GLOBAL™ ANALYSER SOLUTIONS G·A·S

CompactGC4.0

Key Performance

Proven Performance

- **The speed of a MicroGC.....**
  CompactGC$^{4.0}$ delivers results in seconds
- **The robustness of a process GC.....**
  CompactGC$^{4.0}$ resists aggressive media thanks to solid detectors and diaphragm valves
- **The versatility of a laboratory GC.....**
  CompactGC$^{4.0}$ offers 7 different detectors and exchangeable columns

Performance prioritised

Robust diaphragm valves, high performance separation columns and robust, highly sensitive detectors are key to the CompactGC$^{4.0}$.

CompactGC$^{4.0}$ is a reliable performer for a wide range of applications. It provides high throughput at low cost of ownership. CompactGC is a proven analyser concept, appreciated worldwide.

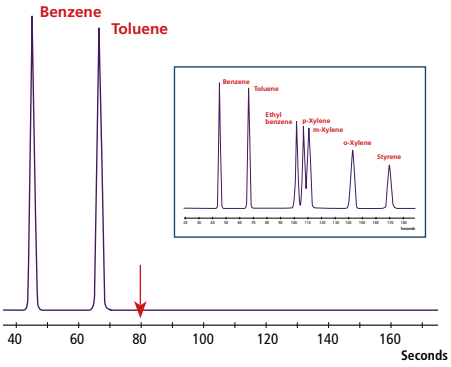
Fast Performance

CompactGC$^{4.0}$ is a fast performer.

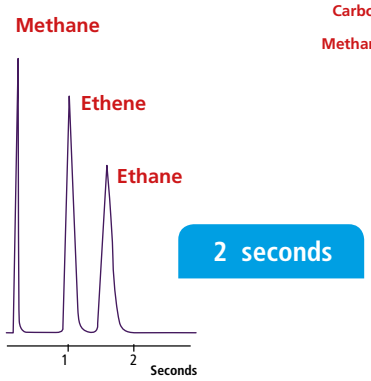
Results are delivered in seconds, achieved with fast injection, narrow bore columns and fast highly sensitive detectors. The typical runtime is 2-120 seconds. Analysis time is reduced even more by using backflush option and pressure programming to accelerate late eluting components.
Cycle time is equal to run time: no additional flush or conditioning steps are needed.

Isothermal or temperature programmed

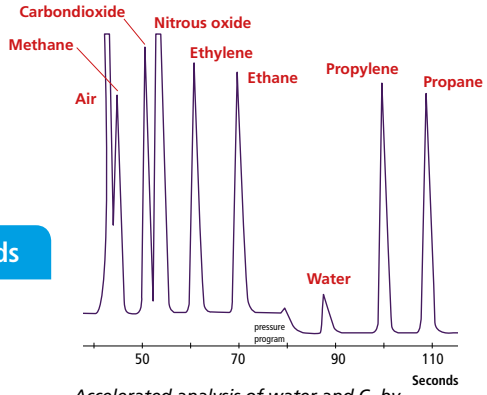
Isothermal conditions are often preferred for analysis of permanent gas or a limited number of hydrocarbons. In case of components with a wider range of boiling points, temperature programmed columns are the first choice. CompactGC$^{4.0}$ uses low mass separation columns with rapid cooling and heating, up to 1200 °C/min. See application examples on page 10 and 12.



Shortening runtime to 80 seconds by using a backflush option



C_1 and C_2 analysis in only 2 seconds.



Accelerated analysis of water and C_3 by pressure programming of the carrier gas

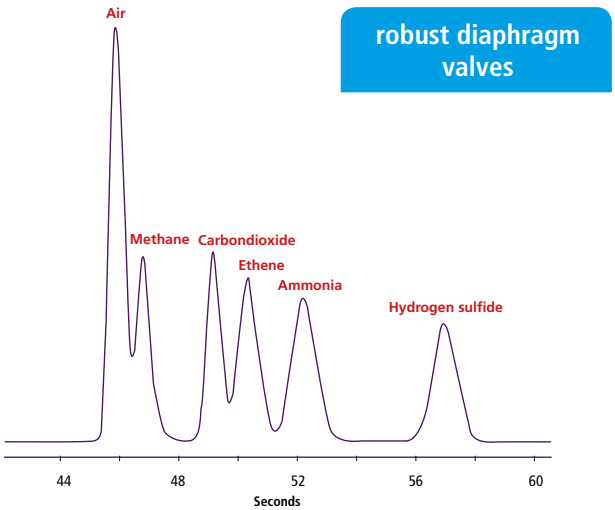
Reliable Performance

CompactGC$^{4.0}$ is a reliable performer.

Proven GC technology from laboratory GCs and process instruments are used for high uptime.
Injection valves normally account for the majority of the maintenance costs in gas analysis; therefore robust diaphragm valves are used to guarantee millions of injections.

Rigid, maintenance free detectors with a long lifetime ensure reliable performance for many years. Column switching techniques like backflush and heart-cut effectively protect your analysis column. The durable setup also allows analysis of aggressive components, for example high percentage H_2S or ammonia.

GAS diaphragm valve offers an extended lifetime and internal purge for extreme low leakrate



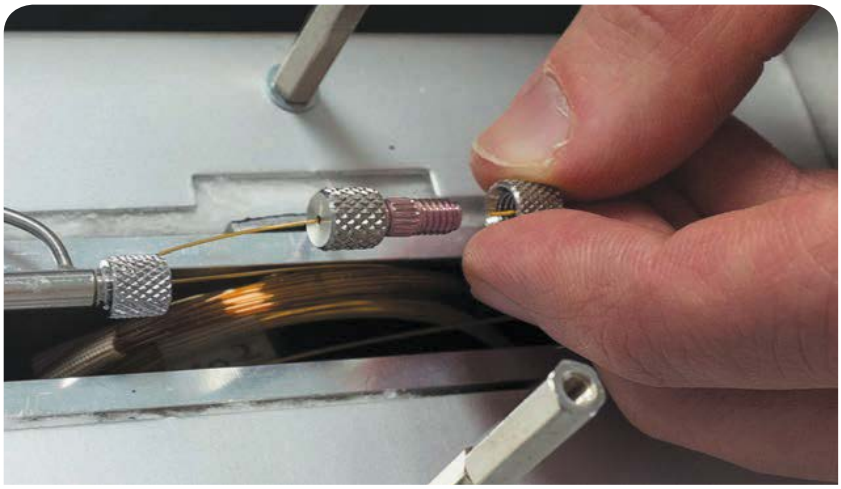
Solid detectors and diaphragm valves allow analysis of high % NH_3 and H_2S

Cost Effective Performance

CompactGC$^{4.0}$ is a cost effective performer

Columns are replaced by the user in a minute, with resulting low operational cost and high flexibility. Capillary as well as micro-packed columns can be installed.

