Da Vinci
LABORATORY SOLUTIONS

DVLS Refinery Gas Analysis Solutions

Solutions for a Fast Analysis of Refinery Gases & LPG

Boosting laboratory efficiency

DVLS Refinery Gas Analyzer (RGA)

Da Vinci Laboratory Solutions (DVLS) offers an automated gas solution to characterize the composition of refinery gases and liquefied gases under pressure such as LPG, Ethylene and Propylene. Next to determining the hydrocarbon content, permanent gases and hydrogen sulfide the RGA also reports calculation parameters such as Calorific and/or BTU Value, Density, Average Molar Mass etc.

Key Benefits

- **High Quality GC Hardware**
  The Refinery Gas Analyzer is based upon the flexible, reliable Agilent 8890 GC configured with dedicated columns, valves, inlet and detectors.
- **Fast analysis of refinery gases**
  The multi-channel configuration allows to inject the gas samples into the separate channels at the same time. All channels operate simultaneously to provide a fast gas analysis in less than 5 minutes.
- **Maximum System Uptime**
  The unique hardware design of the side carrier reduces the system downtime during the periodical regeneration of the separation columns.
- **Representative Injection of Liquefied Gases**
  Add a DVLS Pressure Station, GSV and/or LSV to the RGA to allow a representative injection of liquefied gases such as LPG.
- **Standard Methods Compliance**
  The Gas Analyzers comply with the various standard test methods to determine the composition of the refinery & liquefied gases and to report the gas calculations.
- **Automated Reporting of Gas Calculations**
  The analyzers include the PetroReporter software for data processing and reporting of the gas calculations. Examples of the included calculations are Liquid Volume, Molar Weight, Real Specific Gravity, CV, BTU etc.
- **Application Guarantee**
  Each analyzer is tested according to the in-house testing procedures to check the system performance and to verify the analyzer specification by a reference sample test. Factory Acceptance Test will be scheduled upon request.

Fast Analysis of Refinery Gases

Application Range

The Refinery Gas Analyzer determines:

- C1 – C5 Hydrocarbons
- C6+ Hydrocarbons
- Permanent gases:
  - Hydrogen
  - Oxygen
  - Nitrogen
  - Carbon Monoxide
  - Carbon Dioxide
- Hydrogen Sulfide
- Extended refinery gas analysis up to BTEX (optional)
- Customized gas components (optional)

Performance Specifications

- C1 – C5, Individual Hydrocarbons; C6+ group: 0.01 – 100 % Vol
- C9+, BTEX (Extended): 0.01 – 100 % Vol
- O_2/Ar, N_2, CO and CO_2: 0.02 – 100 % Vol
- H_2S: 0.1 – 10 % Vol; higher H2S content as option
- He and H_2: 0.02 – 100 % Vol

Standard Methods Compliance

Samples	Test Method
Refinery Gases	• ASTM D1946, D2504, D7833 • DIN51666 • EN 15984 • UOP539, UOP603
LPG	• ASTM D2163, D2593, D4424 • IP 405 • ISO 7941, EN27941
Gas Calculations	• ASTM D2598, D3588 • EN 589 • ISO 8973

High Quality GC Hardware

The DVLS Refinery Gas Analyzer is based upon the Agilent 8890 Gas Chromatograph (GC) with built-in intelligence and electronic pneumatic control (EPC). The Agilent Gas Chromatograph consists of three different channels; each channel is configured with its own detector. The system includes:

- a Flame Ionization Detector (FID)
- two Thermal Conductivity Detectors (TCD)
- a Split/Splitless injection port
- a DVLS Side Carrier with heated zones containing the valves and Molsieve columns
- Ultrasilc coated sample path
- PetroReporter software to report the composition and gas calculations

