validating Laboratory Gas Analyses
Class 5195.1

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Introduction

What do you do I someone asks you to collect a natural gas sample? Do you panic? Do you use the same sample procedure your co-worker has been using for 30 years? Or…do you refer to API Chapter 14.1 and do it correctly?

Overview

- Sample System Location
- Sample System Design and Operation
- Field Sampling Procedures
- Sample Collection Equipment and Procedures
- Sample Identification
- Sample Transportation
- Receiving Samples at the Lab
- Inspecting and Pre-conditioning Samples
- Sample Injection System
- GC Performance Verification
- Calibration Standards – Preparation and Use
- Data Verification / Data Mapping
- Six Sigma Processes

Sample System Location Guidelines

1. Close to the meter, preferably just downstream of it, with at least 5 nominal pipe diameters (5D) of straight run before the sample point.
2. No obstructions to flow are allowed in the upstream section before the sample point.
3. No fittings or obstructions should be located within about 3D downstream of the sample point.
4. Sample points upstream of the meter are acceptable (not preferred), but must not be in the engineered upstream section of the run, where it would only constitute a flow disturbance and destroy the integrity of the meter run.

In this figure, what deficiencies do you see?

1. **No Probe**
2. **horizontal tap**
3. **No heat**
4. **No insulation**
5. **time proportional**
6. **overly complex**

Sample Probes are mandatory

1. Sample system must incorporate a sample probe extending to the center 1/3 of the run for small diameter runs. For larger runs, 10” lengths are more than adequate.
2. Probe should be vertical in a horizontal run of pipe.
3. Probe must be designed to withstand high flowing velocities in some installations (around Ultrasonic Meters for example).

Composite or continuous Sample system design and Operation

1. If the Btu/scf of the stream is greater than approximately 1030 Btu/scf, heat tracing and insulation must be provided from the sample probe to the injection point into the sample cylinder or GC to insure no condensation occurs.
2. Regulators require a great deal of heat input to insure condensation does not occur at the point of regulation.
3. Sample lines should be as short as practical.
4. All materials should be stainless steel or nylon (stainless steel preferred due to its toughness and relative safety).

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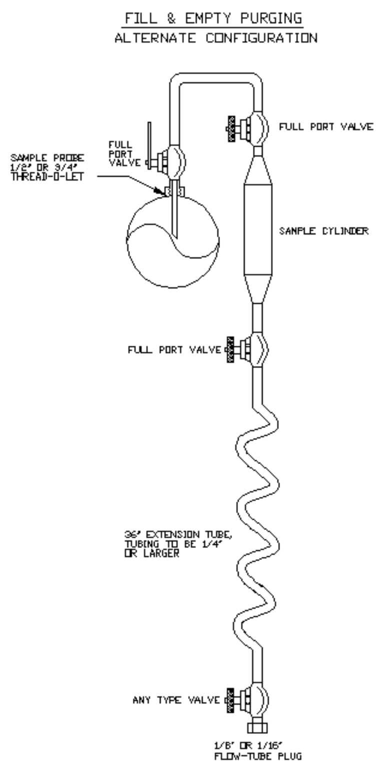
What deficiencies are apparent in this photo?

- Very long line
- No heat tracing
- Incomplete Insulation
- Needs to be carefully leak tested on a regular basis

Field sampling procedures. Ask yourself:

1. For Spot Sampling, especially with streams over approximately 1050 Btu/scf, is a preferred method being used (fill and empty or helium pop)?
2. For composite or continuous systems, is the sample taken proportional to flow?
3. For spot sampling,are you considering diurnal (daily) and seasonal changes in composition.



Sample equipment selection and Procedures

1. Probes must be engineered to withstand anticipated maximum flowing velocities and downstream equipment may need protection should the probe break off.
2. Automated, flow proportional, composite sampling systems provide the most representative samples when designed and operated properly.
3. Careful calculations are necessary to insure composite samples are sufficient for analysis, but also insure sample cylinders are not over-pressured, resulting in a safety hazard, releases to the atmosphere and loss of sample.

Sample Labels

1. Once collected, samples must be carefully labeled with critical information necessary for tracking the sample back to its source.

2. Sample source temperature and pressure should be noted. For new locations, an estimate of the Btu content and contaminant levels should be provided.

