PERFORMANCE TESTING FOR NATURAL GAS SAMPLE SYSTEMS

Class # 5520

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INTRODUCTION

As we enter the second decade of the 21st century, technology is changing at an ever increasing rate. This holds true for all aspects of our lives, including communication, transportation, commerce, the internet, etc. The production, transportation and sampling of Natural Gas has also been affected positively by this surge in technology. For the purposes of this paper, the focus will be the analysis of Natural Gas. One example of a quantum leap in analysis is the method for measuring water concentrations in Natural Gas. In 30 years, the industry standard for water measurement has gone from manual chilled mirror analysis or stain tubes, to electrolytic cell-based analysis, to Tunable Diode Laser (TDL) technology. In addition, properties and characteristics of natural gas can not only be monitored digitally, but they can be monitored remotely through wireless network technology. Changes in pressures, temperature or flows in a gas pipeline can be seen and corrected via laptops.

Some have referred to the Gas Chromatograph (GC) as a Natural Gas cash register. This instrument determines the heating value of natural gas based off the concentrations of different hydrocarbons present in the gas stream. As such, it is very important that these readings are correct. Technology gives the ability to calibrate and troubleshoot GC's to ensure that they are correctly analyzing the gas that enters into it. With all the trouble that goes into calibrating and maintaining analyzers, how do we know that the sample entering the GC is representative of the flowing gas? In fact, the largest source of error in analysis comes from the sampling system! Over the years products and techniques have been introduced that facilitate the extraction, transport and conditioning of natural gas to be compatible with analyzers, but most of the early efforts were aimed at protecting the delicate and expensive analyzers. It wasn't until the early 1990's that companies began to focus on delivering an actual representative sample to the analyzer.

REPRESENTATIVE SAMPLE

A good example of this distinction between delivering a representative sample and protection of the analyzer is the rejection of liquids for sample conditioning. One should reject the liquids at the pressure and temperature of the flowing gas in the pipeline in order to extract a representative sample of gas containing entrained liquids. If liquid is rejected after a change in pressure or temperature, the gas no longer represents what was flowing in the pipeline. It is still necessary, however, to remove the liquids before they enter into the analyzer, or damage to the analyzer may occur (See Figure #1). The analysis will not be correct, but the analyzer is protected. Prior to the early to mid-1990s, the practice was just to remove liquids in order to protect the analyzer. No thought was given to maintaining a representative sample during the extraction, transportation and conditioning before entering the analyzer. Methods need to be utilized to ensure that sample systems do not alter the sample. By validating and performance testing a sample system, better system designs can be achieved, and troubleshooting the sample system will be easier.

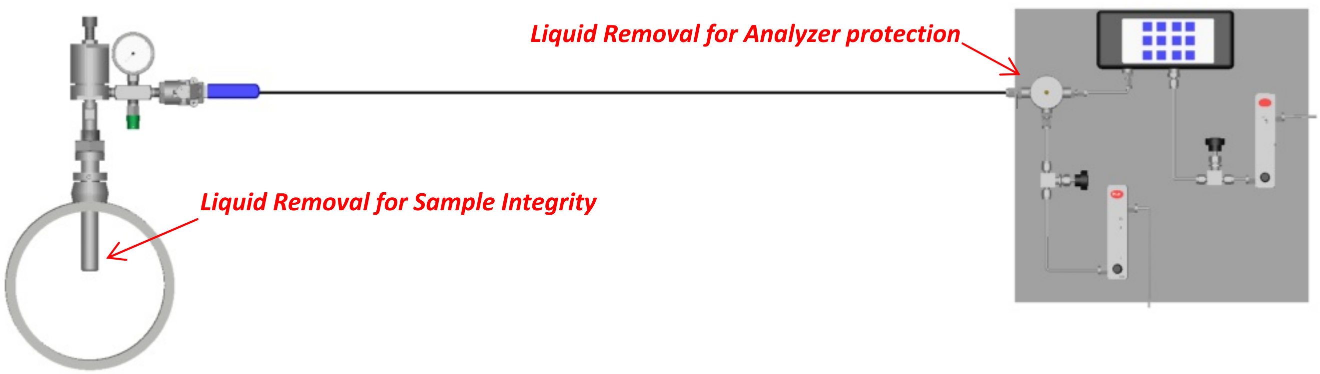

Figure #1- Sample System showing differentiation between removal of liquids for sample integrity and analyzer protection