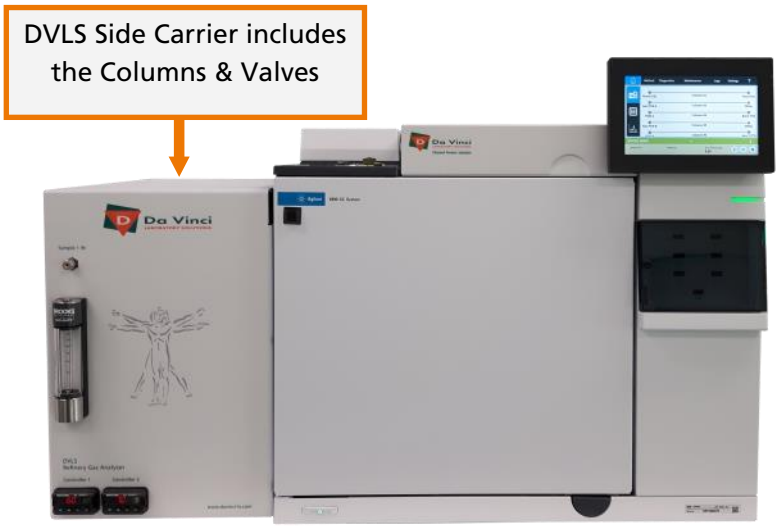


Figure One: The DVLS Refinery Gas Analyzer

The gas samples are simultaneously injected into three separate channels:

1. FID Channel determines C1-C5, C6+ group
2. Back TCD Channel separates Oxygen/Argon, Nitrogen, Carbon Monoxide, Carbon Dioxide and Hydrogen Sulfide
3. Aux TCD Channel determines Helium and Hydrogen

Customized Refinery Gas Analysis

Easy Column Regeneration

Da Vinci developed a side carrier that contains the columns and valves. This unique hardware design includes a built-in column conditioning which reduces the system downtime during the periodical regeneration of the Molsieve columns.

Figure Two: The heated DVLS Side Carrier

Customize your Analyzer

To customize your refinery gas analysis we offer various hardware options:

- Mode for extended refinery gas analysis up to BTEX
- Hydrogen Carrier
- a Liquid Sampling Valve (LSV) for the sampling of liquefied gases
- a Pressure Station for the sampling of (liquefied) gases
- a Vacuum Pump for sample introduction through the use of Tedlar bags
- Inert Valves for the use of corrosive gases
- Fourth Channel containing:
  - ✓ GSV- Column – Detector
  - ✓ Methanizer for the trace analysis of CO/CO_2 conform UOP603 or SCD/PFPD for Sulfur analysis

Representative Injection of Liquefied Gases

For a representative analysis, the sample must remain in the liquid phase during the injection process, this is especially required for LPG or other gases which are liquid under pressure.

Figure Three: DVLS Pressure Station

The DVLS Pressure Station (as shown in Figure Three) keeps the sample under pressure by using high pressure Nitrogen, which controls the outlet pressure and the flow through the sample loop.

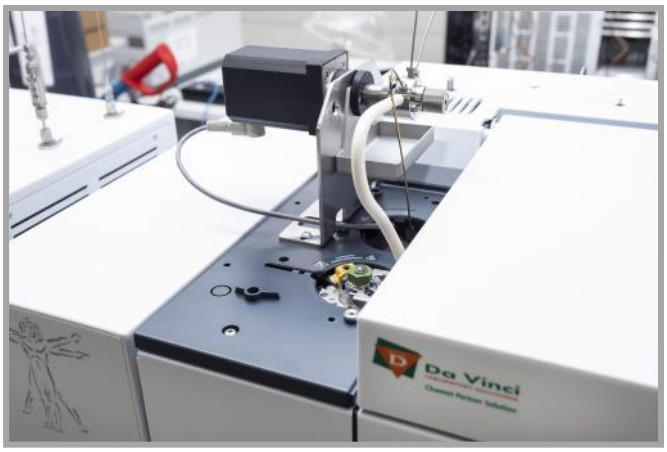


Figure Four: The Liquid Sampling Valve

Automation of Analysis Results

The Agilent GC is controlled by Agilent OpenLab software. The DVLS PetroReporter software automates all aspects of the calibration, gas analysis through customized data reporting.