The CompactGC concept is also very maintenance friendly. Finger tight couplings are used for a 100% leak free connection without the need for tools. All parts are highly accessible thanks to the transparent design.



Easy exchangeable columns / low cost of ownership

Priority on Performance

● Up to 4 channels

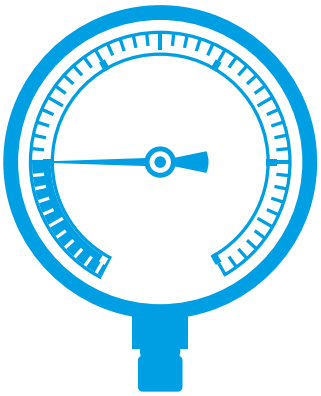
CompactGC$^{4.0}$ offers up to 4 analysis channels with independent injection loops, columns and detectors for analysing a wide range of components.

● Inert sample path

For the analysis of polar component at low concentration levels like ppb Sulphur, an inert sample path is mandatory. This is achieved by the use of high quality materials like Sulfinert/Silconert tubing.

Sampling from small volumes or low pressures

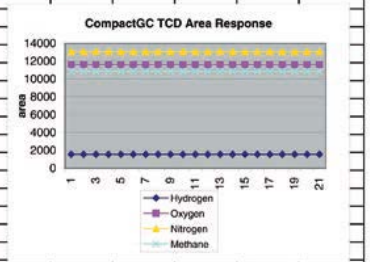
Sample loops are adequately flushed when sufficient sample volume is available. If only a small volume is available, or the sample is offered at low pressure, accurate injection is challenging. CompactGC$^{4.0}$ provides a vacuum sampling option by vacuuming the sample loops down to 4 mbar before sampling. As a result a few ml available sample is adequate and memory effects are avoided.

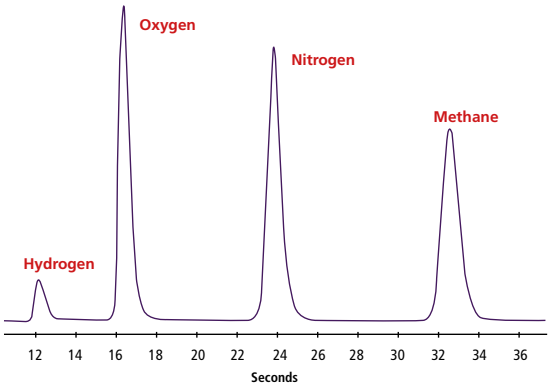


Highly repeatable

First class GC hardware offers low RSD% and high linearity.

H_2	O_2	N_2	CH_4					
1562	11623	13082	10866					
1565	11625	13085	10874					
1566	11629	13090	10863					
1562	11622	13087	10867					
1562	11621	13086	10871					
1565	11620	13086	10874					
1562	11620	13082	10868					
1562	11623	13084	10869					
1562	11623	13077	10870					
1562	11619	13084	10872					
1562	11617	13080	10866					
1560	11617	13080	10868					
1565	11627	13085	10871					
1563	11617	13078	10871					
1566	11623	13088	10867					
1562	11616	13082	10866					
1559	11617	13083	10871					
1561	11615	13085	10872		H_2	O_2	N_2	CH_4	
1564	11620	13076	10869		1.87	3.70	3.67	2.98	STDEV
1564	11619	13079	10867		1563	11621	13083	10869	AVERAGE
1562	11618	13082	10865	n=20	0.12	0.03	0.03	0.03	%RSD

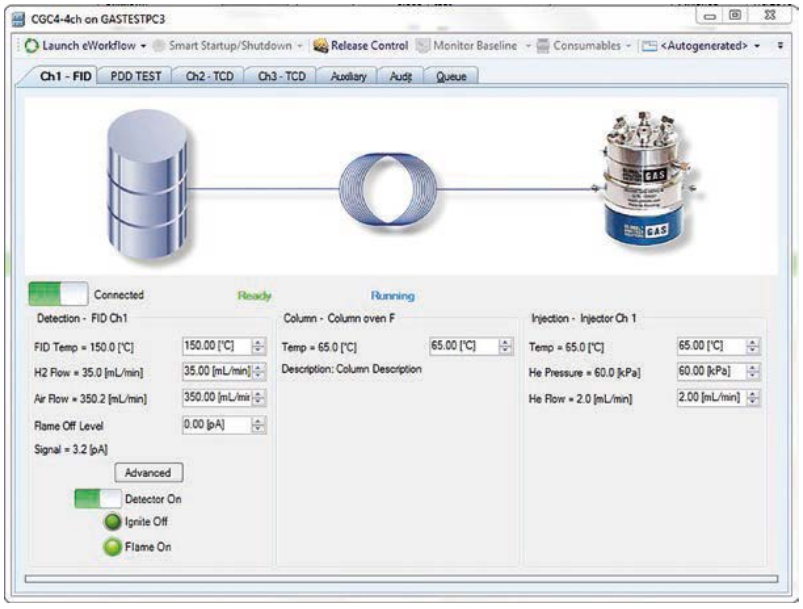




Chromatogram used for RSD% calculation. 1% conc. level (H_2: 5%)

Chromatography Data Systems

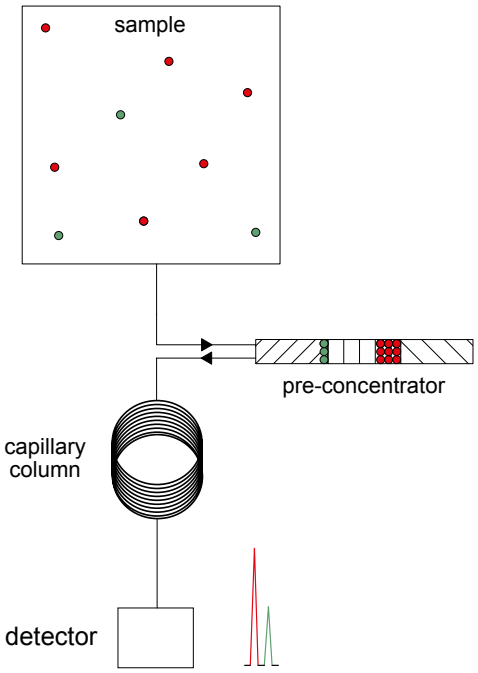
Instrument control drivers are available for Chromeleon, OpenLab and EZChrom. All GC parameters like flow, pressure, temperature and detector settings are controlled by the chromatography data system.



