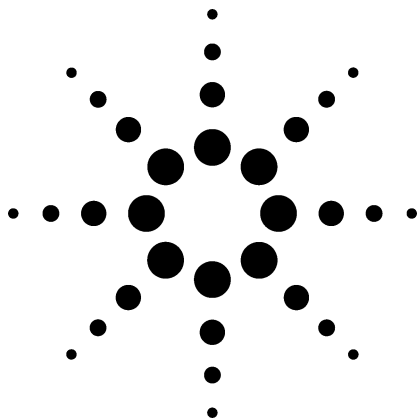


Complete Analysis of Refinery Gases in Seconds Using the Agilent 3000 Micro Gas Chromatograph

Application



Hydrocarbon Processing

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Fast and Reliable Hydrocarbon Analysis

The micro gas chromatograph (GC) refinery gas analyzer (RGA) performs a complete analysis of hydrogen, saturated and olefinic hydrocarbons (C_1 - C_5 , and C_6+ grouped peaks), plus fixed gases (O_2 , N_2 , CO , and CO_2) in less than 160 seconds.

With a single GC, you can now analyze complex samples in seconds, providing faster feedback to your plant and process engineers. The Agilent RGA offers tremendous precision and a simple, cost-effective means to meet the demanding analytical reporting needs of your laboratory and staff.

The System

Refinery gas samples are introduced and separated on four independent GC modules simultaneously. Each GC module houses a silicon micro injector, a temperature-controlled capillary column, and a micro thermal conductivity detector (TCD). The column's stationary phase is different in each module, providing the complete analysis of a wide range of refinery-type gases.

The system incorporates precolumn backflush-to-vent capability to ensure long-term column performance and to reduce cycle times on several of the columns. The backflush feature is simple to use and, using the factory-established chromatographic method, requires little input from the operator.

The Agilent sample conditioning system and Cerity chromatography software package provide a simple and complete solution to analytical needs.

The Analysis

Refinery gas samples are delivered to the sample inlet of the GC after passing through a sample conditioning system, which selectively removes any liquid fractions and particulate matter from the sample. This ensures that only gas phase sample is delivered to the RGA. An internal vacuum pump draws this conditioned sample into each module's micro injector, which then injects the mixture onto each of the capillary columns for analysis (Figure 1). Precolumn backflush-to-vent ensures column longevity and shortens cycle times. Agilent Technologies' Cerity data system displays chromatograms for all four channels simultaneously and automatically generates a report including the concentration of each component normalized to 100% and the calculated heating value (Table 1). Data can be easily exported to spreadsheet applications.



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Peak Identification

1. Hydrogen
2. Oxygen
3. Nitrogen
4. Methane
5. Carbon monoxide
6. Carbon dioxide
7. Ethylene
8. Ethane
9. Acetylene
10. Propane
11. Propylene
12. 1,2-Propadiene
13. Propyne
14. iso-Butane
15. n-Butane
16. *trans*-2-Butene
17. 1-Butene
18. iso-Butene
19. *cis*-2-Butene
20. iso-Pentane
21. n-Pentane
22. 1,3-Butadiene
23. Methyl acetylene
24. 3-methyl-2-Butene
25. *trans*-2-Pentene
26. 1-Pentene
27. *cis*-2-Pentene
28. n-Hexane

