Analysis Report

Water/Gas Samples

CAL-GT-01 - Grubbenvorst

Californie Wijnen

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1. Procedures Description

1.1. Sampling Sequence

Two gas samples were collected at the poor boy vent and two water samples before the separator at well AL-GT-01 - Grubbenvorst. The water samples were collected using the displacement procedure.

The two pressurized gas samples were collected from the gas line at the same pressures, temperature and flow rates.

Because the gas is cooling on its path from the separator, there is likely to be liquid running within the pipework leading from the separator.

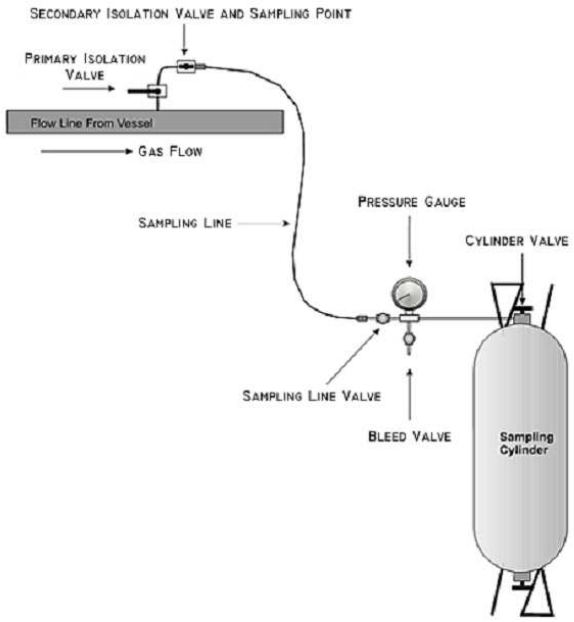

Figure 1 – Gas Sampling

Similarly, the thermal contraction of the water or gas slippage into the pipework may result in free gas travelling along the liquid line.

Therefore, the water sample was collected at the bottom of the water leg to avoid collecting cushion gas, and the gas sample was collected at the top of the gas line to avoid collecting condensed liquid.

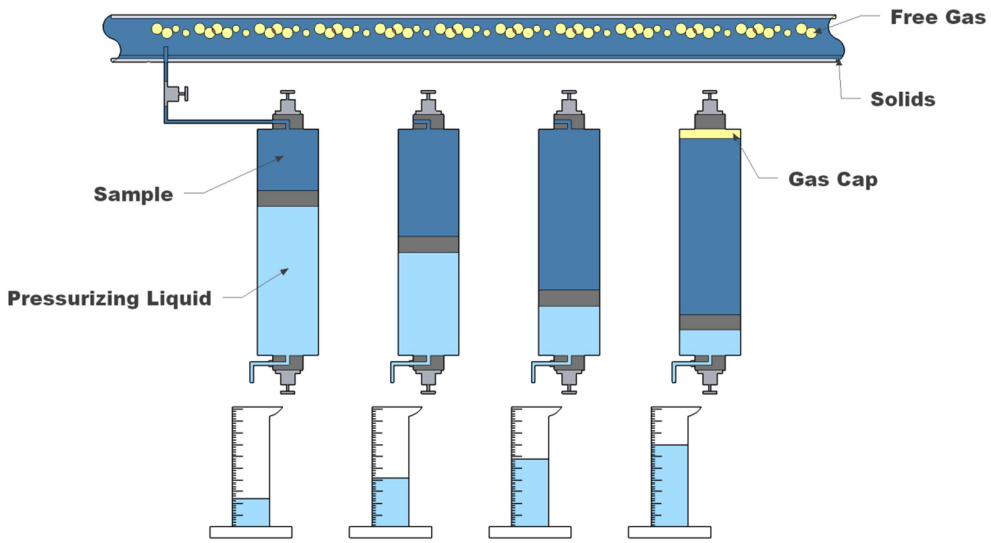

Figure 2 - Water Sampling

1.2. Samples Preliminary Checks and Analysis

1.2.1. Visual Inspection upon Receiving the Samples

Upon receipt, the samples were visually inspected for any obvious faults, i.e. leaks, bent valves or any other mechanical problems. All the sample cylinders were all found to be in good condition.

