Varian Refinery Gas Analyzers

A FAMILY OF OPTIMIZED GC ANALYSIS SOLUTIONS



The source and composition of refinery gases varies considerably. Measuring gas composition precisely and accurately is a significant challenge in today's refinery operations. Varian's refinery gas analyzers are designed to deliver superior, reliable results for a wide range of sources and analysis throughput requirements.

Key Benefits

- A complete range of refinery gas analysis (RGA) solutions. Varian offers three RGA solutions to meet the broadest range of stream sample types and throughput requirements.
- A powerful, easy to use GC solution. Varian's 450-GC or 490-GC Micro-GC, and Galaxie[™] Chromatography Software is a very powerful combination designed to achieve the best possible results. In addition, these systems do not require a high degree of operator.
- A highly flexible solution for analysis. All Varian's RGA solutions can be configured to analyze gas and pressurized liquids (LPG) through the use of a fully integrated Micro-Gasifier, giving the flexibility to accommodate a wide range of stream types.

- Operational procedures are fully documented. All Varian RGA analyzers not only incorporate proven GC hardware and software but also arrive pre-loaded with analysismethods, and included ocumentation specific to the application required.
- A comprehensive, single vendor solution. Varian provides complete solutions. The hardware, software, application optimization, documentation, installation and performance verification are all provided by Varian, offering an all inclusive, convenient analysis solution.

NOTICE: This document contains references to Varian. Please note that Varian, Inc. is now part of Agilent Technologies. For more information, go to www.agilent.com/chem.



Varian Solutions for Refinery Gas Analysis Typical sources for refinery gases include atmospheric or FCC overheads, ethylene, propylene production, fuel gas, stack gas and off gas from desulfurization. The physical stream types range from gas to highly pressurized gas or liquid. Varian's refinery gas analyzers (RGA) are 'turnkey' systems pre-configured and tuned at the factory to conformtoindustrystandardmethodsincluding:UOP539, DIN-51666 and ASTM D2163. The RGA systems are based either on the Varian 450-GC or 490-GC.

All analyzers employ a proven and optimized multichannel approach to determine the concentration of individual saturated and unsaturated hydrocarbon components up to and including C5 (C6 and higher components as a composite peak) and all permanent gases, including hydrogen and hydrogen sulfide in a single analysis. Included in every system is Varian's powerful Galaxie[™] Software to provide complete analyzer control, data acquisition and flexible report generation.



Figure 1. The 450-GC RGA has outstanding flexiblity, analytical power and robustness.

Varian offers three RGA systems to meet the widest range of analysis requirements:

Standard RGA: A three channel 450-GC with a multivalvedesignusingbothcapillaryandpackedcolumns. The first channel is optimized for the analysis of permanent gases, the second is designed for light hydrocarbons, and the third specifically for hydrogen. The system is configured and fully tested in accordance with industry standard methods. Total analysis time for all components is less than 25 minutes.



Figure 2. The separation of light hydrocarbons using the Standard RGA. (Please refer to Table 2 for peak identification)



Figure 3. Analysis of the permanent gases using a Rapid RGA. (Please refer to Table 2 for peak identification)

▶ *Rapid RGA:* A three channel 450-GC that utilizes a multi-valve design in which the packed columns used in the Standard RGA are replaced by micro-packed columns in both the hydrogen and permanent gas channels. Since the micro-packed columns are installed in a separate heated zone, the capillary columns located in the GC oven can be temperature programmed in a more aggressive manner. This provides a substantial reduction in overall analysis time from up to 25 minutes to 5 minutes (or 7 minutes with H₂S) for high sample analysis demand.

However, because micro-packed columns have reduced sample capacity, streams containing a high concentration of some components (e.g. propylene steam) may require some hardware tuning by Varian.



Figure 4. The analysis of light hydrocarbons using the Rapid RGA, with complete separation in less than five minutes. (Please refer to Table 2 for peak identification)





Figure 5. Picture 1 shows a 'traditional' RGA with all columns mounted in oven. Picture 2 shows the micro-packed columns mounted in the separate heated zone in the Rapid RGA.

