SCION INSTRUMENTS

Natural Gas Analyzer

- A Family of optimized GC Solutions

Scion Natural Gas Analyzer

Natural gas is bought and sold as a bulk commodity with price based on its energy content. It is very important for all stakeholders in the natural gas supply and consumer chain to accurately determine the heating value of their streams. Scion offers a full range of GC based solutions for the analysis of natural gas. The analyzer family is designed to offer superior results through the use of industry proven hardware, software, optimized columns and consumables, and is backed by a team of global sales and support specialists.

Key Benefits include:

- A complete range of natural gas analysis (NGA) solutions. Scion offers many different NGA gas chromatography analyzers to meet the broadest range of stream sample types and throughput needs, whether the analysis is conducted in a laboratory, at-line or in the field.
- Easy to operate, powerful GC solutions. Scion's GC with compassCDS Chromatography Software, form a powerful combination and do not require a high degree of skill to be used successfully.
- Flexibility to analyze natural gas, liquified petroleum gas or natural gas liquids (NGL). Scion's GC based NGA analyzers can be configured to measure the composition of LPG or NGL streams through the use of specialized sample conditioners, ensuring sample integrity is constistently maintained.
- Operational procedures are fully documented. All Scion NGA analyzers not only incorporate proven GC hardware and software, but arrive with the pre-loaded analysis method(s) and documentation specific to the application.
- Comprehensive single-vendor solution. Scion is proud to provide complete solutions. The hardware, software, application optimization, documentation, installation and performance verification are all delivered by Scion.

Figure 1: The Scion GC based Natural Gas Analyzer.

Solutions for Natural Gas Analysis

Gas chromatography offers a proven means to determine the composition and heating value of natural gas and related streams quickly and cost effectively. Scion's natural gas analyzers (NGAs) are standard 'turnkey' systems pre-configured and tuned at the factory to ensure their compliance with standard methods used to determine the heating value of natural gases and related streams. They can also be specially configured to determine other components of interest (eg. sulfur compounds), to ensure suitability for use in downstream processes. The analyzers are based on the Scion GC gas chromatograph platforms and Scion's compassCDS Chromatography Software. All systems employ a proven and optimized multi-channel/multi-dimensional approach to determine the heating/calorific value of natural gas, as well as quantify individual components.
Scion offers several NGA systems to meet the widest range of analysis needs.

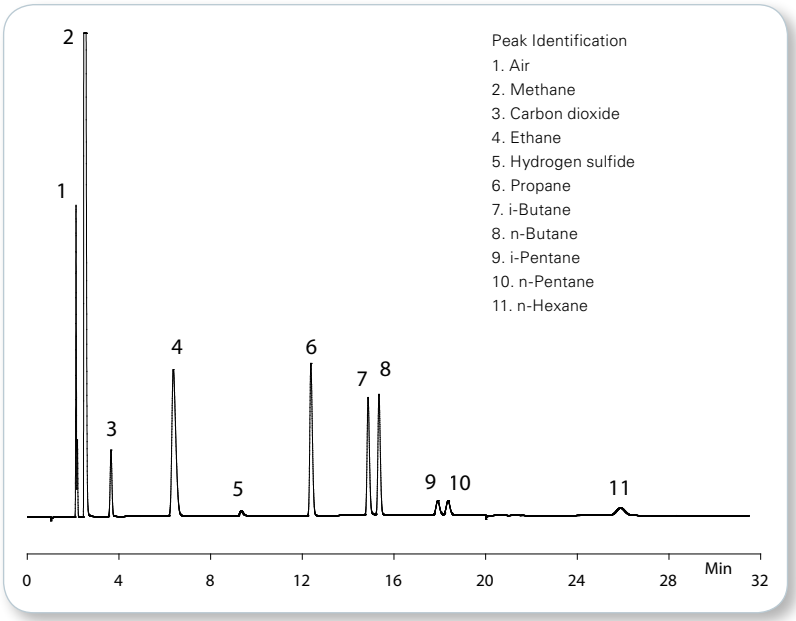


Figure 2: Chromatogram of natural gas sample from 'System A'. Up to 10 Min TCD signal, 10 to 31 Min FID signal.