1.2.2. Opening Pressure Measurement

The pressurized sample cylinders at room temperature were connected at the pressurizing water end to a high pressure pump, the opening pressure was read at the pump display.

For the gas cylinders, a pressure gauge was attached to the top valve at room temperature. The opening pressure was directly read at the gauge.

1.2.3. Gas Bottle Water Check

With the gas sample in a vertical position, a few cc's were purged from the bottom valve in order to check the water content.

No water was found.

1.2.4. Gas H_2S Presence Check

With the gas samples in a vertical position, a few cc's were purged on a paper strip imbibed with Lead Acetate. H_2S reacts specifically with lead acetate to form a lead sulfide brown stain.

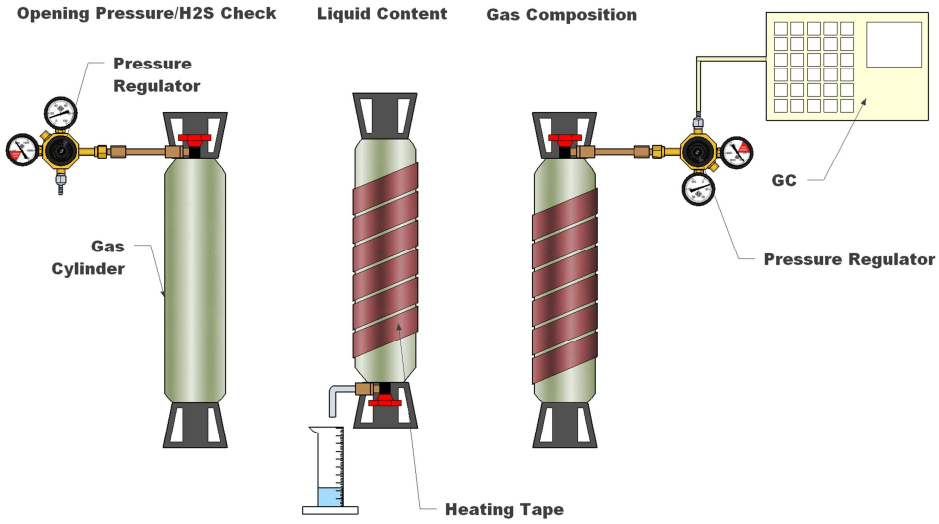

Figure 3-Gas Samples Quality Check

1.2.5. Samples Restoration

The liquid samples were pressurized to the working pressure and stabilized by shaking.

While connected to a positive displacement pump, the samples were heated up to a temperature of 95^0C and homogenized for 24 hours prior to any removal of samples.

