BTU DETERMINATION OF NATURAL GAS USING A PORTABLE CHROMATOGRAPH

Class # 5030.1

Burt Reed
Business Development- Btu Products
ABB Totalflow
3700 W. Sam Houston Parkway
Houston, Texas USA

Introduction

The analysis of natural gas by using a gas chromatograph has become the one of the most important components in gas measurement in today's energy industry.

On line Chromatographs:

Gas chromatographs have become rugged, field ready devices that work in a variety of conditions and climates. On line chromatographs reside at the sample location in many instances and perform their analysis on a real time basis in many changing weather conditions. It is these changes in the weather, particularly low temperature conditions that have changed the shape and functionality of the modern gas chromatograph. Smaller footprint gc's allow them to be placed very near the sample point so that long tubing runs in the low temperature environments are eliminated. They also provide near real time analysis and other gas quality information to be used in gas control and accounting systems.

Portable Chromatographs:

Sometimes it is not economically feasible to have a dedicated on line gas chromatograph at all the sample locations in a system. One very viable solution is to use a portable gas chromatograph which is transported to the site with the analysis being performed at the location. This capability provides all the advantages of real time analysis along with protection from the temperature conditions that may cause analysis problems.

Gas Chromatograph Operations:

A modern real time, on line gas chromatograph takes a sample from a flowing gas stream and breaks down the components of the gas to provide a heating value (Btu) and other valuable properties such as density, specific gravity and compressibility. The gas sample is moved through the chromatograph by means of a carrier gas, typically helium. The sample moves through a series of stainless steel partitioning columns which contain earthen particulars surrounded by a liquid phase that separates the gas into its various component gases by their molecular weight and boiling point. These individual component gases are then sent over a detector which measures the amount of each gas component in the mixture. Each of the components of the gas sample have their own heating value. The heating values of all the components are multiplied by their mole percent and then added together to provide an overall heating value for the sample being analyzed.

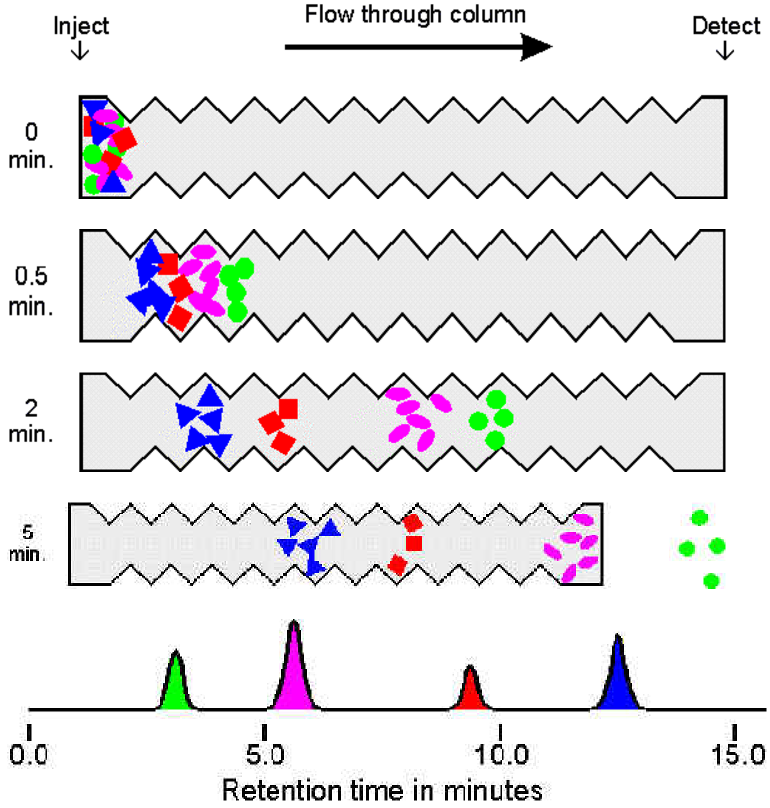


Fig. 1-Gas separation through column

Here is a typical natural gas sample mixture and the range of the measurable percentage:

- Air (.01 to 100%)
- Methane (.01 to 100%)
- Carbon Dioxide (.01 to 100%)
- Ethane (.01 to 50%)
- Propane (.005 to 100%)
- Isobutane (.005 to 15%)
- Normal Butane (.005 to 15%)
- Neo Pentane (.005 to 10%)
- Isopentane (.005 to 10%)
- Normal Pentane (.005 to 10%)
- Hexane + (.005 to 5%)

The "quality" information derived from the gas analysis is then combined with the volume or "quantity" value of the gas to come up with an overall energy measurement. Most custody transfer agreements are done on the amount of energy that is delivered or purchased. It is for that reason that the quality of the gas is such an important component in today's natural gas industry.

