OPERATION AND MAINTANCE OF ONLINE GAS CHROMATOGRAPHS

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INTRODUCTION

The gas chromatograph (GC) is an integral component of the natural gas custody metering station and has a significant impact on the accuracy of the fiscal flow calculation. For this reason, it is imperative that you install, operate and maintain the GC with the goal of maximum reliability and accuracy.

THE SAMPLE HANDLING SYSTEM

The quality of the analysis can only be as good as the quality of the sample that is presented to the GC. Therefore, it is critical that the sample handling system deliver the clean, dry, and pure gas phase samples that the GC requires. This not only ensures an accurate analysis, but it also ensures that the GC operates reliably.

The role of the sample handling system is to do the following:

- Extract a representative sample. A sample probe should always be used and installed according to the recommendations of API 14.1[1].
- Remove contaminants. Particulate matter greater than two microns, as well as free liquids from the sample stream, must be removed without affecting the composition of the gas sample. The use of sample probes that incorporate particle filters and moisture membrane filters are highly recommended.
- Reduce and control the sample pressure. The sample pressure at the inlet of the GC should be set to the GC manufacturer's recommendation, typically 20 PSIG (140 kPaG).
- Maintain the sample composition. The sample temperature should not drop below the hydrocarbon dew point, which would cause the heavy hydrocarbons to condense into the liquid phase. Ensure that the sample temperature is kept to "at least 30ºF (17ºC) above the expected hydrocarbon dew point" (API-14.1)[2]. The use of electrical heat tracing on all sample lines set to a temperature of between 90 ºF (32ºC) and 100ºF (38ºC) is now widespread practice.

[1] API 14.1 Sixth Edition (Feb. 2006) – Chapter 7.
[2] API 14.1 Sixth Edition (Feb. 2006) – Section 6.6

INSTALLING GAS CHROMATOGRAPHS

Modern GCs are designed to operate unattended in harsh climates. Manufacturers typically specify a wide operating temperature between 0ºF and 140ºF (-18ºC and 60ºC). However, the operational requirements for technician access necessitate at least a rudimentary shelter. The location of the GC should be chosen so that:

- It is as close as practical to the sample point. The time taken for the sample to travel from the sample probe to the GC, known as sample lag time, should be as short as possible and less than half the cycle time of the analyzer.
- It allows easy access to the GC for maintenance.
- It can include an Ethernet connection port for a laptop computer.
- It can ensure the GC ambient temperature is kept within the manufacturer's specified limits. In colder climates it is often necessary to install the analyzer in a heated analyzer hut, which is also preferred by a majority of technicians.
- It can provide for the storage and connection of the carrier and the calibration gas tanks. Typical calibration gases have a hydrocarbon dew point that is much higher than the lowest operating temperature of the analyzer, and the gas should therefore be maintained at a temperature at least 30ºF (17ºC) above the gas' hydrocarbon dew point to maintain its integrity. If the ambient temperature approaches this limit, then the calibration gas bottle should be heated, and the transport tubing to the GC should be insulated and/or heated.

Remote communications to the GC, via modem or Ethernet access, is quickly becoming a standard installation requirement for custody transfer applications. The ability to remotely verify the correct operation and to then troubleshoot the GC in the event of an analysis issue, without requiring the technician to travel to site, is a major long-term savings to the operating company.

OPERATING GAS CHROMATOGRAPHS

The daily operation of the GC is completely automated. At a custody metering location, the GC self-calibrates once a day, and provides alarms on critical operating parameters. These alarms should include, but not be limited to, the following:

- Response Factor deviation. During a calibration cycle the GC recalculates the Response Factor for each of the components analyzed. If the Response Factor deviates by an excessive amount from the last daily calibration, it is an indication that there has been an excessive drift in the analysis. A deviation alarm trigger is typically set to 10%, which allows for daily variations due to atmospheric pressure changes and normal detector drift.
- Un-normalized Total. When the concentration of each of the components is calculated at the end of an analysis cycle, the sum may not add up to 100%. For natural gas applications where the analysis results are to be used for calculating the gas properties, the compositions are mathematically normalized so that the sum is equal to 100% before they are used for any calculations. The sum before the normalization is referred to as the “un-normalized total” and is an indicator of the quality of the analysis. Normal variation of the un-normalized total (+/- 1%) is expected due to several reasons including:
    - Not all the components are measured.
    - Variations in the sample injection pressure.
    - Analytical measurement uncertainty.