1.2.5.1. Flash Separation

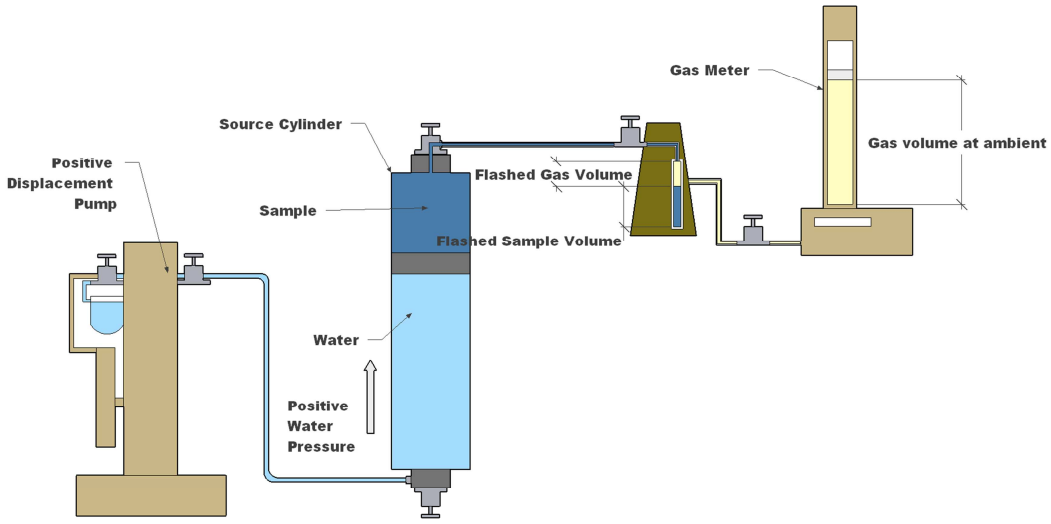

Figure 4 - Flash Separation Layout

A volume of a single-phase water was pumped from the sample cylinders into a trap connected to a gas meter at atmospheric conditions of pressure and temperature.

The flashed water and gas volumes, separation temperatures and atmospheric pressures were accurately recorded. The composition of gas was subsequently measured using the procedure described below. The flash GWR (gas water ratio) was calculated as the ratio between the flashed liquid and the collected gas.

1.2.5.2. Sample Composition

The resulted gas fractions from the flash and the oil collected from the annulus were analyzed using the gas chromatography procedure.

1.2.5.2.1 Gas Composition

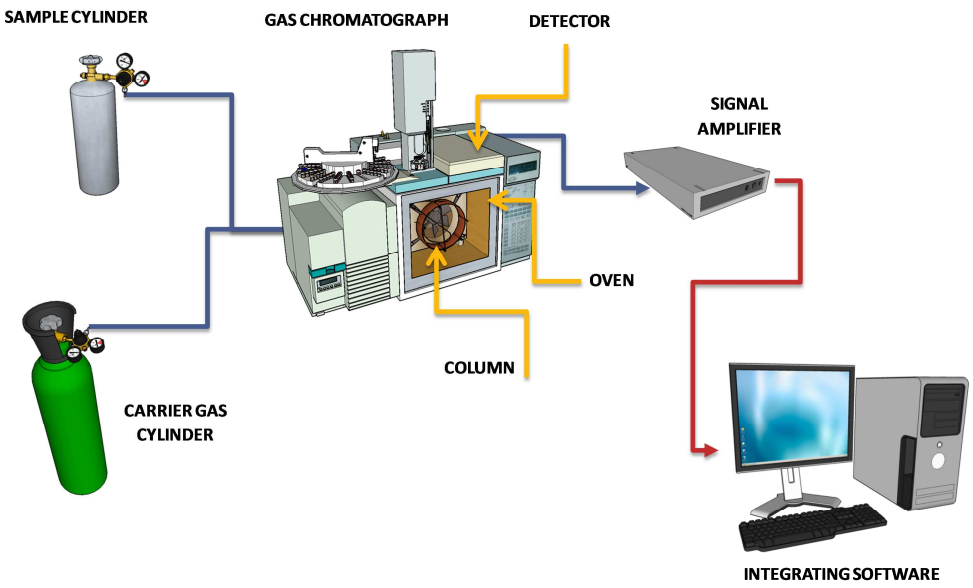

Figure 5 - General Chromatographic Procedure Layout

Compositions up to C_{11+}were measured. Components: porous polymer and mole sieve columns, TCD detector (for C_1-C_3, permanent gases), capillary column and FID detector (for C_4 to C_{11+}).

1.2.5.3. Water Analysis

1.2.5.3.1 Full Water Analysis

ICP is used to identify and quantify the positive ions present in water samples.A standard measurements as presented in a water analysis report consists of the following elements; Sodium, Potassium, Magnesium, Calcium, Aluminum, Barium, Strontium and Other elements can be investigated on special request.

- The chloride content will be measured by Argent metric method.

- The content of hydroxide, carbonate and bicarbonate will be measured by titration.

- The sulfate content will be measured by turbidity method or a spectrophotometer.