3. Any information the lab should consider should be included.

4. Sample cylinders must be properly labeled, indicating flammability, any hazardous components, suspected water content and classification information.

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Sample transportation

1. The cylinder must be capped to protect the valve threads and to insure no leakage will occur in transit.

2. The cylinder must be properly restrained.

3. Valves must be capped and should be protected.

4. Complete paperwork must accompany the samples during transport.

Receiving samples at the lab:

1. Samples should be logged in and examined upon delivery.

2. Samples with reactive components should be analyzed immediately.

3. Should a sample be suspect for any reason, consideration should be given to discussing the sample with field personnel.

Preconditioning Samples

1. Place samples in a convective oven to insure they are heated to at least 30F warmer than sample collection temperature (flowing stream temperature at the time of collection).

2. Maintain the samples at this temperature for at least two hours.

3. Labs often use a fixed oven temperature, such as 140F, for pre-conditioning samples.

When reviewing an online GC, look for the following:

- Conditioned Environment?
- Sufficient heat on regulators?
- Leak Free
- Proper Configuration?
- Current GPA 2145 physical properties?
- Analyses applied flow proportionally?
- Short sample line runs with adequate heat tracing and insulation?
- Carrier gas type?
- Expected composition of the stream fully considered?
- C6+, C7+, C9+, ??

Sample injection system

Insure the GC inlet system has adequate protection for the GC (regulation, filtration and dehydration).

Is the GC Performing to Standards?

1. Determine that the repeatability and reproducibility of the machine are within API Chapter 14.1 recommendations.
2. If analyses are particularly sensitive; for example, in anticipation of litigation - consideration should be given to calibrating the GC immediately before and after the analysis in question.

Here's the Criteria:

Repeatability is how closely a specific g.c. can get the same answer in back-to-back runs on the same sample with the same operator and using the same procedures.

Reproducibility is how well a g.c. can analyze a calibration gas with a well-known analysis. An alternate definition, currently used by the GPA, is how well two g.c.'s can agree when analyzing the same sample. The first definition is more meaningful.

Component Mol%	Repeatability (+/-)	Reproducibility (+/-)
0 to 1	0.02	0.04
1 to 5	0.10	0.13
5 to 15	0.18	0.26
15 to 30	0.28	0.38
30 to 50	0.40	0.50
> 50	0.52	0.63

Calibration standards – verification and use

1. Always insure the calibration standard contains all the components in the stream to be analyzed and that the concentrations are close (generally within 200 Btu/cf).
2. Insure that the C6+ or C7+ components are well defined.
3. NOTE: For HCDP predictions using Equation of State calculations, a C9+ or better analysis is recommended.
4. Verify that the calibration standard is not out of date and has not been mishandled.
5. Insure the standard has been properly stored and with its temperature constantly maintained at least 30F above the calculated hydrocarbon dewpoint temperature at least 24 hours prior to use.
6. Insure that the standard is gravimetrically prepared in accordance with API Chapter 14.1 recommendations and not a blend with calculated concentrations.

Data verificaton / Data mapping

1. Periodically map the accounting processes from the sample point thru the entire accounting process.
2. Identify redundancy in the process.
3. Identify gaps in the process.
4. Review all spreadsheets used in the process for accuracy and currency.
5. Determine if performance goals are being met. If none exist, apply six sigma principles to establish appropriate goals at each node in the process.
6. Periodically review performance goals to see if they are being met and if they are appropriate.
7. Periodically review physical properties and other information for agreement with current industry standards.

Audit trail

1. Any time data is transmitted from one smart device to another, it must be verified electronically for accuracy.

2. If a change in a value can affect the calculated volume or energy content of a stream, both the old new values must be maintained in the audit trail.

3. Accountants and other personnel must not have the ability to alter these key values without it being reflected in the audit trail. It should be date and time stamped as well.

4. Contracts generally specify when revisions to volumes or energy contents trigger reallocations or retroactive adjustments to custody transfer quantities. Be sure you understand contract terms and conditions.

Conclusion

As you can see, insuring good analyses from a GC is quite involved, but when broken down into step by step items, it is very “doable”. In addition to being “doable”, it is absolutely essential since metering, sampling and analysis must all be performed correctly if accurate measurement is to be attained.