Basic NGA (System A)

This is the simplest of all available natural gas analysis systems. As shown in Figure 3, the system employs a single valve column designed for simplicity, a Thermal Conductivity Detector (TCD) and Flame Ionization Detector (FID). The TCD is used for the determination of O_2, N_2, CH_4, CO_2 and Ethane, while the FID, connected in series, determines hydrocarbons in low concentrations, i.e. C3-C5 and C6+ back-flushed grouping peak (late back-flush). A single unheated 4 port Liquid Sampling Valve (LSV) is available for LPG type samples.

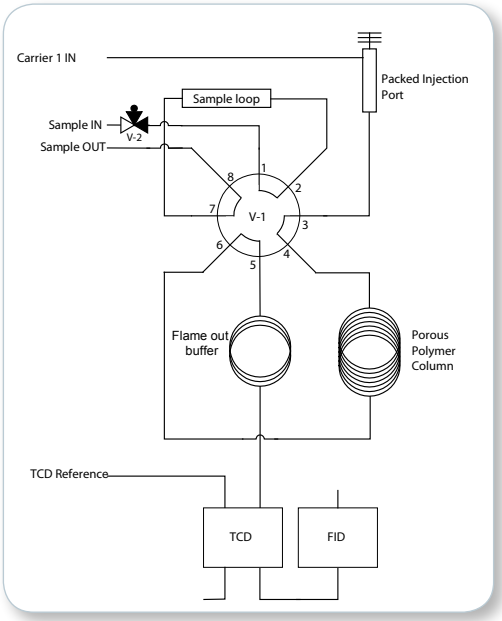


Figure 3: System configuration schematic diagram for Natural Gas Analyzer 'A'.

Natural Gas Analysis

NGA/Natural Gas Liquids (System B)

This system is optimized for the analysis of natural gas or de-methanized hydrocarbon matrices. For natural gas, the components of interest are typically oxygen, nitrogen, carbon dioxide, methane, ethane, propane, butane, isobutane, pentane, hydrogen sulfide, and C6+ as a composite peak. For de-menthanized streams (liquid natural gas) the components of interest are typically carbon dioxide, ethane, propane, butane, iso-pentane, hexane, and C7+ as a composite peak.

The system is configured with a 10 and 12 port valve (a third liquid sampling valve is added if liquid streams are to be analyzed) and three analysis columns connected to TCD and FID detectors (Figure 4). The system simultaneously injects the stream onto two column systems, a Molsieve column for the determination of O_2 and N_2 without the use of coolants, and short/long Non-Polar columns for the analysis of hydrocarbons and CO_2. The Non-Polar columns are set up for early back-flush, which optimizes sensitivity while reducing run time (from 25 minutes using the system 'A' configuration to less than 15 minutes) (Figure 5). The System „B" is extendable with two standard options. For the analysis of de-methanized liquefied natural gas distillates (i.e. propane, butanes and pentanes) an automated 4 port Liquid Sampling Valve is available to inject the sample as a Liquid. For the analysis of hydrogen and helium in natural gas a He/H_2 channel is available as extra GC channel.

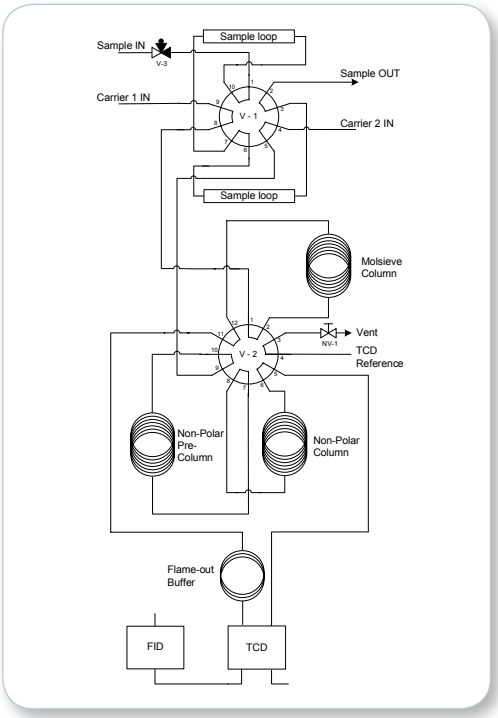


Figure 4: System configuration schematic for Natural Gas Analyzer 'B'.