- The hardness of the water samples will be calculated by based on the content of Calcium and Magnesium. Values will be reported as $CaCO_3$ content in ppm, grains per gallon and Degrees German (G.D.H.)

- Specific gravity of the water sample will be either measured by a pycnometer or densitometer.

- PH will be measured.

2. Provided Information

2.1.1. Summary of Well Data

Well: CAL-GT01

Reservoir Fluid: Water/Gas

Reservoir Pressure: 635 psia

Reservoir temperature: n/a ^{0}C

Vertical Depth: n/a m

2.1.2. Summary of Sampling Data

Table 1-Summary of Sampling Data

Sample type	Well	Sampling Point	Sample no.	Date Sampling	Sep Water Leg Pressure (barg)	Sep Gas Line Pressure (barg)	Sep Average Temperature (^{o}C)	Line Water Flow Rate (liter/sec)	Sep Gas Flow Rate (m^3/hr)
Pressurized Water	CAL-GT01	Before Choke	Sample 1 (water)	7 August 2012	n/a	atm	80	65.4	n/a
Pressurized Waters	CAL-GT01	Before Choke	Sample 2 (water)	7 August 2012	n/a	atm	80	65.12	n/a
Pressurized Gas	CAL-GT01	Poor Boy Vent	Sample 1 (gas)	7 August 2012	n/a	atm	80	n/a	n/a
Pressurized Gas	CAL-GT01	Poor Boy Vent	Sample 2 (gas)	7 August 2012	n/a	atm	80	n/a	n/a

3. Analysis Results

3.1. Preliminary Check Results

Table 2-Preliminary Check Results

Sample Type	Sample no.	Opening Pressure (psig)	Opening Temperature (^{0}C)	Sample Volume (cc)
Pressurized Water	Sample 1 (water)	54	24	700
Pressurized Water	Sample 2 (water)	53	24	700
Pressurized Gas	Sample 1 (gas)	atm	24	20000

3.2. Gas Compositional Analysis

Table 3-Gas Composition Sample no. 1 (Gas)

Component		Mole%	Weight
H_2	Hydrogen	0.000	0.000
H_2S	Hydrogen Sulphide	0.000	0.000
CO_2	Carbon Dioxide	36.573	48.415
N_2	Nitrogen	57.644	48.571
C1	Methane	5.610	2.707
C2	Ethane	0.000	0.000
C3	Propane	0.141	0.187
C4	i-Butane	0.000	0.000
C4	n-Butane	0.000	0.000
C5	i-Pentane	0.000	0.000
C5	n-Pentane	0.000	0.001
C6	Hexanes	0.002	0.004
	MC Pentane	0.000	0.000
	Benzene	0.000	0.000
	Cyclohexane	0.000	0.000
C7	Heptanes	0.001	0.003
	MC Hexane	0.000	0.000
	Toluene	0.001	0.003
C8	Octanes	0.004	0.012
	E-Benzene	0.000	0.000
	M/P Xylene	0.000	0.000
	O-Xylene	0.001	0.002
C9	Nonanes	0.004	0.014
	1,2,4 TMB	0.000	0.001
C10	Decanes	0.009	0.038
C11+	Undecanes +	0.010	0.042
	Total	100.0	100.0

Calculated Gas Properties	
Gas Density (kg m^{-3} @ 0°C)	1.486
Gas Mole Weight (g mol^{-1})	33.246
Real Relative (to air) Density of Gas @ 0°C	1.149
Mole weight of Heptanes Plus (g mol^{-1})	129.430
Density of Heptanes plus (g cm^{-3} at 60°F)	0.780
Mole Weight of Undecanes plus (g mol^{-1})	147.000
Density of Undecanes plus (g cm^{-3} at 60°F)	0.789
Gross Calorific Value (MJ m^{-3}) @ Combustion Temp of 25^{0}C (superior) and @ metered temperature of 0^{0}C	2.431

Table 4- Flashed Gas Composition Sample no. 1 (water)