Energy calculation formula:
Mcf (gas quantity) X Btu/cf (gas quality) = MBtu
MBtu/1000 = MMBtu or dekaTherm (Energy)

Chromatogram:

One of the most important outputs of a modern on line gas chromatograph is the chromatogram itself. This is a graphical depiction of the different peaks that are caused by the various gas components as they move over the detector. (Figures 2a and 2b). The modern gas chromatograph uses the area under the peak and the height of the peak in the chromatogram to determine the exact amount of each gas component to use in the calculation. The graphical chromatogram is also very useful in troubleshooting potential problems with the analyzer. If the peaks shift from their normal location on the timeline it could be an indication of a problem with the separation columns or other components of the analyzer.

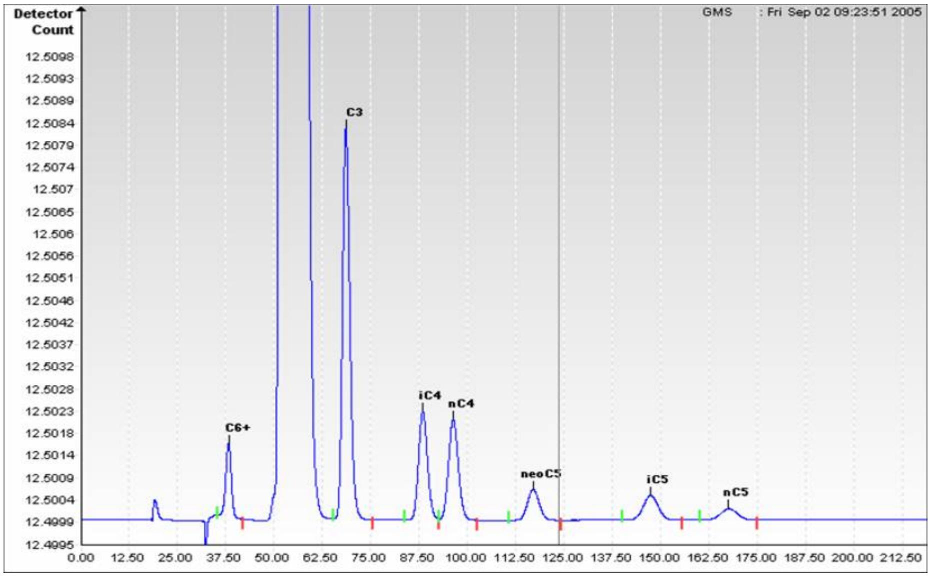


Fig. 2a C6+ Chromatogram 1

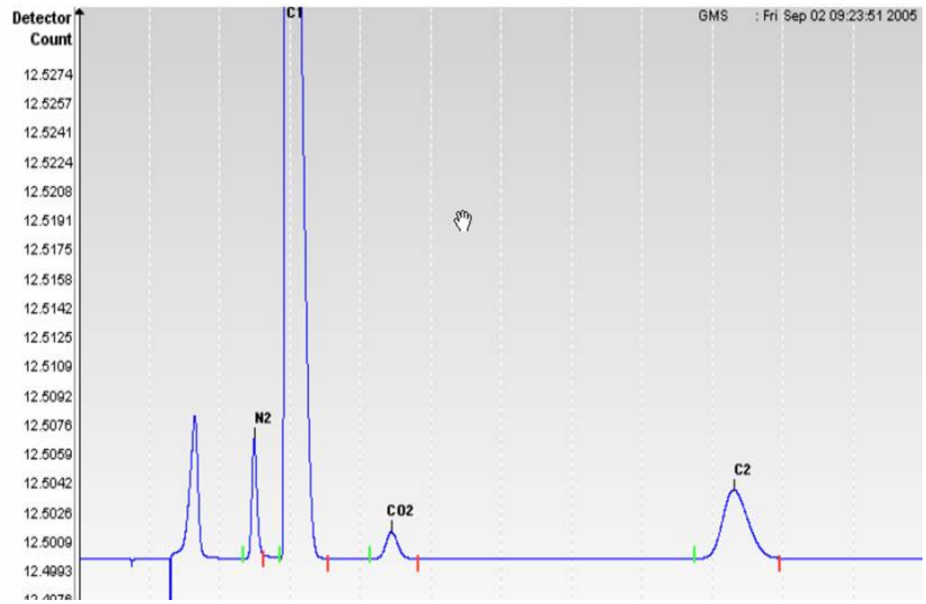


Fig. 2b C6+ Chromatogram 2

Portable Operation Considerations:

It is important to keep in mind that a portable gas chromatograph must function in the same way as a static GC would function in the field. Care must be taken to insure that the sample being analyzed is a clean, dry representation of the gas in the pipeline. The portable unit itself will be inside a vehicle most of the time is being used, but not always. The device must obviously be rugged enough to withstand the rigors of riding over rough terrain in a work vehicle and still remain a sensitive, accurate analyzer. (Fig. 3A)

Fig. 3A-Chandler Eng. Gas Chromatograph in Jeep