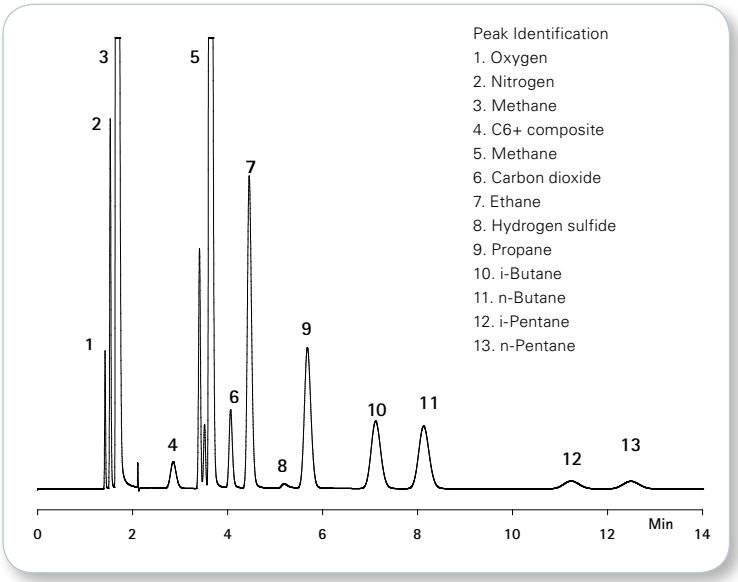


Figure 5: Chromatogram of natural gas samples from 'System B'. Note separation of oxygen and nitrogen.

"Rich" Natural Gas Analysis

NGA/Natural Gas Liquids - Extended Analysis (System C)

This system is specifically designed to analyze 'rich' natural gas or natural gas liquid streams by separating all hydrocarbon components up to C16. As with System B, it separates and quantifies oxygen and nitrogen, as well as measuring hydrogen sulfide down to ~100 ppm.

The system is configured with a 14 port valve and 6 port valve. The 14 port valve enables the system to introduce the sample stream simultaneously to three independent columns with automated detector switching which provides high sensitivity detection of all components of interest. The valves are installed in the multi-valve oven for flexible operation of the conventional column oven. Two of the sample paths flow onto Molsieve and porous polymer columns to separate oxygen, nitrogen and carbon dioxide, ethane, methane, ethane and H_2S, and the other via a 'splitter' onto a high performance non-polar capillary column to separate the hydrogen components up through C16. The 6 port valve is used to direct the separated components fraction

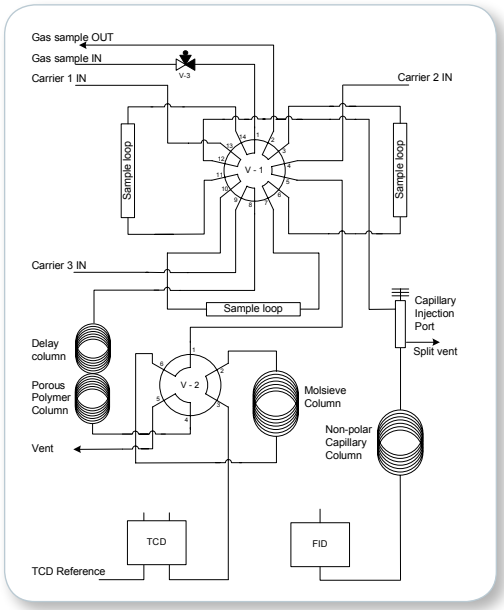


Figure 7: System schematic for Natural Gas Analyzer 'C'

to the TCD detector while components remaining on the Molsieve column are flushed to vent. If natural gas liquids are to be analyzed, a third valve (liquid sampling) is added to the configuration described above. For natural gas containing hydrogen and helium a He/H_2 channel is configured additionally.