Component		Mole%	Weight
H_2	Hydrogen	0.000	0.000
H_2S	Hydrogen Sulphide	0.000	0.000
CO_2	Carbon Dioxide	74.763	69.216
N_2	Nitrogen	6.764	3.986
C1	Methane	2.858	0.965
C2	Ethane	0.000	0.000
C3	Propane	1.715	1.591
C4	i-Butane	0.170	0.207
C4	n-Butane	1.655	2.023
C5	i-Pentane	0.554	0.841
C5	n-Pentane	2.007	3.045
C6	Hexanes	2.745	4.850
	MC Pentane	0.240	0.424
	Benzene	1.911	3.141
	Cyclohexane	0.387	0.686
C7	Heptanes	1.273	2.571
	MC Hexane	0.462	0.955
	Toluene	1.106	2.143
C8	Octanes	0.702	1.581
	E-Benzene	0.024	0.054
	M/P Xylene	0.115	0.257
	O-Xylene	0.034	0.076
C9	Nonanes	0.279	0.710
	1,2,4 TMB	0.011	0.031
C10	Decanes	0.173	0.488
C11+	Undecanes +	0.051	0.158
	Total	100.000	100.000

Calculated Gas Properties	
Gas Density (kg m^{-3} @ 0°C)	2.144
Gas Mole Weight (g mol^{-1})	47.537
Real Relative (to air) Density of Gas @ 0°C	1.659
Mole weight of Heptanes Plus (g mol^{-1})	93.220
Density of Heptanes plus (g cm^{-3} at 60°F)	0.799
Mole Weight of Undecanes plus (g mol^{-1})	147.000
Density of Undecanes plus (g cm^{-3} at 60°F)	0.789
Gross Calorific Value (MJ m^{-3}) @ Combustion Temp of 25^0C (superior) and @ metered temperature of 0^0C	27.662

Table 5- Flashed Gas Composition Sample no. 2(water)

Component		Mole%	Weight
H_2	Hydrogen	0.000	0.000
H_2S	Hydrogen Sulphide	0.000	0.000
CO_2	Carbon Dioxide	48.342	50.719
N_2	Nitrogen	31.627	21.121
C1	Methane	3.704	1.416
C2	Ethane	0.000	0.000
C3	Propane	2.889	3.037
C4	i-Butane	0.036	0.050
C4	n-Butane	1.180	1.635
C5	i-Pentane	0.105	0.181
C5	n-Pentane	10.279	17.679
C6	Hexanes	0.376	0.754
	MC Pentane	0.002	0.005
	Benzene	0.258	0.480
	Cyclohexane	0.061	0.122
C7	Heptanes	0.275	0.629
	MC Hexane	0.128	0.300
	Toluene	0.295	0.647
C8	Octanes	0.279	0.712
	E-Benzene	0.006	0.015
	M/P Xylene	0.016	0.039
	O-Xylene	0.005	0.013
C9	Nonanes	0.050	0.146
	1,2,4 TMB	0.001	0.004
C10	Decanes	0.025	0.078
C11+	Undecanes +	0.062	0.219
	Total	100.000	100.000

Calculated Gas Properties	
Gas Density (kg m^{-3} @ 0°C)	1.883
Gas Mole Weight (g mol^{-1})	41.947
Real Relative (to air) Density of Gas @ 0°C	1.457
Mole weight of Heptanes Plus (g mol^{-1})	97.742
Density of Heptanes plus (g cm^{-3} at 60°F)	0.790
Mole Weight of Undecanes plus (g mol^{-1})	147.000
Density of Undecanes plus (g cm^{-3} at 60°F)	0.789
Gross Calorific Value (MJ m^{-3}) @ Combustion Temp of 25^{0}C (superior) and @ metered temperature of 0^{0}C	26.019

3.3. Flashes Results

Flash StandardGas Water Ratio Sample 1 (water): 43.9liters of gas at standard conditions /$m^3$of water at standard conditions

Flash Standard Gas Water Ratio Sample 2 (water): 34.0liters of gas at standard conditions /$m^3$of water at standard conditions