Performance from ppt to %

CompactGC$^{4.0}$ performs over a wide range of concentrations.
A choice of high sensitive detectors covers every component and concentration range:

Detector	Application expample
TCD (Thermal Conductivity Detector)	Many applications like permanent gases and hydrocarbons from low ppm to high % levels
FID (Flame Ionisation Detector)	
PDD (Pulsed Discharge Detector)	High purity analysis at low ppb level
PED (Plasma Emission Detector)	
PID (Photo Ionisation Detector)	Conjugated and aromatic hydrocarbons
PFPD (Pulsed Flame Photometric Detector)	Selectively measures ppb sulphur components
MS (Mass Spectrometer)	Provides positive identification of your components



Pre-concentrator : ppt level analysis

A pre-concentrator module is offered for ppb-ppt sensitivity. A precise volume, typically 25ml to 1L, is sent to an electrically cooled trap to focus the components of interest. The trap is rapidly heated (100 °C/s) for fast injection on the analytical column. Trapping and desorption on the multi-bed adsorbent takes place in reversed flow order, to analyse a wide range of components without the interference of water.

Thermal Desorption Option

Performance Everywhere

CompactGC$^{4.0}$ is a versatile performer.

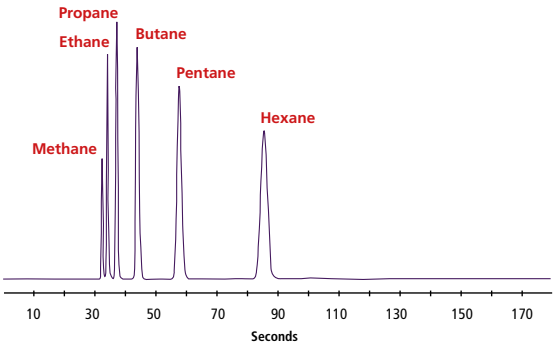
The 19″ industrial standard enclosure allows versatile use on many locations. Beside laboratory measurement and on-line analysis, single or multiple instruments can be stacked in transportable enclosures for on site measurement.

highly transportable

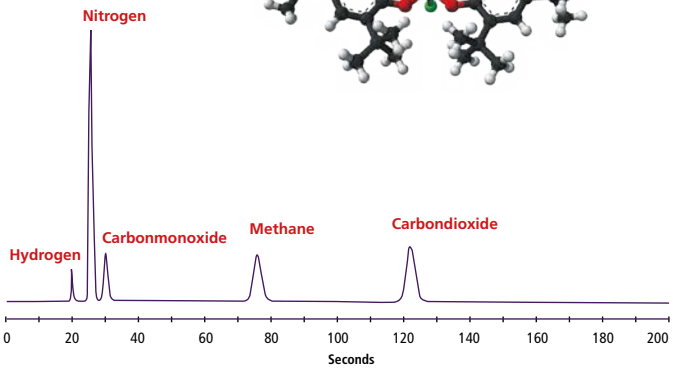
Applications

Catalyst Screening / On-line analysis / Petro

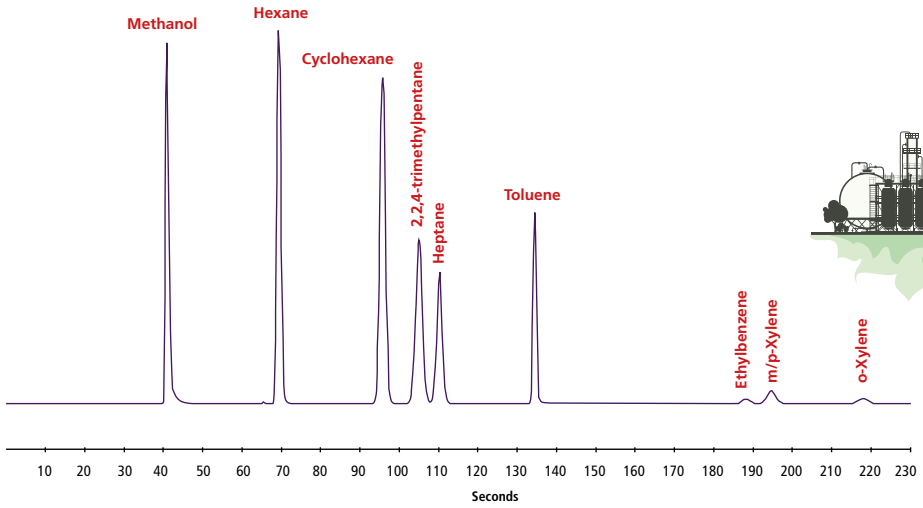
Speed and Flexibility in High Throughput analysis: short run times for fast screening and easy column replacement when new experiments require it.



Fast analysis of C_1-C_6 hydrocarbons (FID)



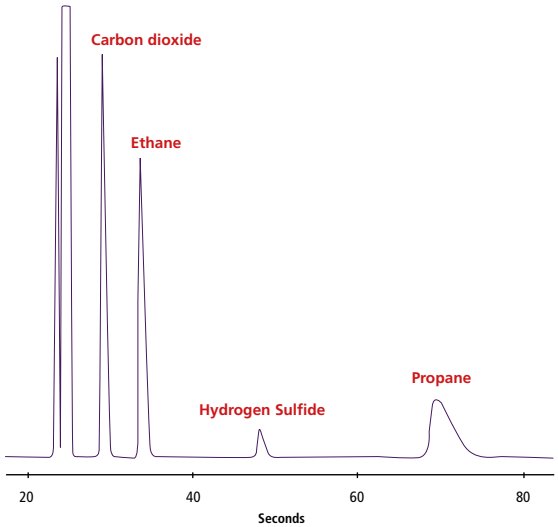
Analysis of CO and CO_2 on single column (TCD)



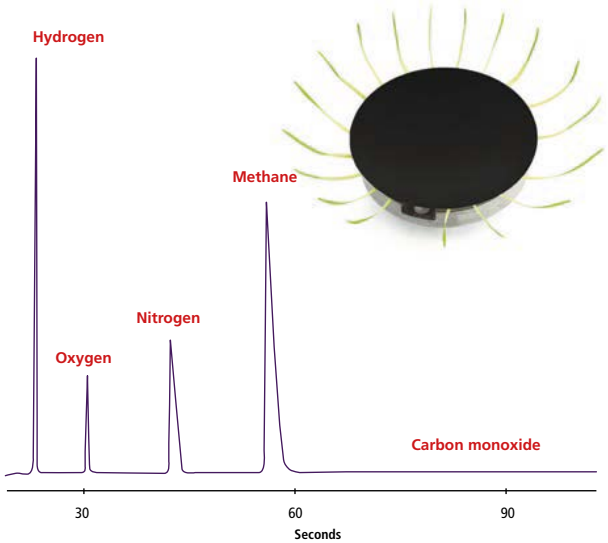
Hydrocarbons (FID)

Biogas

Fast on-line analysis of Biogas. Optional channel available for low ppm Siloxanes (FID) or ppb Sulphur (PFPD).