The portable GC may also have some additional hardware not usually part of a standard on line unit. Items like external rotometers for flow indication and external communication ports such as USB and Ethernet (Fig 3B). In addition there should be external connections for both calibration gas, carrier gas and sample streams. The portable unit must have a sample conditioning module in the system to protect the gas chromatograph from liquids and/or particulates in the gas stream from entering the unit (Fig. 4). To insure that the tubing is not subjected to temperatures below the hydrocarbon dew point of the sample gas, it must be either heat traced or insulated some way. Since the chromatograph is a 12 volt DC powered system the vehicle system could power the unit while it was in transit to the sample locations. Calibration of the portable unit can be done either at site with a calibration blend in the vehicle or at the technician's office with a calibration blend that is housed permanently in that location. It will be necessary to use different calibration gas blends to cover the ranges of the different component concentrations that will be encountered in the field.

Fig. 3B Front view-portable gas chromatograph

Fig. 4 Side View-portable GC with sample conditioning.

Software Considerations:

Portable chromatographs should have the ability to differentiate among the many different locations they will visit during a normal work cycle. The interface software (Fig. 5) must be able to provide a clear record of which location was visited and any special information that applies to that location.
Because each site visit will generate a separate database of information the software for a portable GC must support those individual data files.

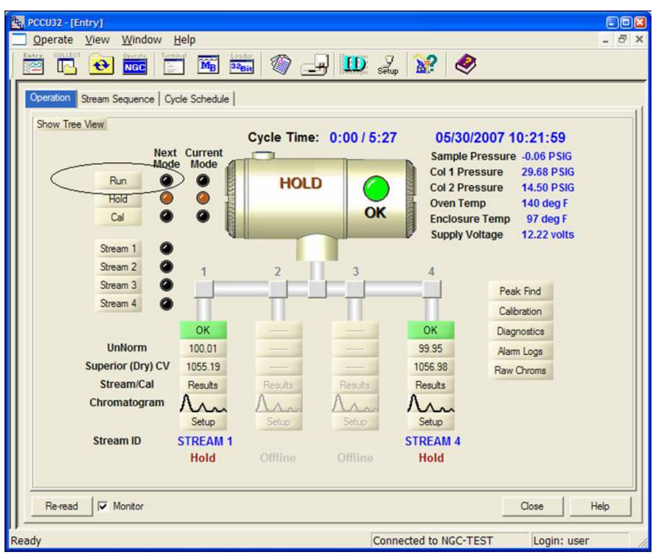


Fig. 5 Specialized Entry Screen for Portable gas chromatograph

The system setup for a portable GC might include stream connection, sample type, report header information and temperature/pressure input units (Fig 6). It might also include a format setup up for downstream data management programs as well as file identification.

