CO_2 Determination of Natural Gas Streams

Class # 5340.1
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Introduction

Carbon Dioxide is measured in Natural Gas for two reasons. First and most often it is measured for energy determination (BTU/CV) by gas chromatography. And the second reason CO_2 is determined is for pipeline integrity. The measured data is transmitted in various ways for records keeping as well as operational input.

CO_2 measurement for energy determination is typically made by gas chromatography. Gas Chromatography is employed in two ways - on line gas chromatography which is used primarily for custody measurement in larger meter stations or by laboratory measurement of composite samplers.

CO_2 determination is useful or even required as upstream and downstream companies attempt to manage their operations more effectively. Priorities vary among these companies as well as budgets. Therefore each method may be justified by specific operation needs to be discussed later.

Analysis Methods

- On line Gas Chromatography – a method that physically separates the primary components in a sample to calculate physical properties calculations. The properties include energy, relative density, compressibility, hydrocarbon dew point and wobbe index. This method provides the user with data used not only to report the properties mentioned above but also to make flow measurement more precise.
- Composite Samplers – this measurement is only made monthly or on other long-term basis and is used to report average values for historic use. In some cases the data may be used in Flow Computers or SCADA to calculate energy data for lower volume flowing energy.
- On Line analysis – such methods are made by analyzers that focus a laser or other light source to emit laser light at a specific wave length to determine the CO_2 concentration

Among the analysis methods above, measurement standards presently exist for gas chromatography and are examined and revised in national and international committee review. However, for on-line analysis only seldom is any interest found for discussion. Therefore most users of on-line analysis in natural gas use the same methods for sample extraction and sample handling. In most cases this is transparent, but for some operations needs such as tariff limit shut down service a keen eye to detail is advisable.

Technological discussion

Gas Chromatography is the most common analysis method found in on-line use in the natural gas measurement. It is common and well-known technology that has seen many improvements lately. In general, analysis methods vary with each manufacturer and users debate themselves upon such factors as cycle time, measurement quality and reliability. CO_2 measurement is no more or less important than the other dozen or so components in the list of components that are measured by a chromatograph. In some cases CO_2 determination by a GC can skew the energy measurement because to be linear, a GC must entirely separate the CO_2 from the methane. In some cases its linearity is sacrificed in longer cycle time applications as a sacrifice to cycle time. But in any case, if cycle time is an issue, no GC is a match for laser spectroscopic determination of CO2 aboard an online analyzer.

Tunable Diode Lasers (TDL) are in wide use for moisture measurement in Natural gas and their use is now emergent for CO_2 and H_2S.
Although relatively new to the natural gas industry, tunable diode laser spectroscopy has been used in other applications for many years. TDL spectroscopy was developed at the Jet Propulsion Laboratory in Pasadena, CA over twenty years ago. These systems have been used routinely on research aircraft and high altitude balloons since 1982 to measure moisture in planetary atmospheres. Recently, their development has undergone several extensions that allow it to measure moisture, carbon dioxide and hydrogen sulfide in natural gas pipelines. The rugged nature of these sensors has allowed them to be used in stack emissions and combustion applications, petrochemical refinery applications as well as remote gas pipelines. Over the past decade, this technology has demonstrated its reliability in thousands of installations worldwide (Figure 1).

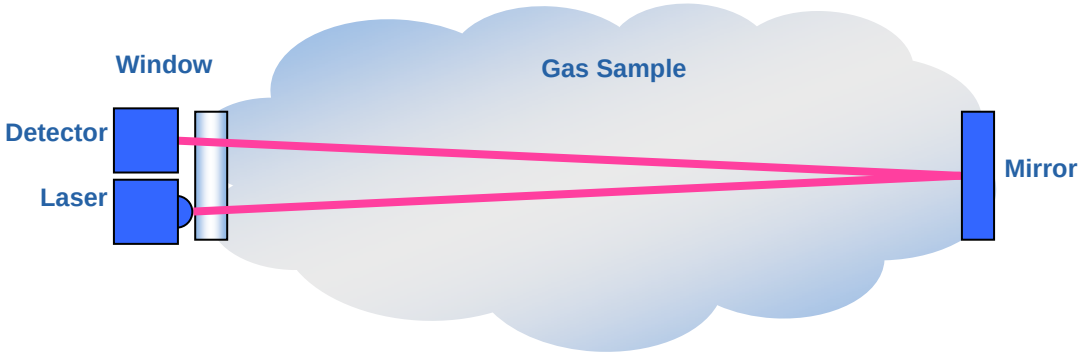

Figure 1; Laser Cell theory

Theory of Operation

Infrared absorption spectroscopy is used to detect the presence of various gases. Each type of gas molecule has characteristic wavelength bands where it absorbs infrared light. The typical non-dispersive infrared instruments use broadband light sources and band pass filters to produce a beam of light with a range of wavelengths that corresponds to the absorption band of the molecule it is trying to detect. The sources are known to drift and become unstable. Such drift can mean less than reliable measurement.

Tunable diode lasers rely upon temperature control along with controlled electrical current to emit laser light that excites the component. Absorbance of the laser light in its specific wave length is in direct proportion to the concentration of a component. The absorbance at a given wave length allows both moisture and CO2 or H2S to be measured on the same analyzer. (Figure 1)

Figure 2; Twin laser cells for measurement of CO2 and Moisture on a single unit

Applications for On-Line CO_2 analyzers

CO2 analyzers are used in natural Gas production, gas processing, gas blending, natural gas transmission, natural gas distribution and by certain industrial users. Facilities in any or all of these may have different needs and requirements. And TDL is a method in wide use.

- Gas Producers use TDL to blend gas from low and high CO2 wells for better quality and to monitor acid gasses (CO_2 and H_2S)
- LNG: On line TDL are used for very low concentrations of CO_2 and H_2O in pre-liquefaction feed for the liquefaction of natural gas.
- Natural gas processing and blending use on-line CO_2 analyzers for tariff control.
- Natural Gas Transmission companies use CO_2 analyzers for three reasons – to monitor and control risk from CO_2, H_2O, and H_2S, to monitor and reference the measurement of gas chromatographs.
- Natural Gas Distribution or their industrial users use the CO_2 analyzers to monitor the gas for quality. Pilot lights can be extinguished by high CO_2.

Advantages of Gas Chromatography

- Gas chromatographs can provide detailed composition for better measurement of flowing energy
- Gas Chromatographs are common technology in Natural Gas Market

Advantages of TDL analysis

- Briefest cycle times for such analyses are about 3 minutes in term. On line TDL can measure and update CO_2 as often as 4 times per second.
- TDL can combine H_2S and/or moisture to provide a set of measurements that effect corrosion.
- TDL analyzers do not use carrier gas or other utilities to make a measurement.

Conclusion: On Line CO_2 determination can be made by either GC or by TDL. If speed of response is an issue or if consumables such as Helium carrier gas are a difficult factor, users choose TDL. If a detailed list of components is a necessity users may choose a GC. Some users use both and find the on-line comparison of CO2 a handy validation for each.