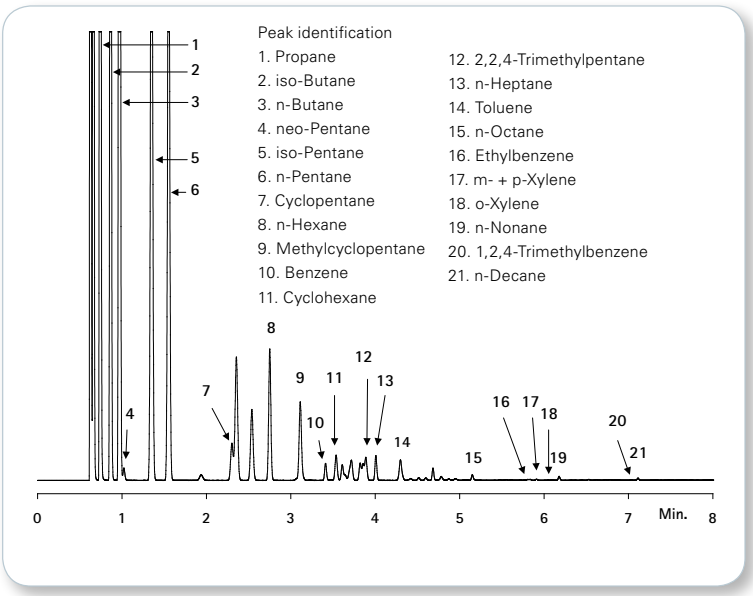


Figure 6: Chromatogram showing natural gas sample from 'System C' FID channel. Note individual separation of C6+ components

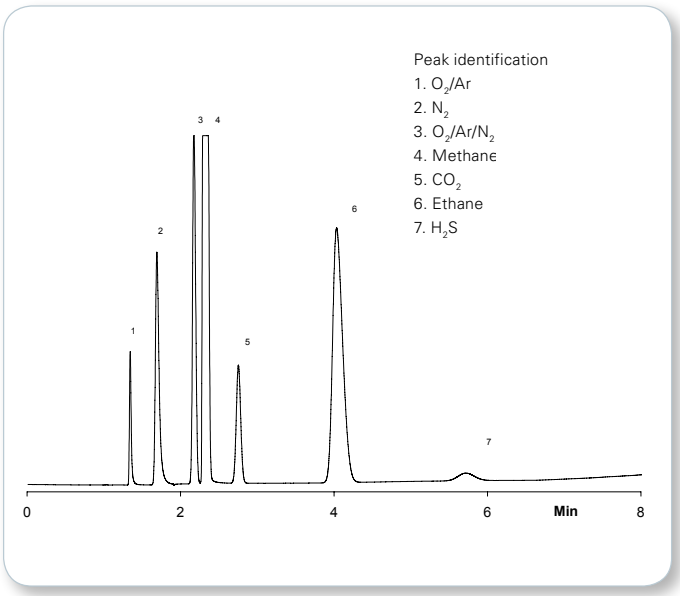


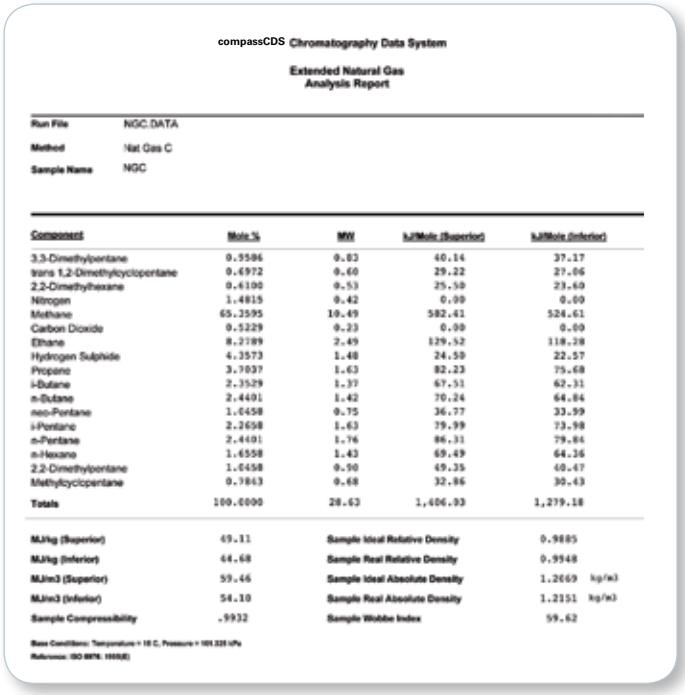
Figure 8: Chromatogram showing natural gas sample from 'system C' TCD channel.