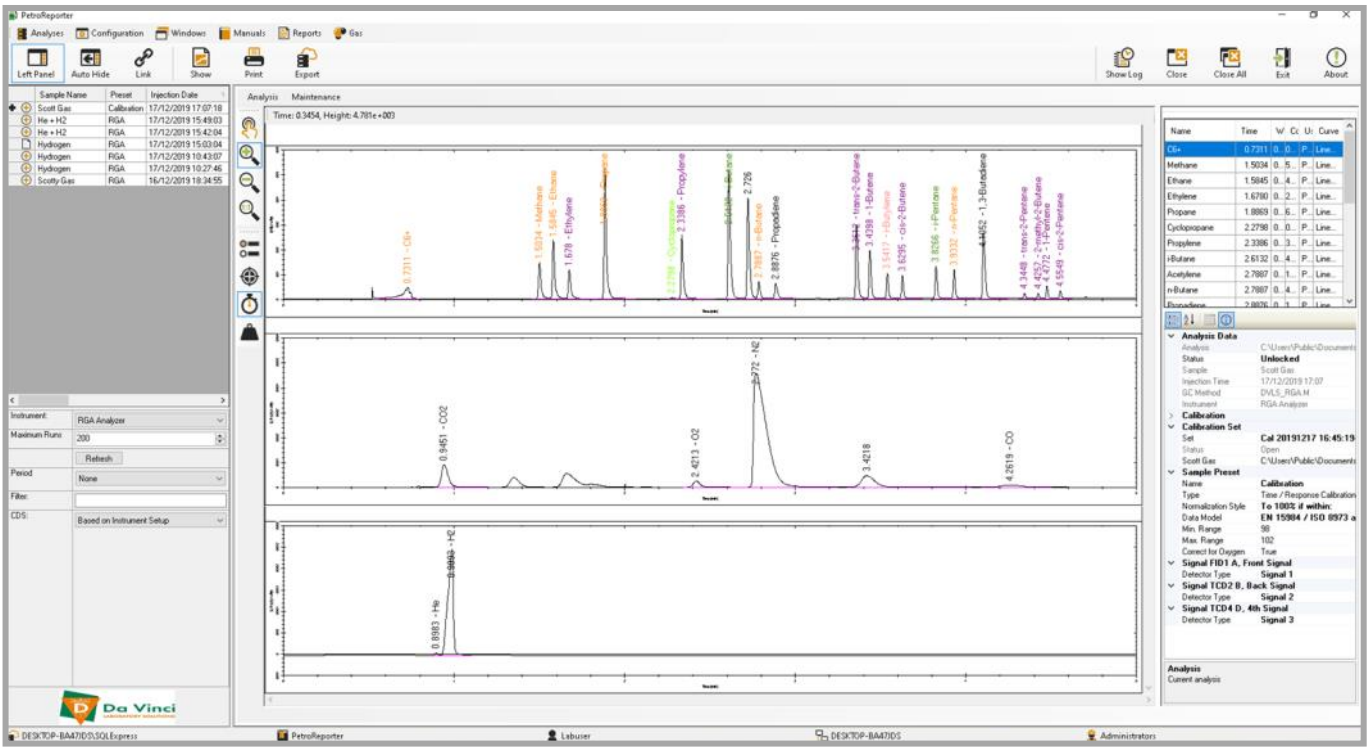


Figure Five displays the PetroReporter Main Menu of a refinery gas analysis

Multi CDS Compatibility

DVLS PetroReporter is compatible with following chromatographic data systems of major suppliers including:

- OpenLAB 2.x
- OpenLAB Chemstation
- OpenLAB EZChrom
- Other CDS interfaces on request such as:
  - Atlas
  - Chromeleon
  - Clarity
  - Compass
  - Totalchrom

Client-Server or Standalone Configuration

PetroReporter can be used either stand-alone or in a network configuration. The client-server architecture of the software allows to process the analysis data from any PC workstation.