  Un-normalized totals outside of these limits can be an indication of poor analysis and/or low sample pressures.
- Low carrier gas pressure. This alarm is also called an “Analyzer Failure Alarm” on a common brand of natural gas chromatographs.

MAINTAINING CHROMATOGRAPH SYSTEMS

Routine maintenance of the GC is limited to maintaining the sample handling system, retrieving and analyzing diagnostic information, and monitoring the alarms. If the diagnostic information is analyzed correctly, the requirement to maintain the physical components of the GC oven can be predicted and scheduled before the quality of the analysis data is affected.

The particle filters and the moisture membrane filters should be replaced on a routine basis. While the frequency of replacing these elements is dependant on the quality of the gas being measured and the location of the metering site, if the filters show visible signs of contamination, the frequency of replacement should be increased. A typical frequency of replacing these elements is monthly for a site on the outlet of a production facility, and every three months for the receipt station at the end of a pipeline.

The following diagnostic information should be collected and analyzed on a regular basis:

- Alarm Log
- Event Log
- Calibration Report. This should be compared to previous reports to compare the drift (response factor and retention time) over time. While the GC will alarm on a gross shift in analysis quality between daily calibrations, a comparison to the original calibrations (from the factory or after the last major overhaul) will highlight a gradual change and provide a trigger for scheduled maintenance.
- Analysis archives. Often the Flow computer or SCADA system will have access to the analysis results and will store them in its own historical database; however, analyzing the archive logs directly from the GC in concert with the other diagnostics may highlight sample handling issues (e.g. day or night variations) that may be missed at the SCADA or Flow Computer level.

A new development is the ability to perform the remote and routine collection of diagnostic information and validate the GC automatically at predetermined times (e.g. 2:00AM). This reduces the need for using a trained technician’s valuable time to perform routine diagnostics, while it also electronically provides a complete audit trail for the custody metering location.

When the comparisons of the calibration reports over time show a dramatic shift in retention times (over 5 seconds), it is an indication that there is contamination in the analytical flow path (refer Figure 1). While it is possible to adjust the valve timing and analysis cycle times to correct any errors in the analysis results, the shift in retention times should be interpreted as a signal to schedule the overhaul of the analytical flow path.

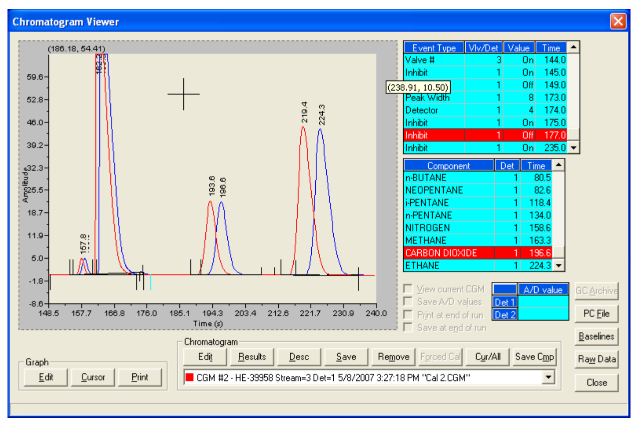

Figure 1 - Retention time drift over time

In approximately 80% of cases of contamination in the analytical flow path, overhauling the analysis switching valves will rectify the issue. Most manufacturers of natural gas chromatographs have very stable analysis columns, and unless there has been a catastrophic failure of the sample handling system that has allowed liquid or particulates to enter the GC, the columns are usually not going to require replacement.

When the analysis valves have been overhauled due to contamination it is important to also overhaul the sample handling system so that the analyzer is not re-contaminated. The particle and moisture membrane filters should be replaced, and the sample lines flushed with a solvent such as acetone or isopropyl alcohol, and then dried with clean, dry air, or helium.

SUMMARY

The correct operation of online gas chromatographs relies heavily on:

- The proper selection of the gas chromatograph, sample handling system, sample lines and sample probe.
- The correct installation of the gas chromatograph and the sample handling system components
- The maintenance and correct operation of the sample handling system and gas chromatograph.

Tracking the performance diagnostics of the gas chromatograph is also critical so that maintenance on the analysis system can be scheduled, and the quality of the analysis is not compromised.