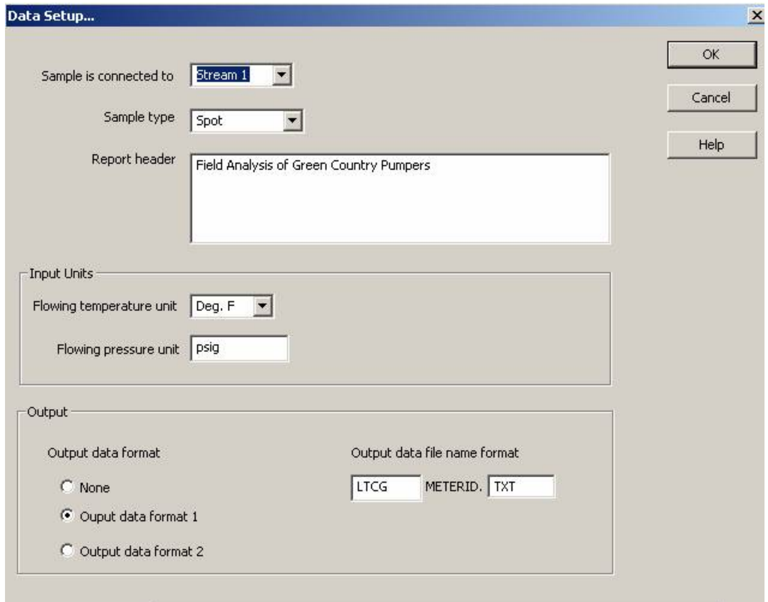


Fig. 6 Portable System Setup Screen

The sample information screen (Fig 7) is important for providing exact location and sample condition data for use in gas quality calculations. Meter ID and geographical location into along with pressure and temperature of the gas flow stream for maintaining audit history of the sample analyzed. In addition, the sample information could include input for components not measured by the analyzer, such as H2O and H2S.

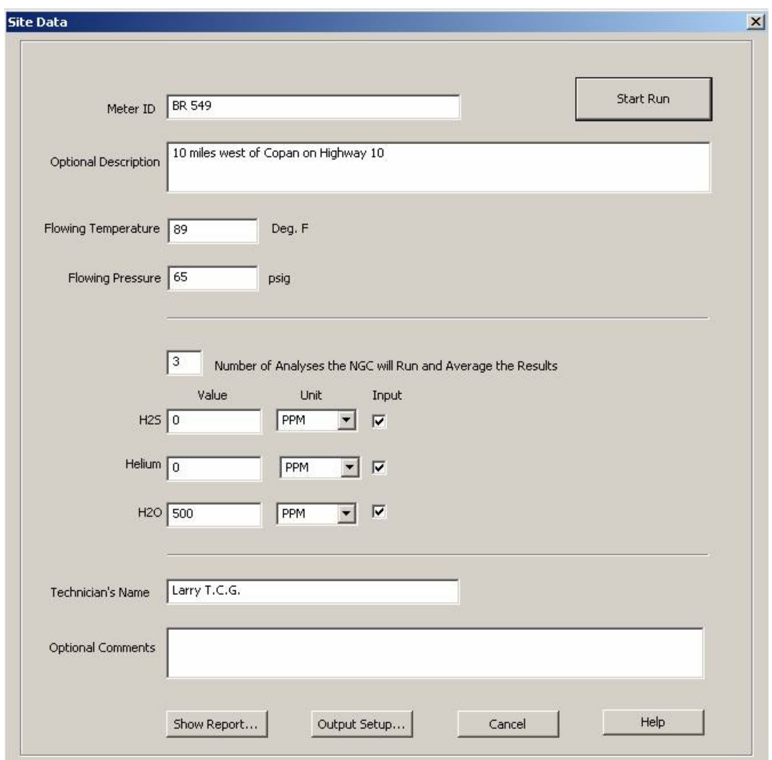
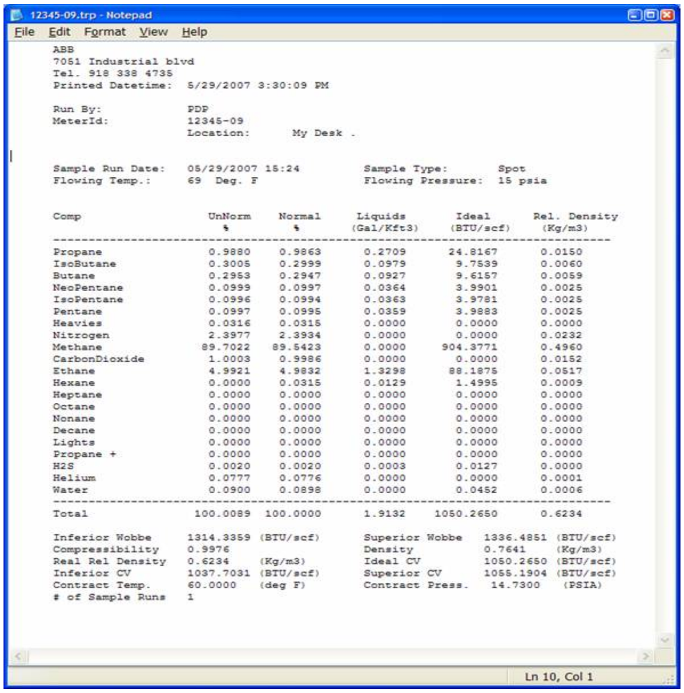