Biogas analysis using Rt-QBond column (TCD)

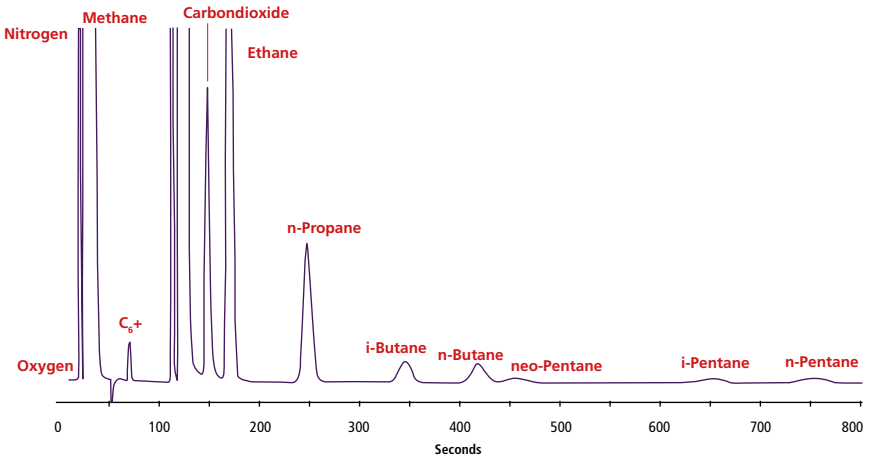


Biogas analysis on Molsieve plot column (TCD)

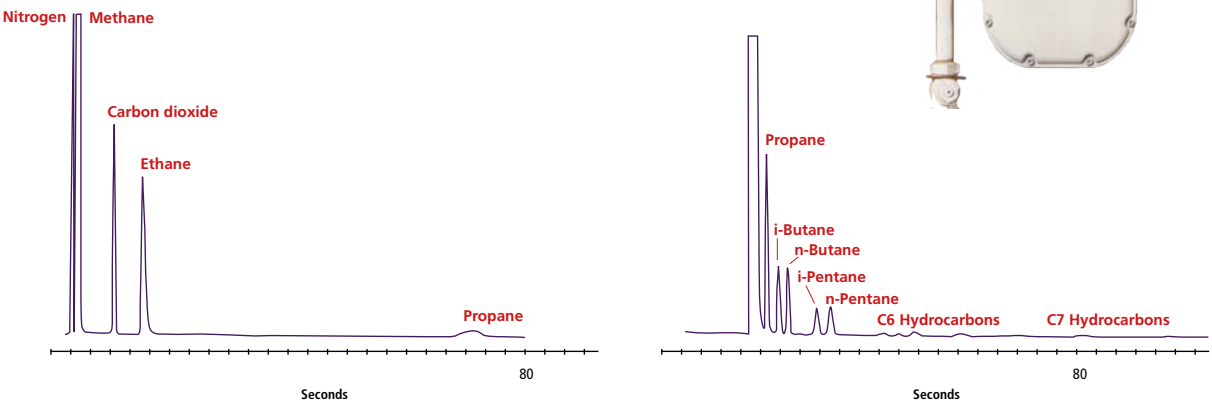
Applications

Natural Gas Analyser

Natural Gas Analysers are available with various configurations on CompactGC. Optional channels are offered for low ppm H_2 or sulphur components. Calorific Value / BTU calculation is also included.



NGA using micropacked columns, including O_2 / N_2 separation (single TCD)



Fast natural gas analysis using capillary columns (double TCD)

Natural gas calculations

Instrument	Trace1300 NGA	**Sequence name**	Data G.A.S. NGA pack
Instrument Method	initial gas injection	**Data Vault**	ChromeleonLocal
Processing Method	New Processing Method	**Report Template**	G.A.S. NGA Report Template
Data File	NGA mix repro TCDs	**Seq. Line**	10
Injection Date	08/Jul/2014	**Peaks**	9
Injection Time	13:21		
Calculation Type	Total		

Physical property report for the dry gas - combustion at 15°C according to ISO 6976

Metering at 0°C and 101,325kPa	Molar basis	Mass basis	Volumetric basis	Calories	Wobbe Index	BTU
Sup. Calorific Value	897.41 kJ/mol	49.60 MJ/kg	40.15 MJ/m3	9587.52 kcal/m3	50.74 MJ/m3	1077.55 BTU/ft3
Inf. Calorific Value	809.73 kJ/mol	44.75 MJ/kg	36.23 MJ/m3	8650.79 kcal/m3	45.78 MJ/m3	972.27 BTU/ft3
Mean mol weight	18.093 g/mol					
Compression factor	0.9972					
Relative Density	0.6261					
Density	0.8094 kg/m3					

Metering at 15°C and 101,325kPa	Molar basis	Mass basis	Volumetric basis	Calories	Wobbe Index	BTU
Sup. Calorific Value	897.41 kJ/mol	49.60 MJ/kg	38.04 MJ/m3	9084.12 kcal/m3	48.09 MJ/m3	1020.97 BTU/ft3
Inf. Calorific Value	809.73 kJ/mol	44.75 MJ/kg	34.32 MJ/m3	8196.57 kcal/m3	43.39 MJ/m3	921.22 BTU/ft3
Mean mol weight	18.093 g/mol					
Compression factor	0.9977					
Relative Density	0.6258					
Density	0.7669 kg/m3					

