TECHNICAL NOTE

NO EMISSIONS MEASUREMENT OF HYDROCARBON GASES USING THE PRECISIVE® GAS ANALYZER

INTRODUCTION

MKS Precisive® Gas Analyzers (Figure 1) have been used in numerous applications for measuring the composition and heating value of hydrocarbon gases. The gases measured include natural gas, liquified natural gas (LNG), biogas, liquified petroleum gas (LPG), and various other hydrocarbon mixtures. The Precisive Gas Analyzer is a nearly real-time gas analyzer, updating in as fast as 1 second intervals, that is based on MKS Instruments' unique Infrared Tunable Filter Spectroscopy (TFS™) platform that can be calibrated for the measurement of a wide range of gases. Table 1 shows a typical hydrocarbon gas analysis configuration with the Precisive analyzer.

The continuous measurement capability provides immediate analytical data for a hydrocarbon gas stream, ensuring control of critical processes. Along with individual species concentrations, the Precisive analyzer can also output calculated parameters for hydrocarbon gas mixtures, including methane number, HHV, HV, Wobbe Index, and specific gravity (per ISO 6976). The Precisive analyzer is an alternative to gas chromatographs (GC) for applications requiring continuous, near real-time data (GC analyzers typically update once every 5 minutes) and/or those facilities lacking the infrastructure to support GC instrumentation. In addition to providing rapid, real-time measurements, the Precisive analyzer eliminates the need for carrier gas and span calibration gas cylinders, greatly simplifying the infrastructure requirements for gas analysis. Side-by-side comparisons of the Precisive analyzer with industry-standard TCD-equipped gas chromatographs in industrial analysis applications showed that Precisive and GC-TCD data are a near perfect match.

Figure 1. The Precisive® Gas Analyzer.

Gas	Analytical Range	Typical Accuracy
Methane	50-100 mol%	< 0.2 mol% or 0.5% of Full Scale (greater of)
Ethane	0-20 mol%	
Propane	0-10 mol%	
Iso-butane	0-5 mol%	
n-butane/n-pentane/n-hexane	0-5 mol%	
Iso-pentane	0-2 mol%	
Carbon Dioxide	0-20 mol%	

Table 1. Example configuration for the Precisive® Gas Analyzer.

The Precisive analyzer was originally designed to operate at atmospheric pressure with a low flow entering the analyzer, such as shown in Figure 2, where the measured gas gets vented to atmosphere when exiting the analyzer. Also, like other high-performance, quantitative analyzers, the Precisive analyzer must be "zeroed"

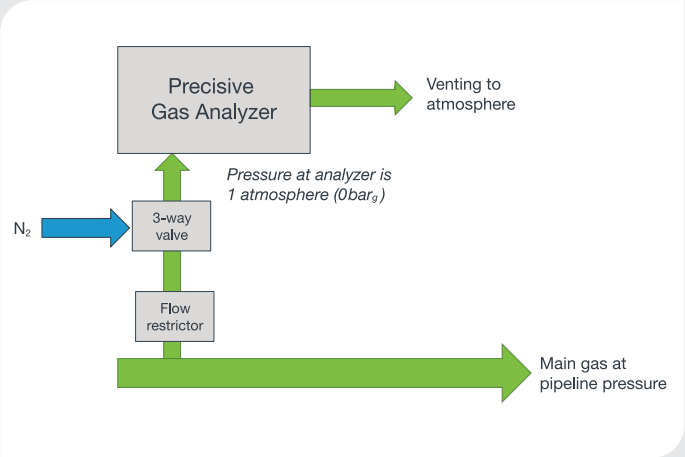

Figure 2. Standard integration of Precisive® analyzer.

or "baselined" periodically (typically at a frequency of monthly or lower) to maintain its long-term accuracy. Typically, it is zeroed using either an inert gas such as nitrogen or dry air. A spectrum of the chosen zero gas is collected each time the gas analyzer performs the zeroing function and subsequent sample gas spectra are referenced to this spectrum. The zero gas is also exhausted to the atmosphere.

The venting of the sample gas can be an issue for the deployment of gas analyzers in modern industrial gas analysis applications. There is increasing pressure to reduce greenhouse gas (GHG) emissions in all industrial activities and GHGs emitted by analytical instruments that frequently sample these streams have come under scrutiny in recent years. "Zero emissions" has therefore become an important requirement for the analytical instruments performing measurements of methane and other hydrocarbon gases in industrial gas streams. Any emissions of sample gas GHGs is considered highly undesirable. The need for zero gas cylinders can also be an issue in the field as it is not convenient to install and maintain those cylinders on-site.

To address those two issues, MKS Instruments has developed a methodology and an analysis model using the Precisive Gas Analyzer that eliminates the venting issue as well as the need for zero gas cylinders.

SOLUTION

MKS Instruments has designed a methodology called the Pressure Differential Method (US patent # US 9,488,570 B2) for zero GHG emission gas concentration measurements that does not require the availability of high-pressure cylinders containing "zero" gas and allows the sample gas at the analyzer exit to be returned to some part of the process at lower pressure (see Figure 3). In this method, the sample gas handling system is equipped with components that allow spectra of the gas stream of interest to be automatically collected at two different pressures (low pressure typically 0 to 1 bar_g and high pressure typically 1.5 to 2 bar_g). The spectrum obtained from the sample at low pressure is used as the reference or "zero" spectrum, which eliminates the need for a separate reference or "zero" gas and therefore the need for high pressure cylinders containing the zero gas. The "sample" spectrum is collected using the same sample gas but at a high pressure, and component concentrations are calculated using a well-established and reliable prediction algorithm on the differential spectrum determined by subtracting the low-pressure spectrum from the high-pressure spectrum. The performance of the analyzer under this mode is similar to the performance under the standard mode using a zero with N_2.