Gas Calculations

The DVLS PetroReporter includes predefined calculations for the analyst, such as:

- ASTM, EN, ISO and UOP standard method calculations
- Carbon content
- Emission factor
- Heating Value, Calorific Value and BTU
- Liquid volume
- Molar mass
- Oxygen correction
- Relative Density
- Real specific gravity
- Vapor pressure
- Customized calculations (optional)

Automation of Analysis Results

Calibration

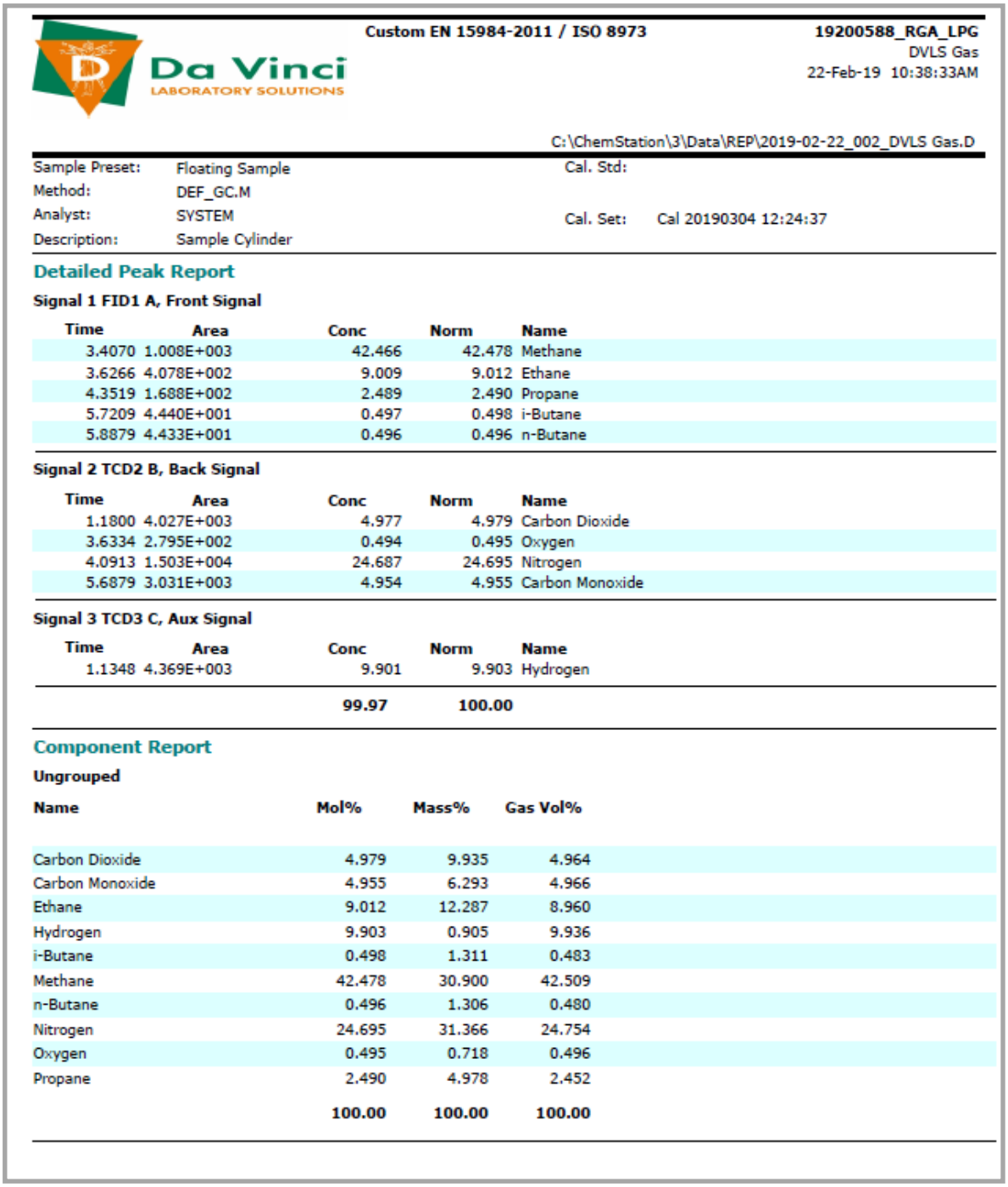
PetroReporter offers several calibration options:

- Single (Linear) calibration
- Multi-level calibration:
  - Linear through zero
  - Quadratic & Quadratic through zero
  - Cubic & Cubic through zero
- Relative Response factors

Gas Method Selection

Select one of the following method options:

- Selectable Gas method for calculation
- Defining calculations by temperature
- Calculation by 100 % normalization
- Calculation by un-normalization



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Custom EN 15984-2011 / ISO 8973