INDUSTRY STANDARDS

Currently, no industry standard addresses performance testing or sample system validation. Some early attempts to introduce performance testing are being made by the International Organization for Standardization (ISO) with the reopening of ISO 10715 (Natural Gas Sampling). Performance testing and validation will be a key issue in the rewrite of ISO 10715. Hopefully, the rewriting of ISO 10715 will encourage other standards making bodies to focus on this issue in future versions of their respective standards.

PERFORMANCE TESTING

In order to properly performance test a sample system, some type of sample gas of known composition (hereby known as "check gas") must be injected into the sample system. This check gas may be a calibration gas, although a gas of known concentrations may be used. The objective is to first introduce the check gas directly into the analyzer and record the results. Next, introduce the check gas into the beginning of the sample system, through the analyzer, and record the results. Any deviation from the original results will tell you if the sample system is performing optimally. In order to fully test the entire sample system, the check gas has to be introduced into the very beginning of the sample point, which is usually the tip of a sample probe. The sample system should be isolated from the source gas. There are several products available which allow this to be possible (see figures #2 & #3). If it not possible to introduce the check gas directly into the probe tip, then introduction should be done as close to the sample point as practical. Note that any additional hardware introduced into the sample system for the sole purpose of performance testing/validation may further alter the analysis.

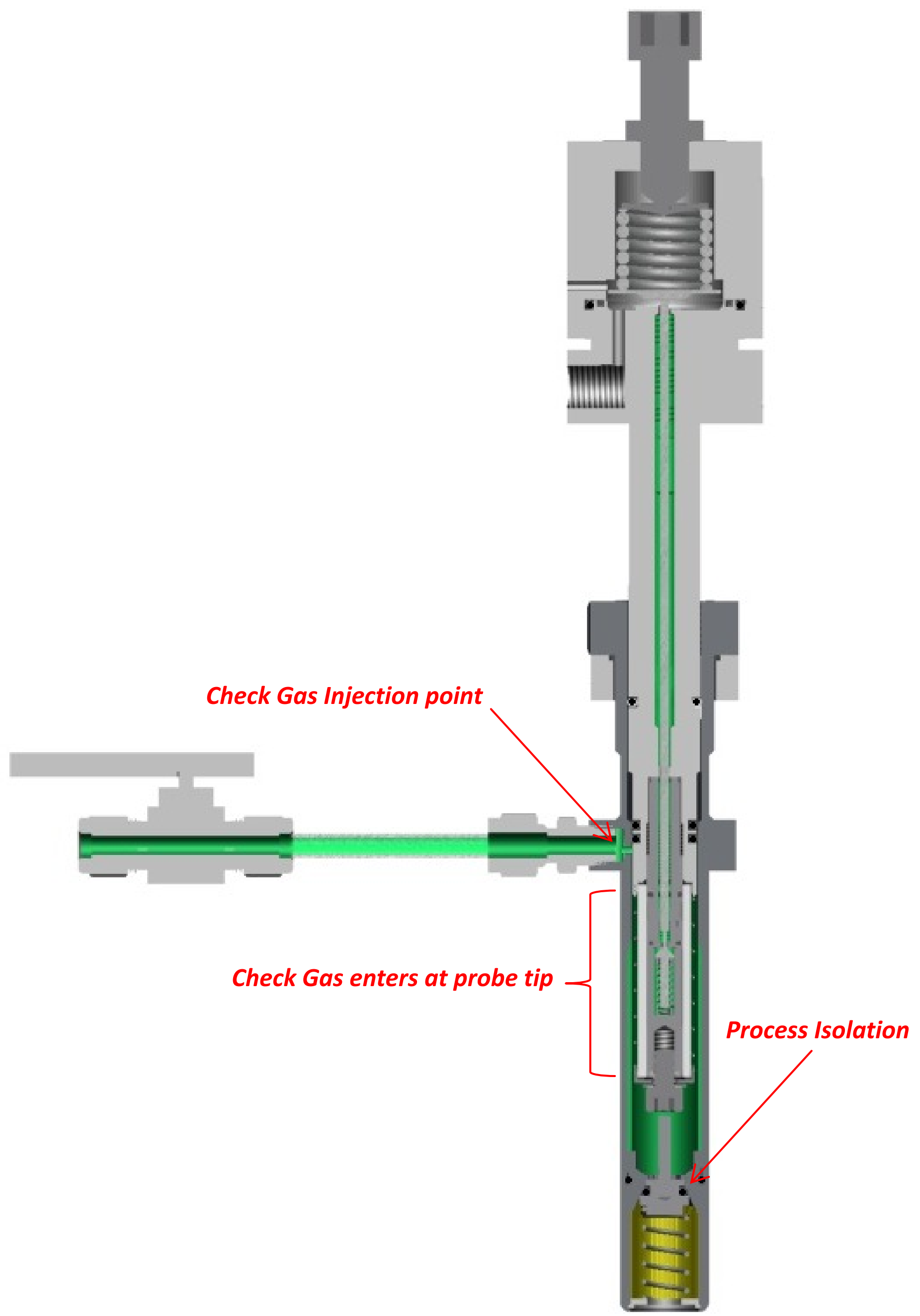

Figure #2- 2 Piece Probe with injection port for check gas

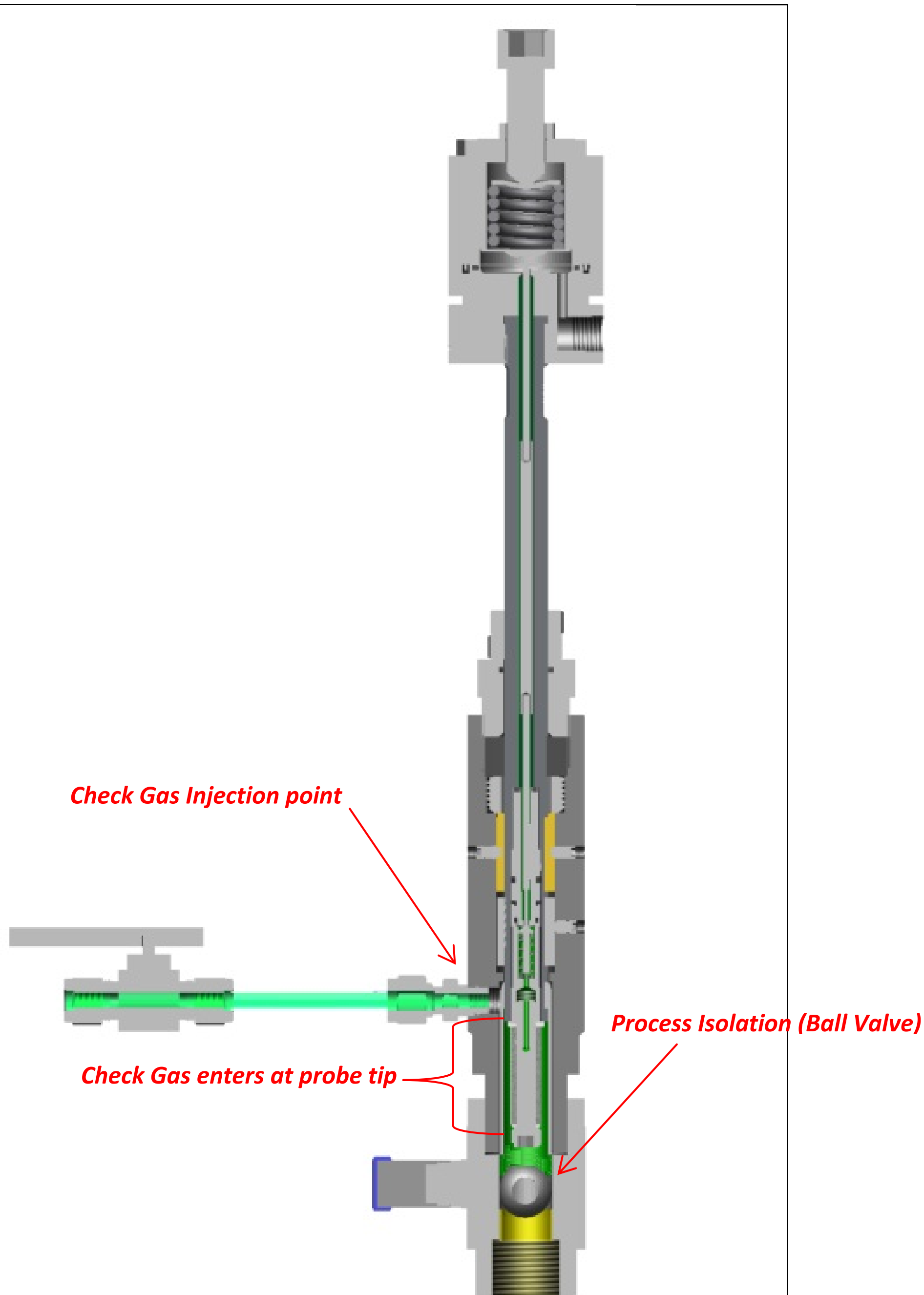

Figure #3- Single piece probe with injection port for check gas

Some components/aspects of sample systems that may lead to sample alteration:

a. Pressure Gauges (See Figure #4)
    a. Bourdon Tubes- Can condense and trap liquids
b. Dead Volume- Large, open areas can cause dead volume, which can affect analysis
    a. NPT Ports (See Figure #5) - NPT ports themselves have large amounts of dead volume.
    b. Oversized Filters

c. Long distances of Tubing
    a. This can increase lag time which can make equilibration of the sample difficult
d. Improper Drains
    a. Improper draining of liquids and particulates can lead to cross-contamination of samples