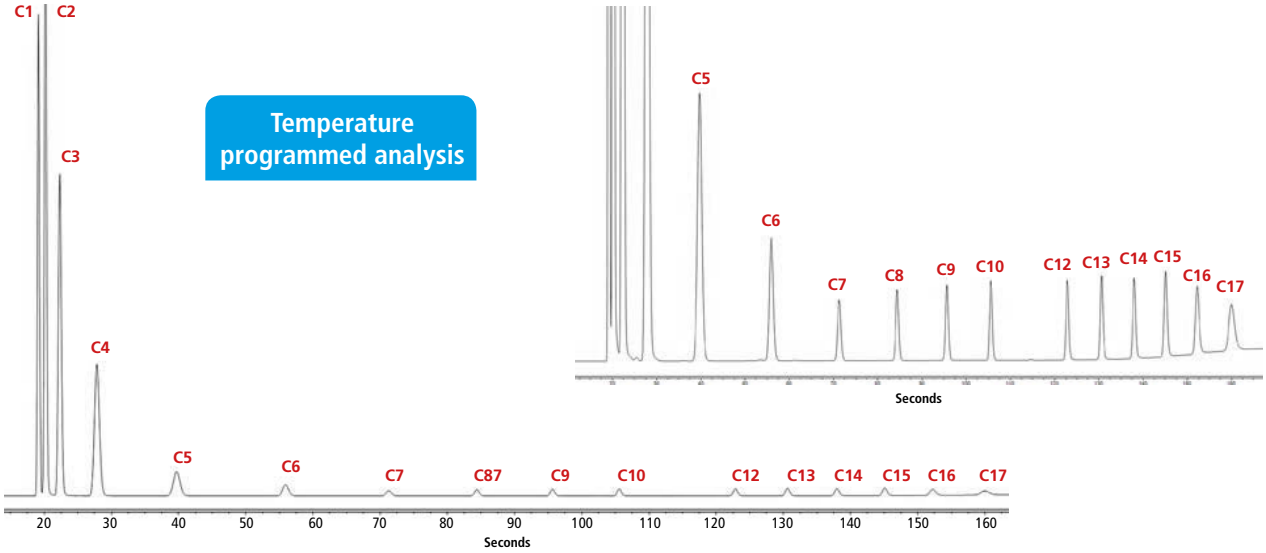
Metering at 20°C and 101,325kPa	Molar basis	Mass basis	Volumetric basis	Calories	Wobbe Index	BTU
Sup. Calorific Value	897.41 kJ/mol	49.60 MJ/kg	37.39 MJ/m3	8928.14 kcal/m3	47.27 MJ/m3	1003.44 BTU/ft3
Inf. Calorific Value	809.73 kJ/mol	44.75 MJ/kg	33.73 MJ/m3	8055.83 kcal/m3	42.65 MJ/m3	905.40 BTU/ft3
Mean mol weight	18.093 g/mol					
Compression factor	0.9978					
Relative Density	0.6257					
Density	0.7538 kg/m3					

Calorific Value reporting by GAS NGA calculation package for Chromeleon

Applications

Hydrocarbon analysis - Natural Gas, Hydrocarbon Processing Industries

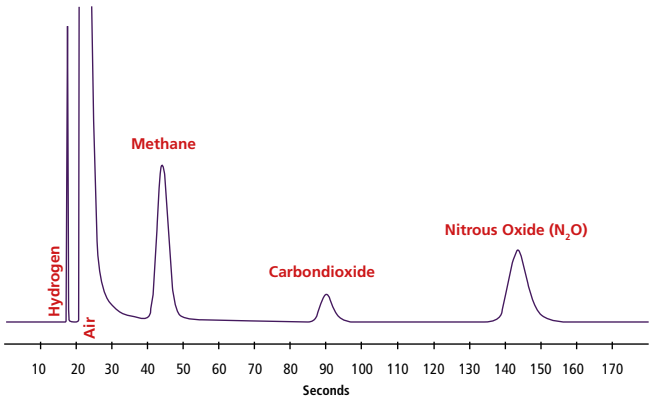
Fast, single channel analysis of a wide range of hydrocarbons, using a temperature programmed column.



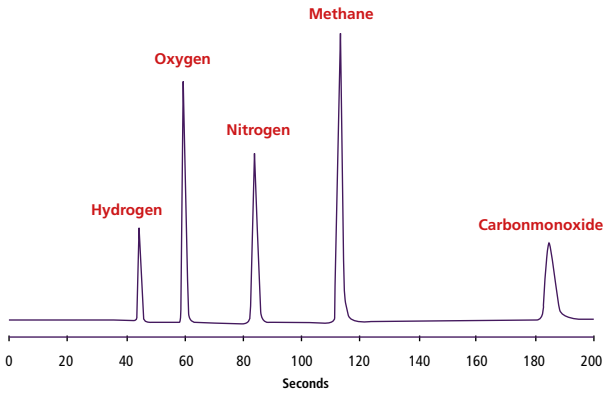
*C_1-C_{17} n-paraffins, FID detection. MXT-1, 3u, 15m*0.28mm, 60-350 °C, 150 °C/min*

High Purity Analysis:

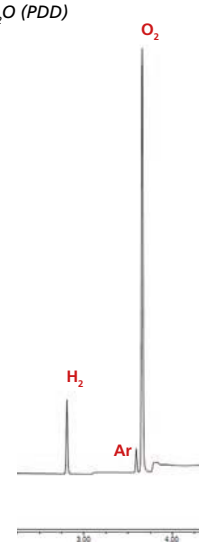
Analysis of impurities in bulk gases by Pulsed Discharge Detector. Highly sensitive: low ppb detection limit.



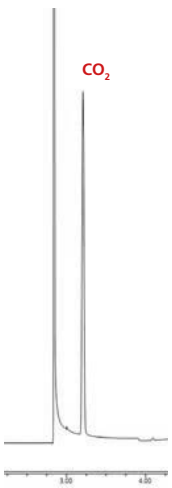
10 ppm CH_4, CO_2 and N_2O (PDD)



5 ppm permanent gases in Helium (PDD)



3 ppm H_2 and O_2 .Bulk N_2 is removed by heart-cut option (PDD)

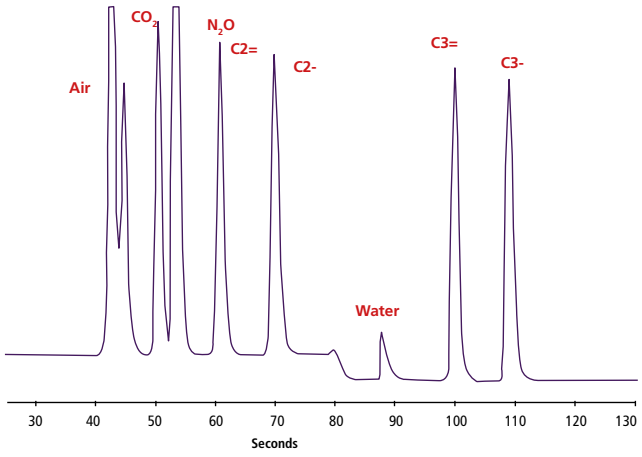


0.5 ppm CO_2. Bulk Argon is removed by heart-cut option (PDD)

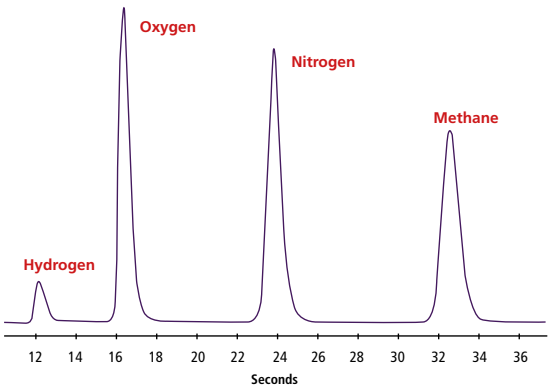
Applications

Fermentation - Biotech - Online measurement

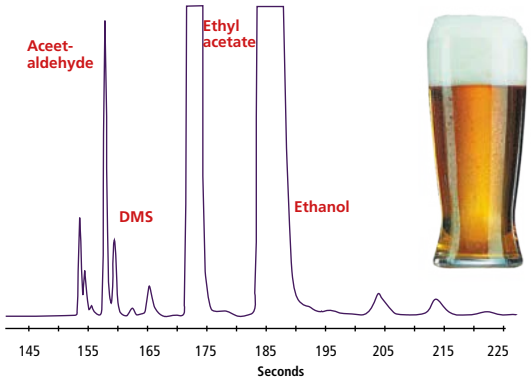
CompactGC is resistent against high water percentages, and is therefore very suitable for fermentation and biotech reactor experiments.