19200588_RGA_LPG
DVLS Gas
22-Feb-19 10:38:33AM

C:\ChemStation\3\Data\REP\2019-02-22_002_DVLS Gas.D

Sample Preset:	Floating Sample	Cal. Std:	
Method:	DEF_GC.M		
Analyst:	SYSTEM	Cal. Set:	Cal 20190304 12:24:37
Description:	Sample Cylinder		

Detailed Peak Report

Signal 1 FID1 A, Front Signal

Time	Area	Conc	Norm	Name
3.4070	1.008E+003	42.466	42.478	Methane
3.6266	4.078E+002	9.009	9.012	Ethane
4.3519	1.688E+002	2.489	2.490	Propane
5.7209	4.440E+001	0.497	0.498	i-Butane
5.8879	4.433E+001	0.496	0.496	n-Butane

Signal 2 TCD2 B, Back Signal

Time	Area	Conc	Norm	Name
1.1800	4.027E+003	4.977	4.979	Carbon Dioxide
3.6334	2.795E+002	0.494	0.495	Oxygen
4.0913	1.503E+004	24.687	24.695	Nitrogen
5.6879	3.031E+003	4.954	4.955	Carbon Monoxide

Signal 3 TCD3 C, Aux Signal

Time	Area	Conc	Norm	Name
1.1348	4.369E+003	9.901	9.903	Hydrogen
		99.97	**100.00**	

Component Report

Ungrouped

Name	Mol%	Mass%	Gas Vol%
Carbon Dioxide	4.979	9.935	4.964
Carbon Monoxide	4.955	6.293	4.966
Ethane	9.012	12.287	8.960
Hydrogen	9.903	0.905	9.936
i-Butane	0.498	1.311	0.483
Methane	42.478	30.900	42.509
n-Butane	0.496	1.306	0.480
Nitrogen	24.695	31.366	24.754
Oxygen	0.495	0.718	0.496
Propane	2.490	4.978	2.452
	100.00	**100.00**	**100.00**

