

An Agilent Process Micro GC Used For the Analysis of Propane and Butane Product Gas Streams (LPG)

Application Note

Micro Gas Chromatography, Petrochemical Analysis, Hydrocarbon Analysis

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Abstract

This application note describes the use of an Agilent 490-PRO Micro GC for the analysis of liquefied propane and butane (LPG) streams for plant quality control and plant processing. The 490-PRO Micro GC features on-board data handling and results calculation. Final results were distributed to the process control system in an unattended manner using industry standard protocols.

A Micro GC with a single analytical column channel and the same method parameters were used for alternating analysis of the two streams. All compounds of interest (ethane, propane, butanes, and pentanes) were analyzed in 60 seconds. This resulted in a near real-time data transfer to the plant process control system for faster trend analysis and, thus, better informed decision making.



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Introduction

Liquefied propane and butane stream (liquefied petroleum gas, LPG) is a mixture of hydrocarbons. It is used as a fuel for vehicles (gasoline alternative) and heating systems, or as a more environmental friendly replacement for chlorofluorohydrocarbons in aerosol propellant and refrigerant gases. A variety of LPG's are known. The composition consists mainly of propane and butane, but various other hydrocarbons such as ethane and pentane are usually present in low concentrations.

Based in Calgary, Canada, QC LAB Inc. has been demonstrating the effectiveness of the Agilent Micro GC instrumentation and their services to the gas processing industry in Canada for over 20 years. A process micro gas chromatograph from Agilent was installed at a propane and butane products producing facility for on-line plant control. Improved product pricing was achieved by delivering specified propane and butane products as opposed to delivering a liquefied petroleum product containing a mixture of both propane and butane.

Instrument setup and sample information

The Agilent 490 Micro GC is designed for fast and accurate analysis of a wide range of gas samples, and can hold up to four independently controlled chromatographic channels. Each channel is a complete miniaturized gas chromatograph and includes a microelectromechanical-based (MEMS) injector, a thermal conductivity detector, and narrow-bore analytical columns.

Additionally, the instrument portfolio includes a process GC, the 490-PRO Micro GC. This instrument features on-board data collection, peak integration, result calculation and generation. Designed to be a system component, the 490-PRO Micro GC does not require a connection with a chromatography data system to generate data and results. To program the method parameters on the 490-PRO Micro GC, use the powerful PROstation set-up tool. During day-to-day use, the PROstation is disconnected and user defined analysis results and information are passed to an external system in an unattended manner using industry standard protocol, such as 4-20mA or ModBus.

The QC LAB set up the 490-PRO Micro GC to provide propane and butane analysis in 60 seconds, with results directly delivered to the plant process control systems to adjust plant processes. The system is equipped with a single analytical channel, containing an 8-m CP-Sil 5 column. Table 1 provides an overview of the instrument settings. This single column

setup provides baseline separation for all components of interest, while using a minimum of helium carrier gas. One bottle of helium lasts for more than 3 years since the system uses just a few mL/min.

The on-line chromatograph is equipped with an automatic multiple stream selection system allowing selection between the two product streams and a calibration gas standard. As a result, the propane and butane product stream can be analyzed intermittently. Moreover, this sample introduction setup make it possible to perform periodic, automated verifications, or calibrations.

Table 1. Agilent 490-PRO Micro GC Instrument Settings

	CP-Sil 5 CB, 8 m
Column temperature	60 °C
Carrier gas	helium, 20 psi (~ 138 kPa)
Injection time	40 ms
Sampling time	30 s
Analysis run time	60 s

Results and Discussion

A single method for two sample streams

The same column channel, instrument settings, and peak integration settings are used to analyze both samples streams. Figure 1 shows a chromatogram for the propane product. This stream mainly consists of propane and some, ethane, *i*- and *n*-butane. The butane stream consists of mostly *i*-butane and *n*-butane, with low levels of the other C2-C5 saturated hydrocarbons. Figure 2 shows a chromatogram of this sample.

With micro gas chromatography, very fast analysis times are achieved. This application note is a very good example of that. All compounds of interest were separated in just 60 seconds. The benefits of fast and on-line analysis were near real-time product composition transfer to the plant process control system. This made faster trend analysis and instant process optimization possible. Some examples of trend plotting are given in Figures 3 and 4. Notification of out-of-specification products in an early stage results in better informed decision making. Plant processes can be quickly adjusted to return to specification product.

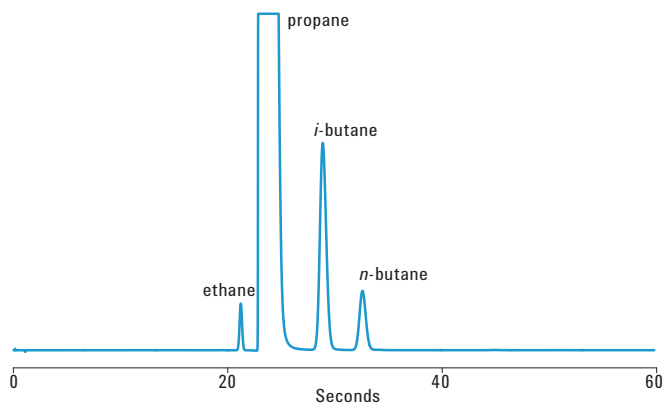


Figure 1. Chromatogram for the propane product on the 8-m CP-Sil 5 CB column channel.