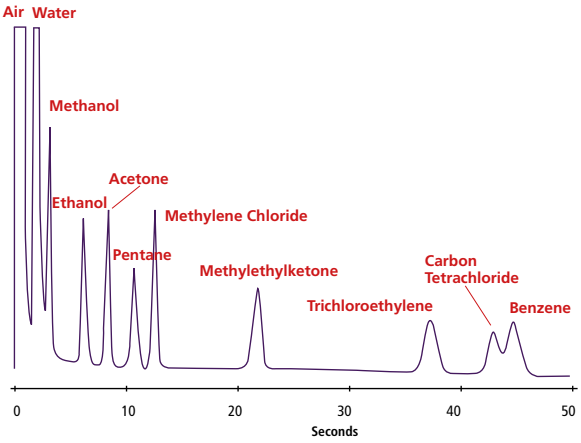
Permanent gases on Rt-QBond (TCD)



Permanent gases on Molsieve plot column (TCD)



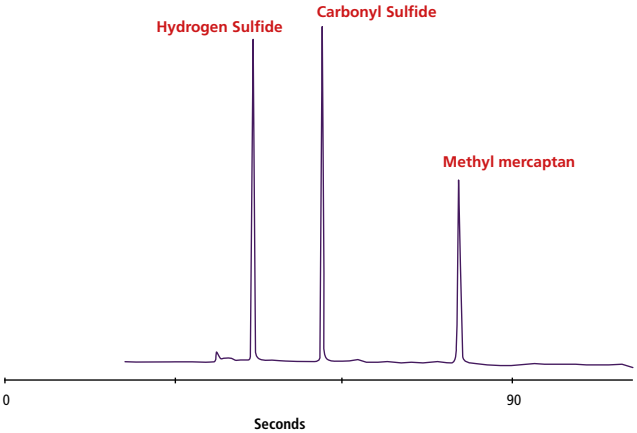
Headspace analysis of beer fermentation



Monitoring of solvent reduction by bacteria

Low Sulphur

CompactGC with Pulsed Flame Photometric Detector: Selective analysis of low ppb Sulphur components. Analysis without pre-concentration on a small footprint.



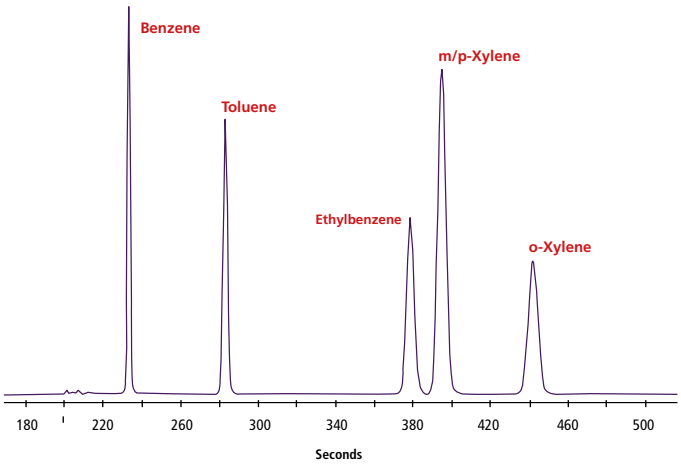
1 ppm volatile Sulphur components in N_2 balance (PFPD)

Applications

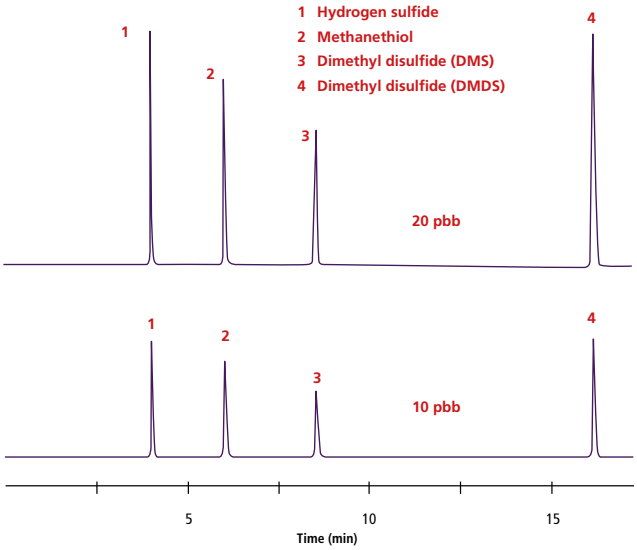
Air toxics, VOC, BTX, Low Sulphur with pre-concentrator module

ppb/ppt concentration levels are measured using the optional Thermal Desorption module. Pre-packed traps with various (multibed) adsorbents are available to cover many applications.

NEW Thermal Desorption Option



100 ppb BTEX in N_2 (FID). LOD: 0.5 ppb (25 ml sample)



Low level ppb Sulphur components (PFPD). LOD: 0.5 ppb (25 ml sample)