3.4. Water Compositional Analysis

Anions

Table 6 – Water Composition

Chloride (Cl^-)	48000 mg/l
Bicarbonate(HCO_3^-)	360 mg/l
Carbonate ($CO_3^=$)	< 10 mg/l
Sulphate(SO4=)	15 mg/l

Cations

Sodium(Na^+)	23800 mg/l
Calcium(Ca^{+2})	3580 mg/l
Magnesium (Mg^{+2})	533 mg/l
Potasium (K^+)	1600 mg/l
Iron (Fe^{+2})	29.2 mg/l
Barium (Ba^{+2})	6.7 mg/l
Aluminium (Al^{+3})	133 mg/l
Strontium (Sr^{+2})	163 mg/l

pH(at 20.°C)	6.7
Total Dissolved solids (TDS)	78101 mg/l
Ca/Mg Hardness as CaCO3	11140 mg/l
Specific gravity	1.054 g/cm3 at 20.°C
Resistivity	0.11 Ohms/meter

3.5. Graphs

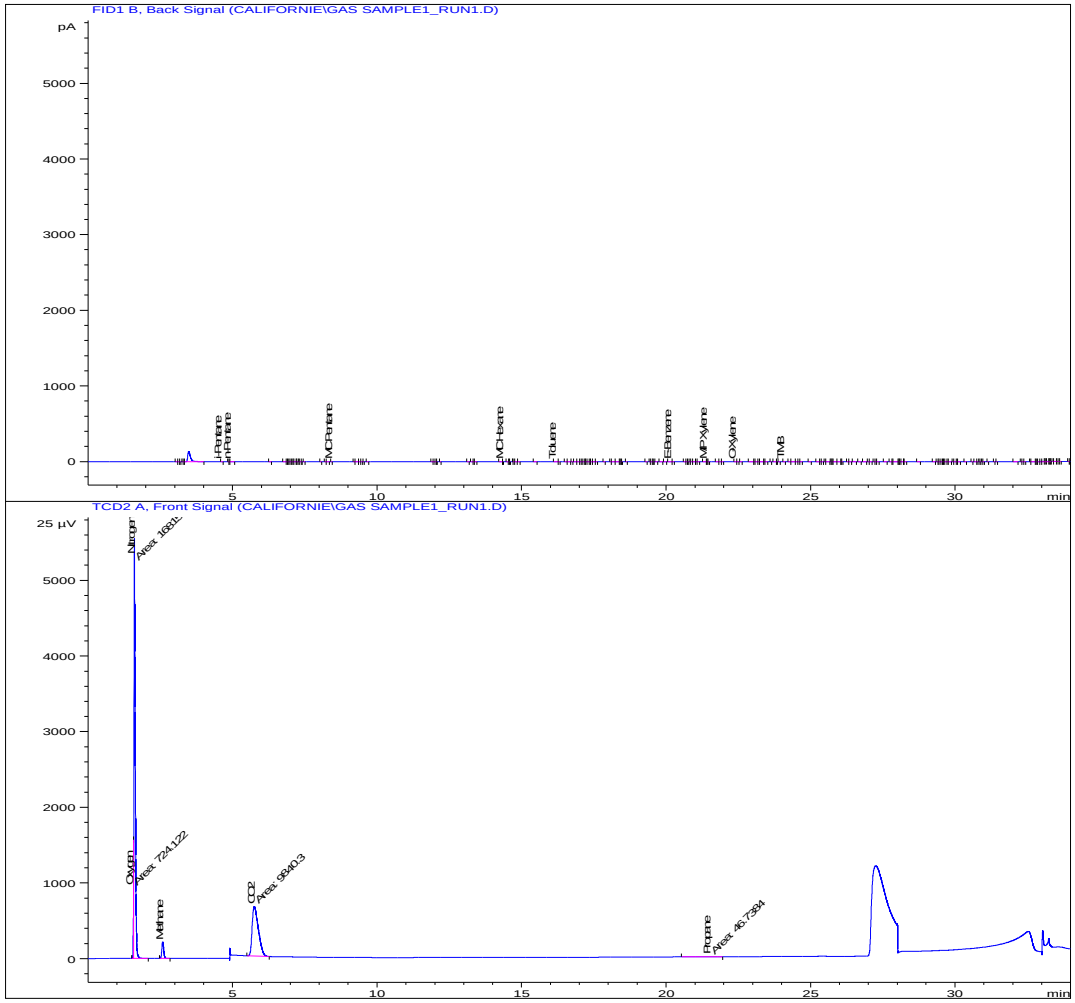

Figure 6-Gas Chromatogram Sample no. 1 (Gas)

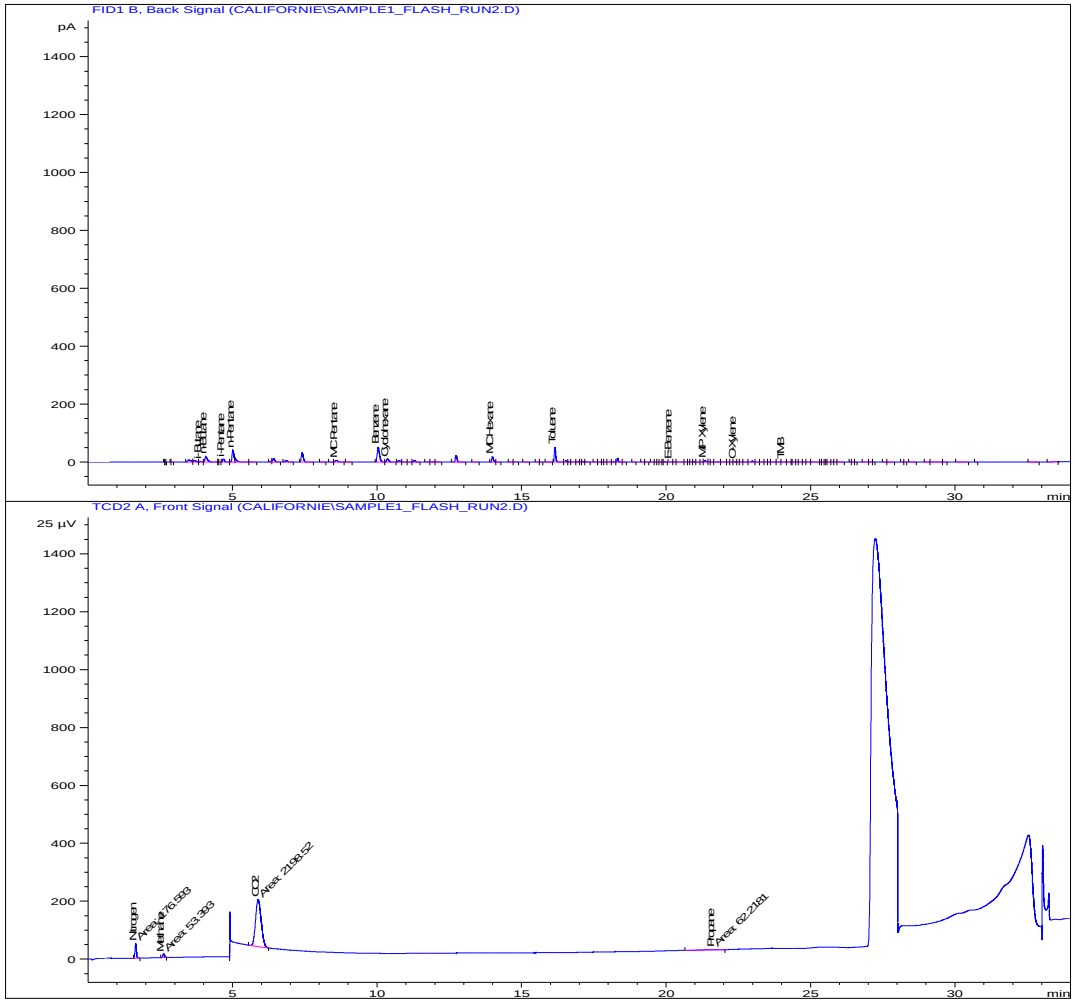

Figure 7-Flashed Gas Chromatogram Sample no. 1 (water)