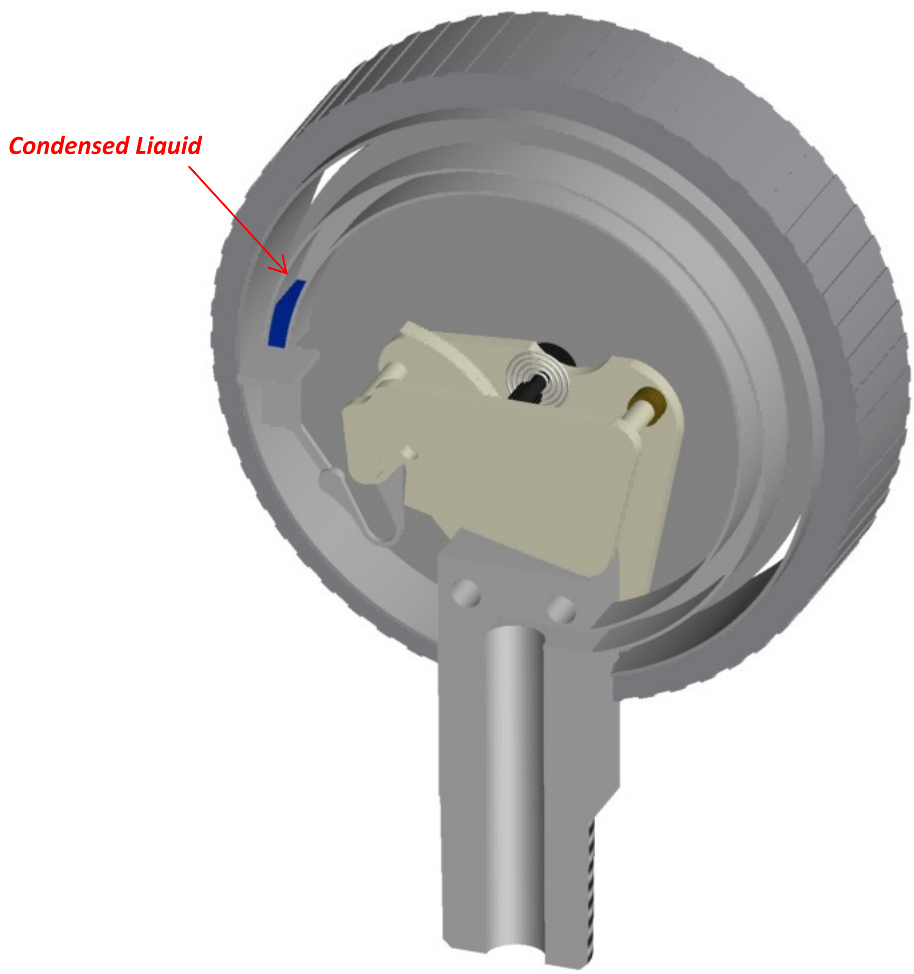

Figure #4- Dead Volume in Pressure Gages with Condensed Liquid in Bourdon Tube

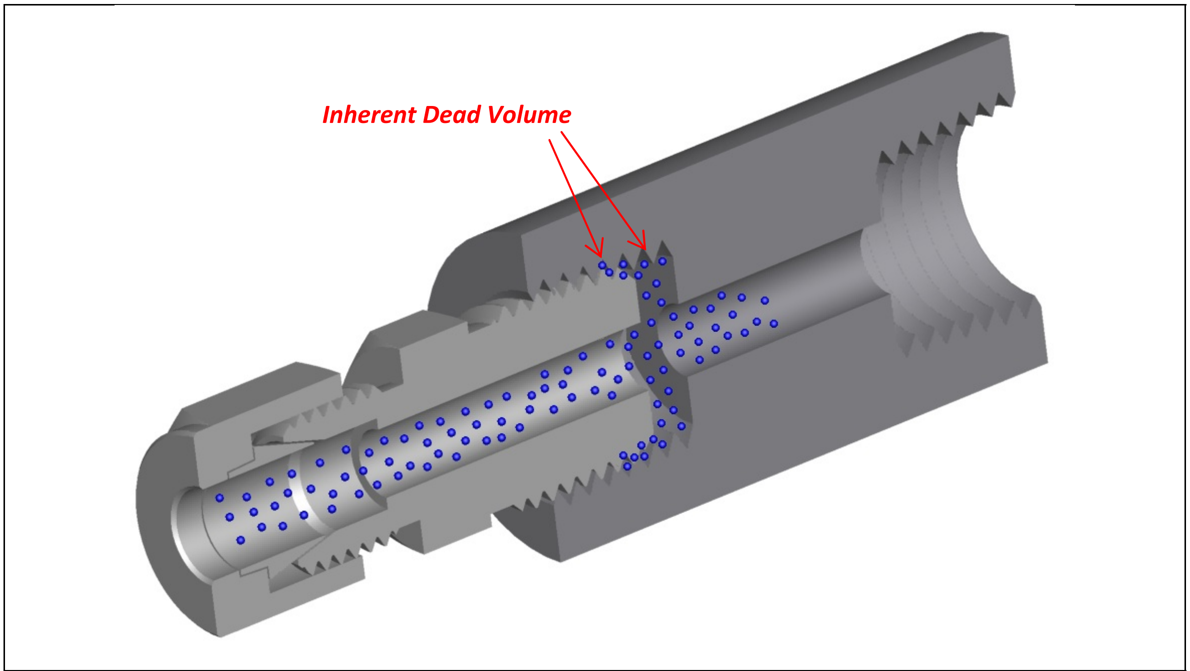

Figure #5- Dead Volume in NPT Ports

COMPONENT DESIGN

One benefit of performance testing and validation will be the development of better, more analytically correct sample system components. Since there is neither a focus nor a push for performance testing, component suppliers usually are not concerned with designing analytically correct components. A focus on performance testing will lead to better designed components. Some improvements may include:

1) Smaller, more easily swept passageways which will ensure fresh samples
2) Removal of unnecessary features that may lead to dead volume
3) Use of pressure gauges with diaphragm isolators

CONCLUSION

While technology has evolved many aspects of the Natural Gas industry, objective evaluation of sample conditioning systems has yet to be one of these aspects. Focusing on the efficiency of sample systems will lead to better, more analytically correct sample system components, which in turn will lead to more accurate analysis. Additionally, performance testing and validation of sample systems will make the design and troubleshooting of sample systems easier and more objective.