TO-15/TO-17 using quadrupole GC-MS

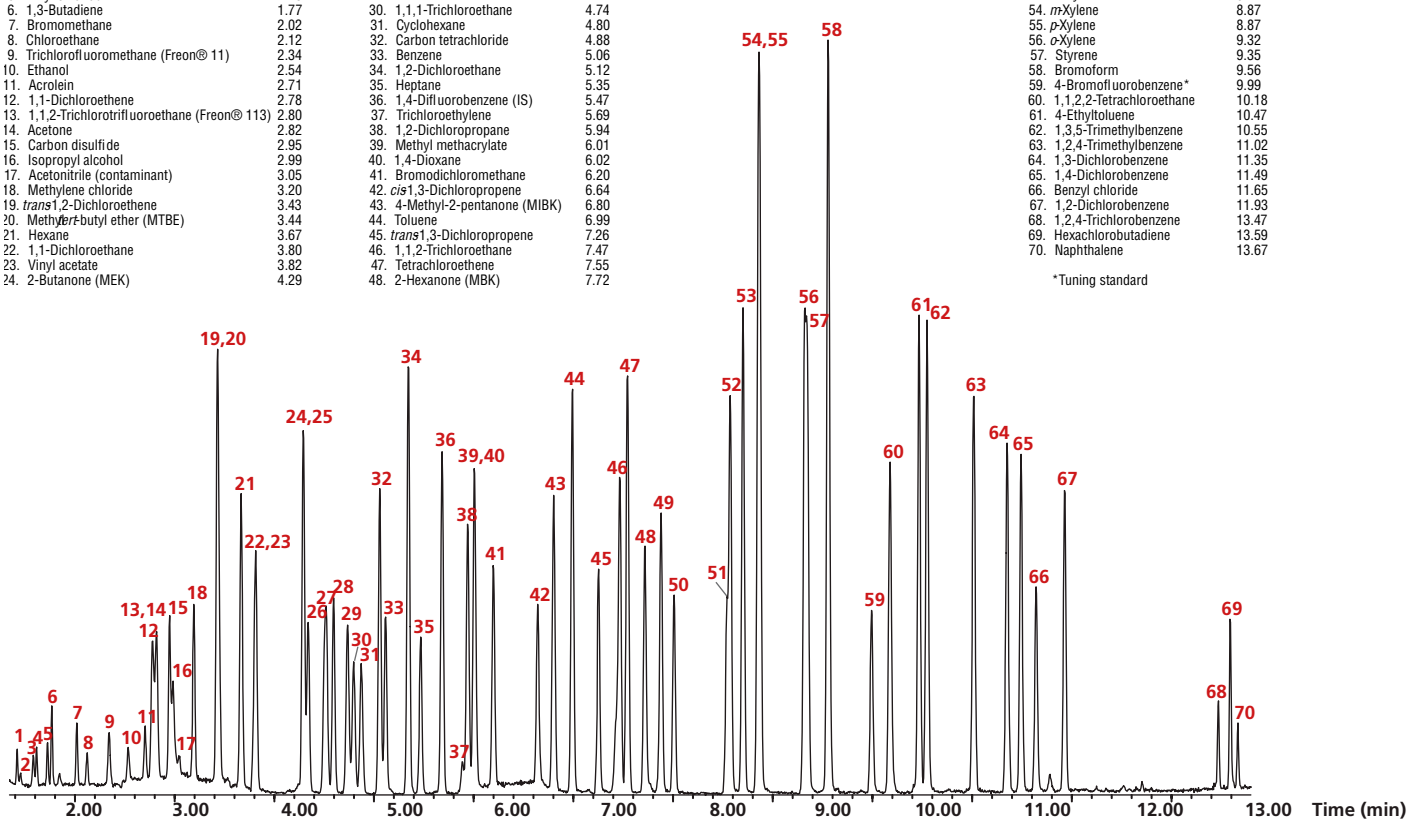
Temperature programmed analysis

Peaks	t_R (min)
1. Propylene	1.42
2. Dichlorodifluoromethane (Freon® 12)	1.46
3. 1,2-Dichlorotetrafluoroethane (Freon® 114)	1.58
4. Chloromethane	1.62
5. Vinyl chloride	1.73
6. 1,3-Butadiene	1.77
7. Bromomethane	2.02
8. Chloroethane	2.12
9. Trichlorofluoromethane (Freon® 11)	2.34
10. Ethanol	2.54
11. Acrolein	2.71
12. 1,1-Dichloroethene	2.78
13. 1,1,2-Trichlorotrifluoroethane (Freon® 113)	2.80
14. Acetone	2.82
15. Carbon disulfide	2.95
16. Isopropyl alcohol	2.99
17. Acetonitrile (contaminant)	3.05
18. Methylene chloride	3.20
19. *trans*1,2-Dichloroethene	3.43
20. Methyl*tert*-butyl ether (MTBE)	3.44
21. Hexane	3.67
22. 1,1-Dichloroethane	3.80
23. Vinyl acetate	3.82
24. 2-Butanone (MEK)	4.29

Peaks	tR (min)
25. *cis*1,2-Dichloroethene	4.29
26. Ethyl acetate	4.34
27. Bromochloromethane (IS)	4.50
28. Tetrahydrofuran	4.52
29. Chloroform	4.60
30. 1,1,1-Trichloroethane	4.74
31. Cyclohexane	4.80
32. Carbon tetrachloride	4.88
33. Benzene	5.06
34. 1,2-Dichloroethane	5.12
35. Heptane	5.35
36. 1,4-Difluorobenzene (IS)	5.47
37. Trichloroethylene	5.69
38. 1,2-Dichloropropane	5.94
39. Methyl methacrylate	6.01
40. 1,4-Dioxane	6.02
41. Bromodichloromethane	6.20
42. *cis*1,3-Dichloropropene	6.64
43. 4-Methyl-2-pentanone (MIBK)	6.80
44. Toluene	6.99
45. *trans*1,3-Dichloropropene	7.26
46. 1,1,2-Trichloroethane	7.47
47. Tetrachloroethene	7.55
48. 2-Hexanone (MBK)	7.72

Peaks	t_R(min)
49. Dibromochloromethane	7.88
50. 1,2-Dibromoethane	8.01
51. Chlorobenzene-d5 (IS)	8.54
52. Chlorobenzene	8.58
53. Ethylbenzene	8.71
54. *m*-Xylene	8.87
55. *p*-Xylene	8.87
56. *o*-Xylene	9.32
57. Styrene	9.35
58. Bromoform	9.56
59. 4-Bromofluorobenzene*	9.99
60. 1,1,2,2-Tetrachloroethane	10.18
61. 4-Ethyltoluene	10.47
62. 1,3,5-Trimethylbenzene	10.55
63. 1,2,4-Trimethylbenzene	11.02
64. 1,3-Dichlorobenzene	11.35
65. 1,4-Dichlorobenzene	11.49
66. Benzyl chloride	11.65
67. 1,2-Dichlorobenzene	11.93
68. 1,2,4-Trichlorobenzene	13.47
69. Hexachlorobutadiene	13.59
70. Naphthalene	13.67

*Tuning standard



TO-15 components on MXT-624. ISQ quadrupole detection, pre-concentration by thermal desorption. Column temperature 40-230°C

Testimonials

- **'The CompactGC is a very reliable performer thanks to the use of robust valves and solid detectors. It is a very flexible microGC, because we can change the separation columns ourselves in minutes when new experimental conditions require that. And we are very satisfied about the support offered by GAS.'**
  Prof. Emiel Hensen, Schuit Institute of Catalysis, Eindhoven University of Technology, The Netherlands