Base Natural Gas Analysis Systems

Analyzer Characteristic	Bruker GC System 'A'	Bruker GC System 'B'	Bruker GC System 'C'
Gas Components Measured			
O_2, N_2, CO_2, CH_4	YES	YES	YES
Ethane, Propane, Butane, Iso-butane, Neo-pentane, Pentane, Iso-pentane	YES	YES	YES
C6+ as a composite peak	YES	YES	YES
C7+ as a composite peak	YES	YES	YES
O_2/N_2 Separation	YES[1]	YES	YES
He/H_2 Separation	NO	YES[3]	YES[3]
Max hydrocarbon number speciated	C6	C7	C16
LPG	YES[4 or 5]	YES[4 or 5]	YES[4 or 5]
De-methanized natural gas/natural gas liquids	NO	YES[4]	YES[4]
Typical analysis to analysis repeatability % RSD	<1.0	<1.0	<1.0
Analysis time	30 min	14 min	15-20 min
Standard Gas Methods			
IP-345	YES		
GPA 2172			
GPA 2177		YES	
GPA 2261		YES	
GPA 2286		YES	YES
GPA 2186		YES	YES
ASTM D5504			YES[5]
ASTM D6228			YES[5]
Natural Gas Calculation Methods			
ISO 6974			
ISO 6976			
GOST-22667			

[1] Requires liquid nitrogen or liquid CO_2 oven cooling
[2] Requires 3rd dedicated channel
[3] Requires additional channel including valve, columns and TCD
[4] Requires LSV to be additionally installed
[5] This method is specifically for sulfur components in natural gas, therefore a sulfur selective detector must be used such as a PFPD

Sulfur components in Natural Gas



compassCDS Chromatography Data System

Extended Natural Gas Analysis Report

Run File	NGC.DATA
Method	Nat Gas C
Sample Name	NGC

Component	Mole %	MW	kJ/Mole (Superior)	kJ/Mole (Inferior)
3,3-Dimethylpentane	0.9586	0.83	40.14	37.17
trans 1,2-Dimethylcyclopentane	0.6972	0.60	29.22	27.06
2,2-Dimethylhexane	0.6100	0.53	25.50	23.60
Nitrogen	1.4815	0.42	0.00	0.00
Methane	65.2595	10.49	582.41	524.61
Carbon Dioxide	0.5229	0.23	0.00	0.00
Ethane	8.2789	2.49	129.52	118.28
Hydrogen Sulphide	4.3573	1.48	24.50	22.57
Propane	3.7037	1.63	82.23	75.68
i-Butane	2.3529	1.37	67.51	62.31
n-Butane	2.4401	1.42	70.24	64.84
neo-Pentane	1.0458	0.75	36.77	33.99
i-Pentane	2.2658	1.63	79.99	73.98
n-Pentane	2.4401	1.76	86.31	79.84
n-Hexane	1.6558	1.43	69.49	64.36
2,2-Dimethylpentane	1.0458	0.90	49.35	40.47
Methylcyclopentane	0.7863	0.68	32.86	30.43
Totals	100.0000	28.63	1,406.03	1,279.18

MJ/kg (Superior)	49.11	Sample Ideal Relative Density	0.9885	
MJ/kg (Inferior)	44.68	Sample Real Relative Density	0.9948	
MJ/m3 (Superior)	59.46	Sample Ideal Absolute Density	1.2069	kg/m3
MJ/m3 (Inferior)	54.10	Sample Real Absolute Density	1.2151	kg/m3
Sample Compressibility	.9932	Sample Wobbe Index	59.62	