Figure Six: ISO 8973 Report of a Calibration Gas generated by PetroReporter

Analysis Reports

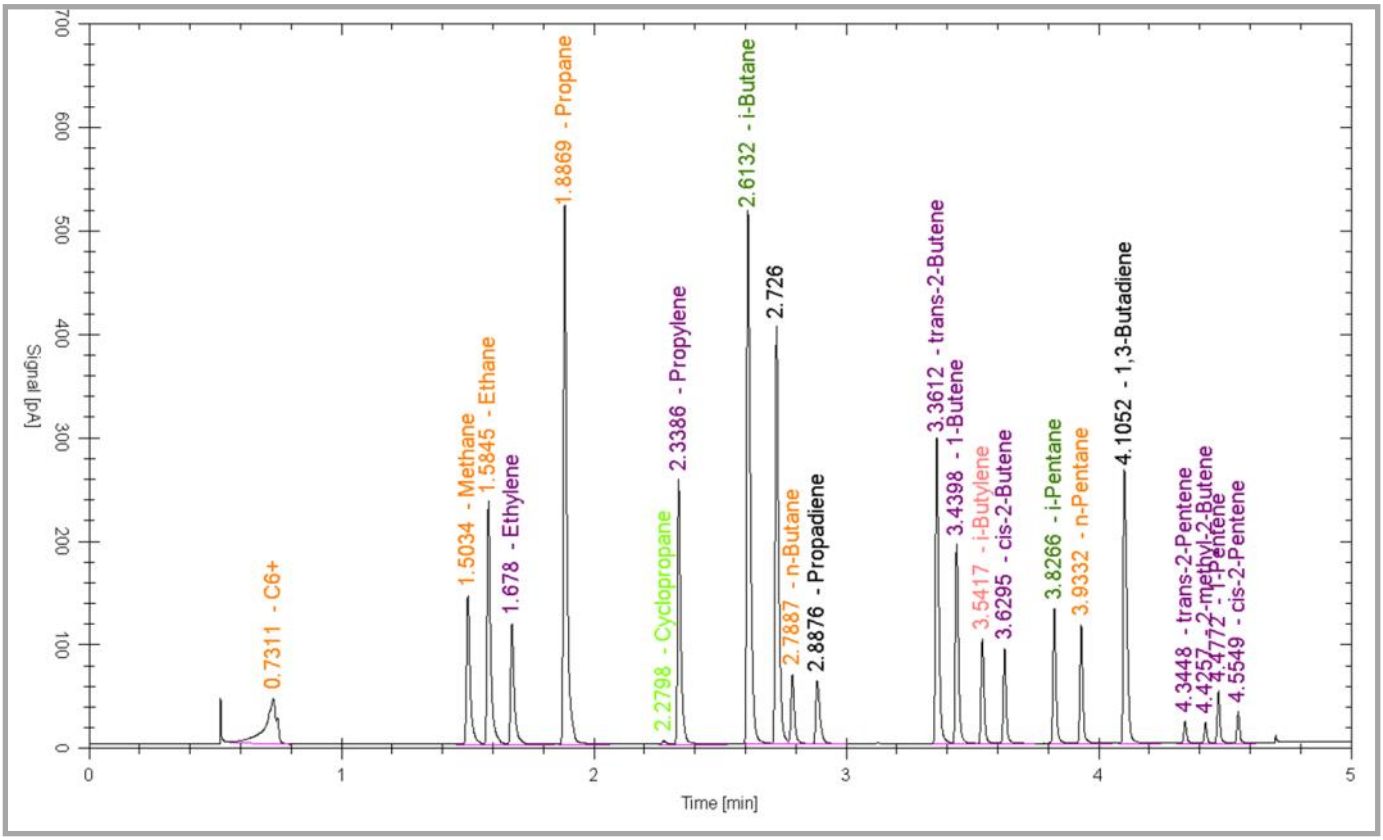

Figure Seven: RGA analysis of Hydrocarbons on the FID channel

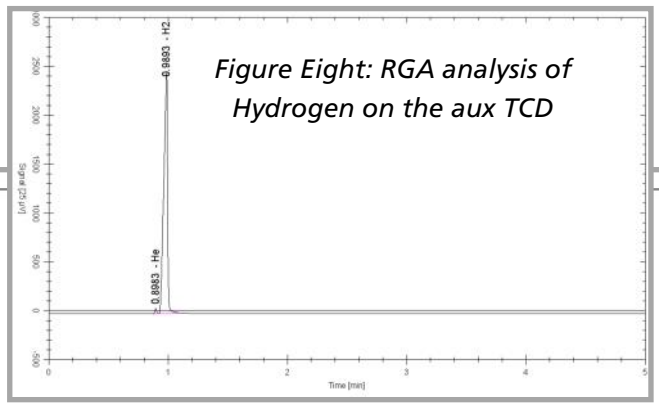

Figure Eight: RGA analysis of Hydrogen on the aux TCD

Figure Nine : RGA analysis of the permanent gases on the TCD channel

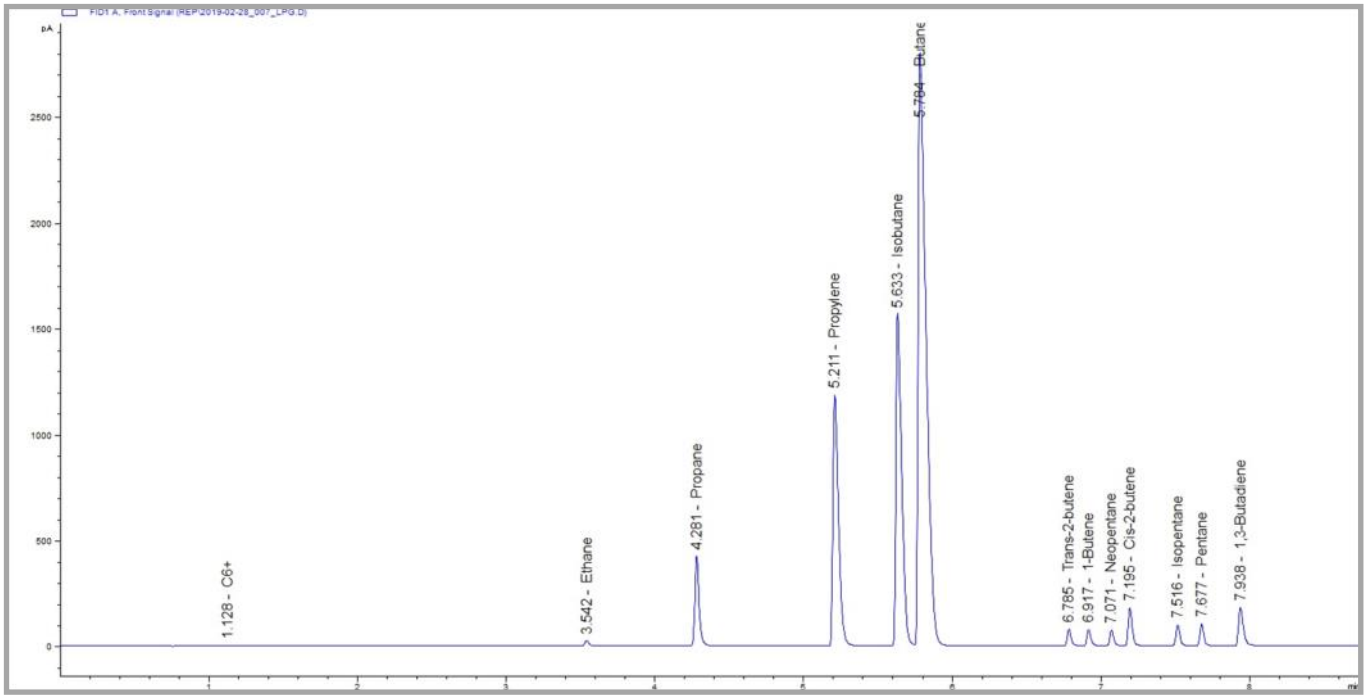

Figure Eleven : RGA analysis of Hydrocarbons in LPG on the FID channel

Physical Properties

Property	Result	
Relative Molweight	55.50	g/mol
Vapor Pressure DS4B	92.0	psig at 100°F (37.8°C)
Vapor Pressure DS4B	736	kPaa at 37.8°C (100°F)
Vapor Pressure DS4B	635	kPag at 37.8°C (100°F)
Vapor Pressure ISO 8973	565	kPa at 37.8°C
Vapor Pressure ISO 8973	593	kPa at 40°C
Vapor Pressure ISO 8973	738	kPa at 50°C
Vapor Pressure ISO 8973	1,213	kPa at 70°C
Vapor Pressure DS4B	106.7	psia at 100°F (37.8°C)
MON DS4B	93.1	
MON ASTM D2598	93.1	b
MON EN589	93.1	
MON EN589 extra	93.1	
Density LPG	558.5	kg/m3 at 15°C