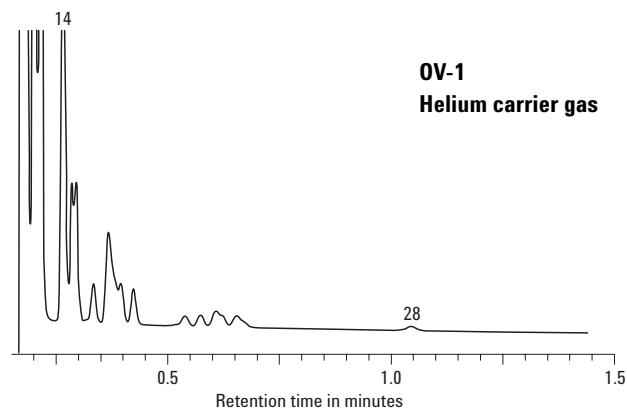
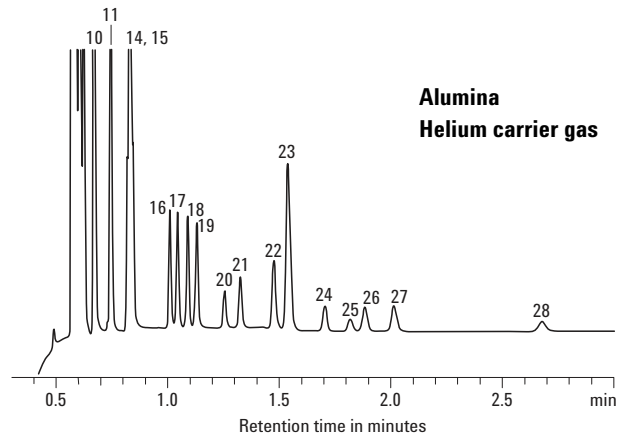
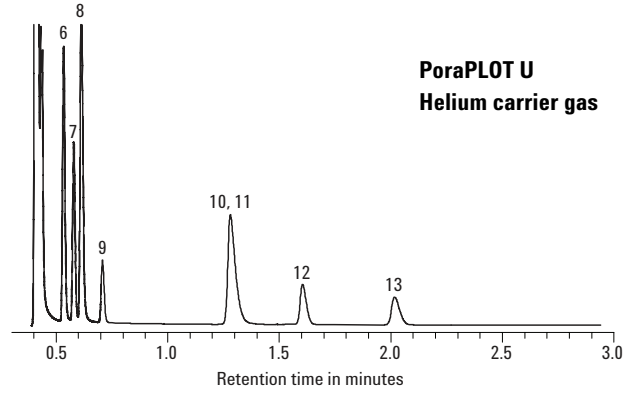
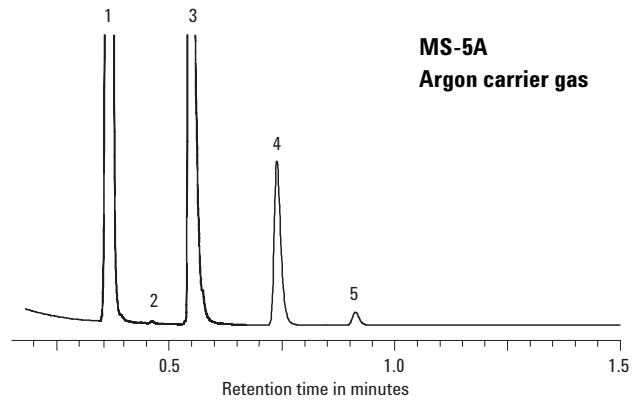


Figure 1. A complete analysis of refinery gas in less than 3 minutes.

160-Second Analysis

There is no longer a 20 to 30 minute wait for refinery gas analysis results. Instead, get results in 160 seconds.

A detailed hydrocarbon analysis is complete in less than 3 minutes, with a 3-minute cycle time between successive analyses. Analysis of more than 150 samples in one 8-hour day or greater than 450 samples every 24 hours is possible.

The RGA provides greater sample throughput, faster analytical feedback, improved laboratory productivity, and efficiency.

Precision

The Agilent RGA provides the precision inherent in its solid-state micro GCs (Table 2). System calibration and maintenance are simplified and analytical precision is improved over conventional systems by using the same style of injector and detector and simultaneously performing an analysis on all four GC modules. Requiring only a single-point calibration of the detector (by virtue of the micro TCD's linear dynamic range of 10 ppm to 100 percent for most analytes), the RGA is ideal for the diverse composition and concentration of samples often encountered in refinery gas applications. The system has a repeatability of 0.5 percent relative standard deviation and a linear detector response of ± 5 percent over five orders of magnitude.

Agilent Technologies uses high resolution capillary columns, offering excellent resolutions of all analyte species at higher concentrations and, with the use of a very sensitive TCD, the system also offers a minimum detectable

quantity of about 10 ppm for most refinery gases. This allows detection of impurities and low-level components in the refinery processes that are not detectable with conventional refinery gas systems. This enables plant engineers to more accurately control the efficiency of refinery processes and thus the quality of the refinery's products.