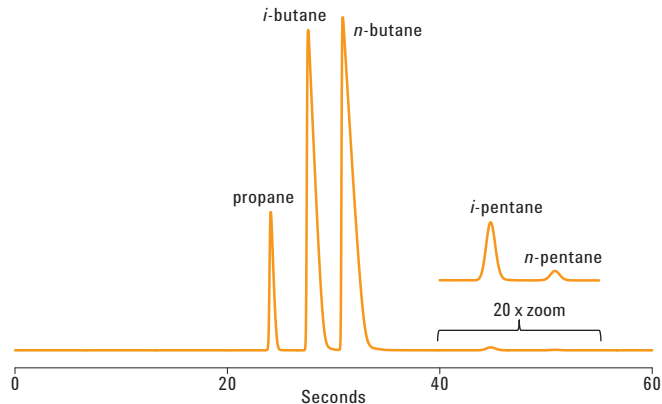


Figure 2. Chromatogram for the butane product on the 8-m CP-Sil 5 CB column channel.

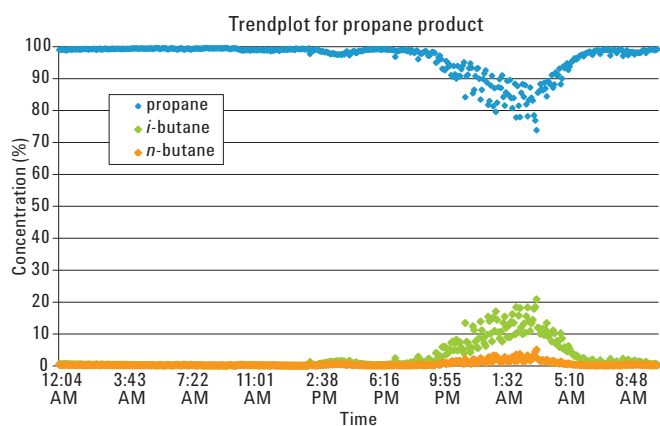


Figure 3. Result trend plotting for propane product stream.

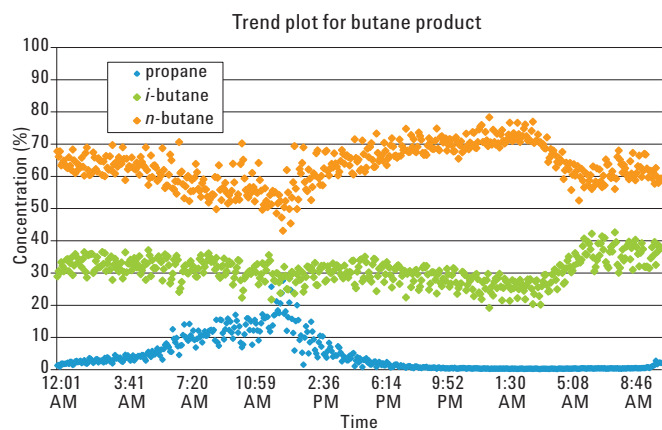


Figure 4. Result trend plotting for butane product stream.

Precise and reliable results, day after day

This system was installed in 2007. Table 2 shows the calculated values for the (calibration) verification obtained in 2009 and 2012 using the calibration curves analyzed during installation in 2007. These results show only minimal deviation from the initial calibrated values. This demonstrates the stable long term performance of the MEMS-based technology.

Precision was recalculated in 2012 using the standard deviation over 10 calibration runs; these numbers are also shown in Table 2. Exceptionally good precision is still observed after 5 years of 24/7 operation. In that period, no maintenance was required and over 1 million (1,160,710) samples were analyzed. This corresponds to over 650 samples per day.

Other than the column carrier gas, the micro thermal conductivity detector does not require the use of gases, such as burner gas or make-up gas, to operate. Additionally, a micro gas chromatograph consumes less carrier gas than a regular gas chromatograph by a factor of ten to twenty. Typical helium use for a single column channel 490-PRO Micro GC is 1–5 mL/min.

Table 2. Overview of the Method Performance Characteristics

	Calibration 2007 (%)	Verification 2009 (%)	Verification 2012 (%)	Precision 2012 (%)
methane	0.985	0.977	1.011	0.00051
ethane	4.800	4.806	4.833	0.00028
propane	89.780	89.794	89.806	0.00153
<i>i</i> -butane	2.140	2.131	2.129	0.00088
<i>n</i> -butane	1.260	1.270	1.241	0.00135
<i>i</i> -pentane	0.521	0.516	0.498	0.00005
<i>n</i> -pentane	0.514	0.507	0.483	0.00006

Conclusion

This application note clearly shows that the Agilent 490-PRO Micro GC, equipped with an 8-m CP-Sil 5 CB column, is capable of analyzing propane and butane streams (LPG) in a process environment. The single channel setup and low carrier gas consumption of the 490-PRO Micro GC also keeps your investment and operating costs to a minimum.

This 490-PRO Micro GC system has been in operation since 2007, maintaining good accuracy and performance, while completing, in total, over 1 million injections in 5 years of operation.

Due to the MEMS-based injector and detector, in combination with short and narrow-bore analytical columns, very fast analysis times were achieved. This application note accomplishes baseline separation and detection of all compounds of interest in just 1 minute. Fast availability of sample composition results in more accurate trend display, better informed decision making, and faster process control.

With the 490-PRO Micro GC, Agilent brings a lab quality analysis to an on-line/at-line application. Built-in on-board data handling and result generation takes over the complete operation of the instrument. It does not require a local operator and runs standalone. All required results and information are automatically passed to external systems using industry standard protocol for optimal process control.

For More Information

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www.agilent.com/chem/microgc

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Printed in the USA
March 11, 2013
5991-1972EN



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