MON ASTM D2598 extra	1.0	c
Density ISO 8973	559.6	kg/m3 at 15°C
Relative Density DS4B	0.5585	at 60F/60F
Relative Density DS4B	0.5586	at 15°C/Vac
Vapor Pressure ASTM D2598	101	kPa (Abs) at 37.8°C
Rel Density ASTM D2598	0.566	at 15.6°C/15.6°C (60°F/60°F)
Rel Density ASTM D2598 + DS4B	0.566	at 15.6°C/15.6°C (60°F/60°F)
Vapor Pressure ASTM D2598	264.3209	kpa at 60°F
Vapor Pressure ASTM D2598	470	kPag at 37.8°C (100°F)
Vapor Pressure ASTM D2598	38.3362	psi at 100°F
Vapor Pressure ASTM D2598	68	psig at 100°F (37.8°C)
Vapor Pressure ASTM D2598 + DS4B	68	psig at 100°F (37.8°C)
Vapor Pressure ASTM D2598 + DS4B	470	kPag at 37.8°C (100°F)
MON ASTM D2598	92.7	
MON ASTM D2598 + DS4B	92.7	
Density LPG	558.5	kg/m3 at 15°C
Vapor Pressure ISO 8973	32,938	kPa at 40°C
Vapor Pressure ISO 8973	40,953	kPa at 50°C
Vapor Pressure ISO 8973	67,342	kPa at 70°C

Figure Twelve : Physical Properties Report of an LPG generated by PetroReporter

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