- **'The GAS CompactGC combines the advantages of a micro GC with the advantages of a traditional laboratory or process GC. Being able to replace or modify the individual parts very easily, bypasses the disadvantages of modularity and offers us an increased flexibility. Besides that the Compact GC has proven to be very reliable with a minimal service requirement. The first prototype of the Compact GC was installed in STCA almost 15 years ago and is still functioning, delivering every day important data for our research projects. Compact GC's are now being used in all of our rese arch laboratories.'**
  Ronald Schoonebeek, Researcher Innovative Research, Shell Global Solutions International BV Amsterdam, The Netherlands

- **'Afrox acquired a CompactGC$^{4.0}$ years ago, for the analysis of Special gases. The instrument was customised by Interscience and installed by Separation Scientific. The instrument has performed better than expected and the support of Interscience and Separation Scientific can only be commended.'**
  Hans Strydom, Production Quality Manager, Afrox-Linde, Johannesburg, South Africa

- **'The technical choices made (valves, surface treatment ...) in the CGC's design ensure a high level of reliability and robustness. The rapid, repeatable and linear measurements allow a significant reduction in their uncertainty. These qualities make this equipment an obvious choice for a metrology laboratory such as the LNE.'**
  Christophe Sutour, Technical Manager, LNE- Laboratoire national de métrologie et d'essais, Paris, France

- **'The support and care delivered by GAS are above expectations.'**
  Kevin Mouthaan, Technician Chemical Engineering and Catalysis, Delft University of Technology, The Netherlands

- **'With the CompactGC we are able to control the impurity levels in our production process and hence increase its efficiency. The return on investment was positive in a short timescale.'**
  Karel Anthonissen, Process Engineer Philips Innovative Applications N.V. Turnhout Belgium

- **'CompactGC offers the robustness of a process GC and the versatility of a laboratory instrument. Trace levels of polar components are correctly analysed due to the inert sample path. In practise, the CompactGC has proven to be a very fast and reliable analyser.'**
  Mr. Markus Beinlich, laboratory manager RWE Metering GmbH Germany

- **'For our fast experimentation the CompactGC has proven to be a very stable and reproducible choice, running for weeks to screen different catalyst divided over 64 reactors. We can easily change our methods for new applications and both the valve oven and the column ovens are very accessible, giving us options to use backflush and switching options to implement in the method.'**
  Frank ten Hoonte, Team Leader Analytics, Avantium N.V, Amsterdam The Netherlands

Specifications

Dimensions:

- 19" standard enclosure, 4HE
- 45 x 18 x 55 cm (w*h*d)
- weight: 22 kg (2 ch. Instrument)

Power:

- 100-240V AC, 47-63 Hz,
- 800W max

Heated zones:

- up to 10

Electronic Gas Control

- connection: 1/8" Swagelock
- max 14 electronic gas supplies
- max inlet pressure 1000kPa
- max outlet pressure 350/700 kPa
- max splitflow: 100 ml/min
- carrier gas He, N_2, Ar, (H_2)
- detector gas depending on detector

Analysis channels:

- 1-4; extendable

Valve oven:

- independently heated, 40-150 °C
- up to 3 valves
- gas sampling or liquid sampling valves
- diaphragm valves with internal purge

Column oven:

- isothermal: up to 3, independently heated, 40-250°C
- programmed column: MXT columns, 40-350 °C, max heating rate 1200°C/min

Detectors

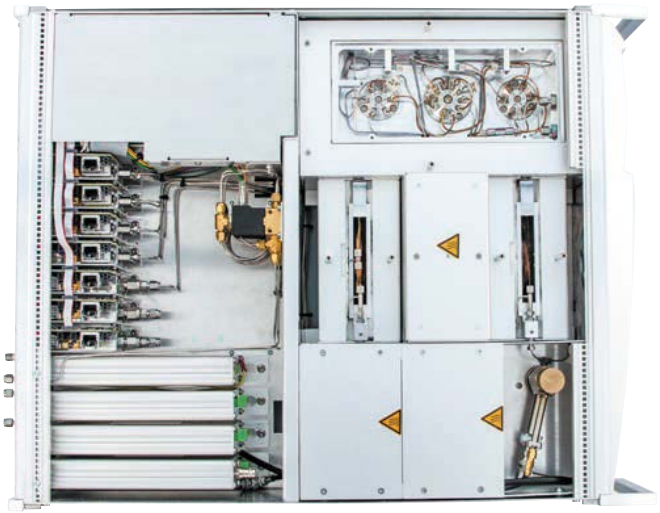
- Thermal Conductivity Detector (TCD)
- Pulsed Discharge Detector (PDD/PDHID)
- Plasma Emission Detector (PED)
- Photo Ionisation Detector (PID)
- Pulsed Flame Photometric Detector (PFPD)
- Mass Spectrometer (MS)

Detector	MDA	Linearity	Remarks
Thermal Conductivity Detector	400pg C2= /ml He	10^5	
Flame Ionisation Detector	1.5 pg C/sec	$>10^7$	Flame out detection
Pulsed Discharge Detector	Low pg range		No radioactive source
Plasma Emission Detector	Low pg range		No radioactive source
Photo Ionisation Detector	$1*10^{12}$ g Benzene	10^5	
Pulsed Flame Photometric Detector	<1 pg S/sec	2.5 orders (5 orders quadratic)	Detects 28 elements
Mass Spectrometer, external	See MS spec		

Specifications

Columns

- capillary 0.32, 0.28, 0.25, 0.15mm ID
- wide bore MXT 0.53mm ID
- micropacked 1/16" OD



Column switching

- diaphragm or rotary valve
- Deans backflush or heartcut

Pre-Concentrator

- Trap low temperature 0-50 °C
- Trap desorption temperature 50-350 °C
- Trap heating rate 100 °C/s
- Trap loading using internal sample pump and Mass Flow Controller
- Trap load and desorb in opposite direction enabling use of multi-bed adsorbents

Sampling

- Gas Samling Valve: diaphragm or rotary
- Liquid Sampling Valve with Sample Securitiser
- Vaporiser option
- inlet temperature: max. 150 °C,
- inlet pressure: max. 21 bar (depending on used valve)
- injection volume: 0.06 ul to 5ml
- Vacuum sampling option: vacuuming sample loop to 5 mbar
- connection: 1/8" Swagelok

Repeatability

- 0.2% RSD or better (n=10, Ethane, TCD detection)

Data communications

- LAN for GC parameter control and data transfer
- Instrument Control drivers for Chromeleon, EZChrom, OpenLab
- optional CGC editor for GC method editing (LAN/RS-232)
- 8 * external events 24V (valve control)
- 4 * SSR output
- 3 * digital input (remote start-stop-prep)
- optional analogue output (0-1V) for detector signals

Environmental conditions

- Ambient operating temperature: 5-45 °C
- Ambient operating humidity: 5-95 %, (non-condensable)

Verulam Scientific Ltd

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