Base Conditions: Temperature = 15 C, Pressure = 101.325 kPa
Reference: ISO 6976: 1995(E)

Figure 9: Natural Gas Report - 'System C' generated using Scion's CompassCDS Chromatography Data Software

There are several methods specifically used for the analysis of sulfur components in natural gas, e.g. ASTM D5504 and ASTM D6228. Scion's natural gas analyzers can be modified to measure sulfur components through the addition of an extra, fully inert channel, dedicated for the determination of low-level sulfur components only. This sulfur channel will be equipped with the Pulsed Flame Photometric Detector (PFPD), a sulfur specific detector. The systems can also be configured and tested exclusively for the analysis of sulfur components as per standard methods, or enterprise specific requirements.

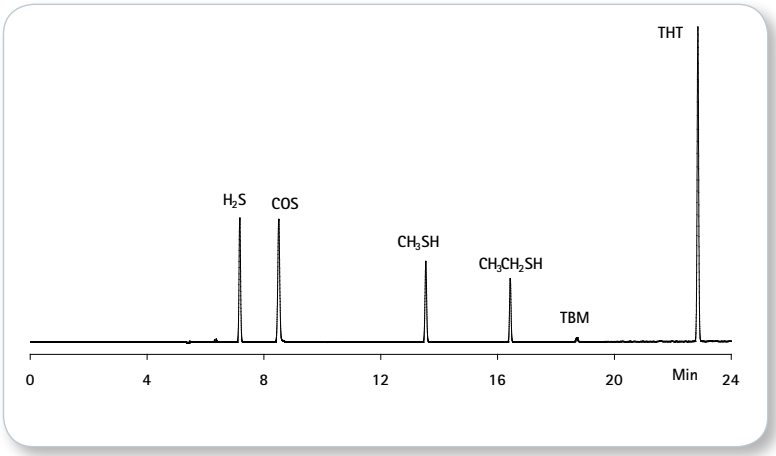
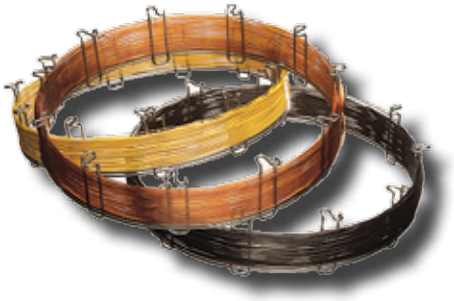


Figure 10: Detection of trace level sulfur components using the 450-GC, specially treated with Inert Steel surface deactivation and Pulsed Flame Photometric Detector (PFPD).

Scion-Certified Consumables for Your SCION GC Series

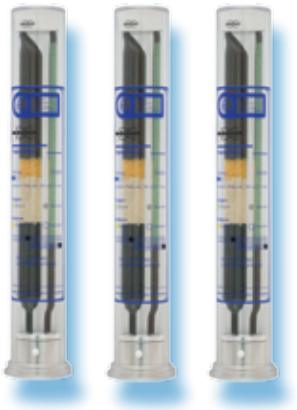
Scion GC columns span a broad range of column diameters, stationary phases, and capillary column materials: Fused Silica (FS) and Inert Steel (IS). Ideal for either routine or research type analyses. Scion GC column offerings bridge across many important applications and include a number of offerings such as:



- Standard WCOT (Wall Coated Open Tubular)
- Solid Stationary Phase PLOT (Porous Layer Open Tubular)
- Inert Steel Micro-Packed and Packed

Super Clean™ Gas Filters

Scion Gas Purification Systems have the range to satisfy your needs from individual to combination filters, from Ultra purity combined with Ultra capacity, to all in one solution kits. Innovative features designed into the product yield extensive benefits to the user.



- Ultra-high capacity for long life, less change and improved productivity
- High-purity output ensures 99.9999% Pure Gas
- "Quick connect" fittings for easy, leak-tight filter changes
- Glass internals prevent diffusion; plastic externally for safety
- Easy-to-read indicators for planned maintenance and improved up-time

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For research use only. Not for use in diagnostic procedures.