Peak No.	Peak Name	Channel	RT (min.)	Result (g/l)	Norm. (%)	Area (uV/Sec.)
1	CO ₂	Front (TCD)	2.6000	0.1000	0.0632	13376
2	C_2H_4	Front (TCD)	2.9550	29.9800	18.9449	4139442
3	C_2H_6	Front (TCD)	3.5367	17.9900	11.3682	2867688
4	C_2H_2	Front (TCD)	5.0283	0.5020	0.3172	49786
5	02	Front (TCD)	9.9200	0.0000	0.0000	37325
6	N ₂	Front (TCD)	10.3267	1.1990	0.7577	2122071
7	CH ₄	Front (TCD)	11.1917	11.9900	7.5767	1394584
8	CO	Front (TCD)	0.0000	0.0000	0.0000	0
9	H ₂	Middle(TCD)	1.6967	36.0300	22.7681	390257
10	C5+	Rear (FID)	2.9217	0.1000	0.0632	58164
11	Methane	Rear (FID)	3.7350	11.9900	7.5767	1492388
12	Ethane	Rear (FID)	4.1283	17.9900	11.3682	4480322
13	Ethylene	Rear (FID)	4.7217	29.9800	18.9449	7411134
14	Propane	Rear (FID)	6.1933	0.1990	0.1258	71402
15	Propylene	Rear (FID)	0.0000	0.0000	0.0000	0
16	i-Butane	Rear (FID)	0.0000	0.0000	0.0000	0
17	n-Butane	Rear (FID)	0.0000	0.0000	0.0000	0
18	Propadiene	Rear (FID)	0.0000	0.0000	0.0000	0
19	Aceylene	Rear (FID)	0.0000	0.0000	0.0000	0
20	t-2-Butene	Rear (FID)	18.5050	0.0990	0.0626	138647
21	1-Butene	Rear (FID)	0.0000	0.0000	0.0000	0
22	i-Butene	Rear (FID)	19.5167	0.0990	0.0626	44492
23	cis-2-Butene	Rear (FID)	0.0000	0.0000	0.0000	0
24	1,3-Butadine	Rear (FID)	22.1367	0.0000	0.0000	16165
25	Methyl actylene	Rear (FID)	0.0000	0.0000	0.0000	0
	Totals			158.2480	100.0000	22817242

Table 1. Varian RGA Analyzer Characteristics.

Characteristics	Standard RGA	Rapid RGA	Micro-GC RGA
No. of Channels/Detectors Used	3	3	4
No. of Column Ovens	1	2	4
Analysis Time	25 min	5 min (7 min with H_2 S)	2.5 min
Repeatability	<1%	<1%	<1%
Linear Bench Space Required	66 cm/26 in.	66 cm/26 in.	15 cm/6 in.
Minimum Component Detection Level	0.01% all components except $H_2S = 0.05\%$	0.01% all components except $H_2S = 0.05\%$	0.01% all components except $H_2S = 0.05\%$
Suitability			
Typical Refinery Gas	Excellent	Excellent	Excellent
Impurities in Bulk Ethylene	Excellent	Excellent	Good
Impurities in Bulk Propylene	Excellent	Excellent	Not Recommended
Impurities in Bulk C4	Good	Good	Not Recommended

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Table 2. Multiple channels of data are conveniently combined into a single analysis report

Micro-GC RGA: A four channel, multi-dimensional system based on the 490-GC Micro-GC. The 490-GC incorporates a novelmicro-electricalmechanicalsystem(MEMS)basedinlet and detector with high performance capillary columns infour individual channels. Each channel is optimized for specific RGA analytes, yielding a total analysis cycle time of less than three minutes.

Due to the use of MEMS components in the Micro-GC, its sample capacity is reduced in comparison to the 450-GC based systems. Therefore, it is more suitable for sample streams with low sample component concentration.



Figure 6. The 490-GC Micro-GC RGA is extremely small at only 6 inches wide.

Channel 1 - Permanent gases





Figure 7. Refinery gas separations on the 490-GC Micro-GC.

Peak Identification

6

7 8 9 10 12

1	Hydrogen	14	n-Butane
2	Oxygen	15	Propadiene
3	Nitrogen	16	Acetylene
4	Carbon monoxide	17	trans-2-Butene
5	Carbon dioxide	18	1-Butene
6	Hydrogen sulfide	19	iso-Butene
7	Methane	20	cis-2-Butene
8	Ethane	21	iso-Pentane
9	Ethylene	22	n-Pentane
10	Propane	23	1,3-Butadiene
11	Cyclopropane	24	Propyne
12	Propylene	25	Butyne
13	iso-Butane	26	C6+ (e.g. n-Hexane)

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