Fig. 7 Sample information Screen

Portable GC Report:

Obviously one of the most important products of a portable GC will be the analysis report that it generates. This document can be viewed in hardcopy or sent through telemetry to downstream departments such as gas control or accounting for incorporation into their systems. The report should present the overall heating value of the sample along with density, compressibility and required variables. It should identify the sample location and time of analysis as well as any other pertinent items.



12345-09.trp - Notepad

ABB
7051 Industrial blvd
Tel. 918 338 4735
Printed Datetime: 5/29/2007 3:30:09 PM

Run By: PDP
MeterId: 12345-09
Location: My Desk .

Sample Run Date: 05/29/2007 15:24 Sample Type: Spot
Flowing Temp.: 69 Deg. F Flowing Pressure: 15 psia

Comp	UnNorm %	Normal %	Liquids (Gal/Kft3)	Ideal (BTU/scf)	Rel. Density (Kg/m3)
Propane	0.9880	0.9863	0.2709	24.8167	0.0150
IsoButane	0.3005	0.2999	0.0979	9.7539	0.0060
Butane	0.2953	0.2947	0.0927	9.6157	0.0059
NeoPentane	0.0999	0.0997	0.0364	3.9901	0.0025
IsoPentane	0.0996	0.0994	0.0363	3.9781	0.0025
Pentane	0.0997	0.0995	0.0359	3.9883	0.0025
Heavies	0.0316	0.0315	0.0000	0.0000	0.0000
Nitrogen	2.3977	2.3934	0.0000	0.0000	0.0232
Methane	89.7022	89.5423	0.0000	904.3771	0.4960
CarbonDioxide	1.0003	0.9986	0.0000	0.0000	0.0152
Ethane	4.9921	4.9832	1.3298	88.1875	0.0517
Hexane	0.0000	0.0315	0.0129	1.4995	0.0009
Heptane	0.0000	0.0000	0.0000	0.0000	0.0000
Octane	0.0000	0.0000	0.0000	0.0000	0.0000
Nonane	0.0000	0.0000	0.0000	0.0000	0.0000
Decane	0.0000	0.0000	0.0000	0.0000	0.0000
Lights	0.0000	0.0000	0.0000	0.0000	0.0000
Propane +	0.0000	0.0000	0.0000	0.0000	0.0000
H2S	0.0020	0.0020	0.0003	0.0127	0.0000
Helium	0.0777	0.0776	0.0000	0.0000	0.0001
Water	0.0900	0.0898	0.0000	0.0452	0.0006
Total	100.0089	100.0000	1.9132	1050.2650	0.6234

Inferior Wobbe	1314.3359	(BTU/scf)	Superior Wobbe	1336.4851	(BTU/scf)
Compressibility	0.9976		Density	0.7641	(Kg/m3)
Real Rel Density	0.6234	(Kg/m3)	Ideal CV	1050.2650	(BTU/scf)
Inferior CV	1037.7031	(BTU/scf)	Superior CV	1055.1904	(BTU/scf)
Contract Temp.	60.0000	(deg F)	Contract Press.	14.7300	(PSIA)
# of Sample Runs	1				

Ln 10, Col 1

Fig. 8 Portable GC Analysis Report

Summary:

The on line gas chromatograph has become on of the most important components in a gas measurement system in today's energy business. A portable GC that can bring the functions of an on line GC to many remote locations is very valuable asset by providing real time, accurate gas quality information for use throughout a company's gas control and accounting systems.