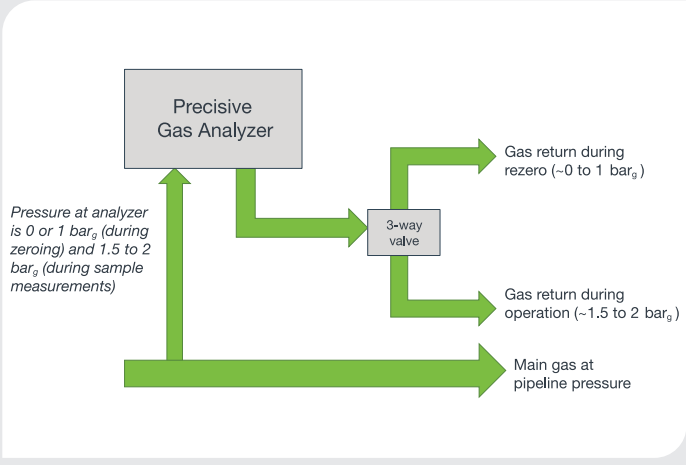

Figure 3. Integration of the Precisive® Gas Analyzer with no emissions.

Figure 4 shows a detailed example of a schematic of the gas handling and control system that can be employed with the Precisive Gas Analyzer configured with the Pressure Differential Method. Note that all the components outside of the analyzer are integrated by the user or a system integrator. All steps in the zeroing process, including pressure switching, purging and spectra collection, can be easily automated and triggered by a single command through the instrument's standard Modbus interface. Typical solutions contain all the necessary hardware and firmware components to enable the automated zeroing process without the need for operator intervention. The sample return to a low-pressure process is also handled by the customer or system integrator.

CONCLUSION

MKS' Precisive Gas Analyzer for hydrocarbon measurement, when equipped with the patented MKS Pressure Differential Method, allows for industry standard grade analysis of hydrocarbon gas streams without the need for high pressure cylinders of "zero" gas and without any greenhouse gas emissions.

As the analyzer does not require zero gas cylinders for routine operation, it significantly reduces operating expenses and handling. The sample gas used in the measurement is returned to the process stream (albeit at a lower pressure), which means the instrument does not introduce any GHG emissions.

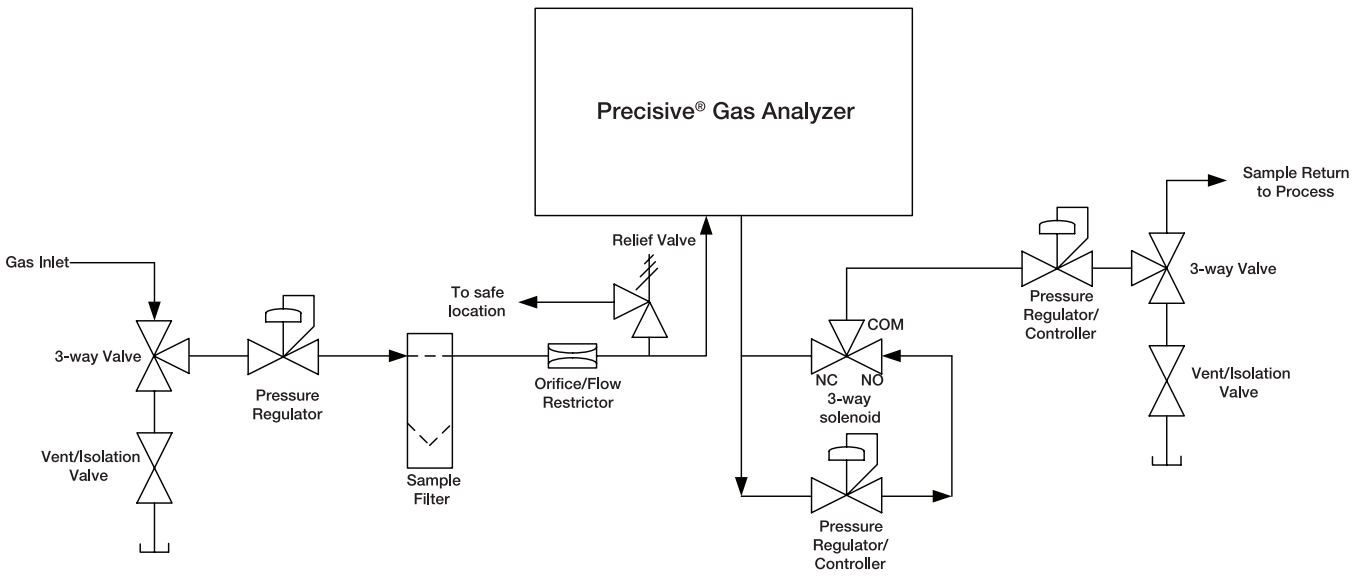

Figure 4. Example of schematic showing gas handling and control components that can be used with the Precisive® analyzer for no emissions measurements.

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TECH NOTE - Pressure Differential Method_01/23