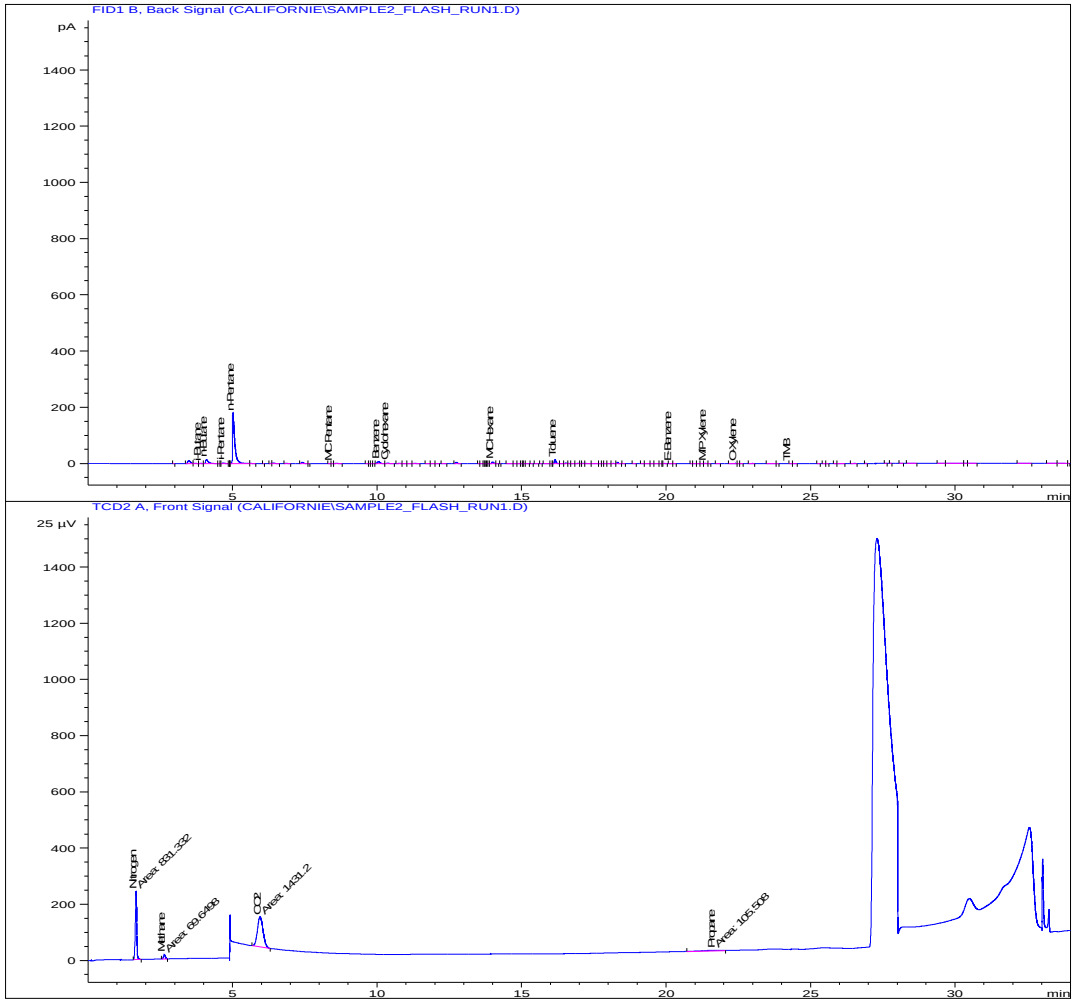

Figure 8-Flashed Gas Chromatogram Sample no. 2 (water)