Easy to Use

The RGA is easy to operate. Simply begin with the chromatographic method stored in the data system; calibrate the instrument; and analyze the samples. The Agilent data system generates a normalized report detailing the refinery gas sample composition. It is that simple.

Table 1 Agilent Refinery Gas Analyzer Report

Component Name	Norm. Mole %	Norm. Wt. %	Mole %	Area	RT (min)	Channel
n-Propane	91.75861	88.15170	91.27688	1127630.83510	0.35248	3
Ethane	0.05770	0.03780	0.05740	875.35141	0.44500	2
iso-Butane	0.04705	0.05958	0.04680	607.90309	0.49755	3
n-Butane	0.04015	0.05084	0.03994	527.11328	0.52007	3
trans-2-Butene	3.85355	4.71046	3.83332	55573.39535	0.64366	3
cis-2-Butene	0.13016	0.15910	0.12948	1592.99436	0.75911	3
n-Pentane	2.91611	4.58380	2.90080	53783.56228	0.89670	3
3-Methylpentane	0.02597	0.04876	0.02583	1224.25302	0.93582	4
n-Hexane	1.17070	2.19797	1.16455	58152.34120	1.00154	4
Totals	100.00000	100.00000	99.47501	1299967.74910	----	----

Component Name	Gross Heat Contribution (BTU/ft ³)	Net Heat Contribution (BTU/ft ³)	Gross Heat Contribution (air corrected) (BTU/ft ³)	Net Heat Contribution (air corrected) (BTU/ft ³)
n-Propane	2308.73834	2124.12002	2308.73834	2124.12002
Ethane	1.02103	0.93397	1.02103	0.93397
iso-Butane	1.52995	1.41163	1.52995	1.41163
n-Butane	1.30973	1.20876	1.30973	1.20876
trans-2-Butene	118.22704	110.47369	118.22704	110.47369
cis-2-Butene	3.99874	3.73686	3.99874	3.73686
n-Pentane	116.90410	108.09744	116.90410	108.09744
3-Methylpentane	1.23371	1.14224	1.23371	1.14224
n-Hexane	55.67731	51.55527	55.67731	51.55527
Totals	2608.63995	2402.67987	2608.63995	2402.67987

Table 2 Excellent Retention Time and Quantitative Precision Over 50 Analyses of Refinery Gas

Component	Column	Mole%	Dev	%RSD
Methane	MS5A	4.980	0.0150	0.305
Carbon monoxide	MS5A	0.997	0.0020	0.238
Ethylene	UPL0T	1.988	0.0100	0.510
Ethane	UPL0T	4.005	0.0200	0.505
n-Propane	Alumina	2.034	0.0070	0.363
iso-Butane	OV-1	0.300	0.0007	0.246
trans-2-Butene	Alumina	0.288	0.0007	0.243
cis-2-Butene	Alumina	0.292	0.0008	0.296
iso-Pentane	Alumina	0.100	0.0004	0.423
n-Hexane	OV-1	0.048	0.0003	0.565

System Configuration and Application Options

The standard RGA configuration meets UOP Method 539-87 and ASTM D 1946 specifications. It can also address other applications related to petroleum refining. These include, but are not limited to, the following:

- Stack gas analysis (N_2 , O_2 , CO , CO_2 , H_2S , CH_4 , C_2H_6 , C_2H_4 , C_2H_2).
- Reductive flue gas analysis (H_2 , CO_2 , N_2O , H_2S , O_2 , N_2 , CH_4 , CO).
- Liquefied petroleum gas (LPG) using a sample vaporizer.
- Extended natural gas analysis with speciation of C_6+ components.
- Analysis of trace level impurities in ethylene and propylene production.

Summary

Agilent provides a family of gas chromatographic (GC) analyzers for both natural and refinery gas. These analyzers include all software, supplies, methods, and support to help to address specific measurement and technical business needs.

Whether selecting from one of our turnkey configurations or requiring a custom analyzer, Agilent will consult with you to define the solution that is right for you. For more information on refinery gas analyzers or other Agilent solutions visit our web site at: **www.agilent.com/chem**

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Printed in the USA
June 7, 2002
5988-6700EN

