Schlumberger

Gas Condensate PVT Study on Separator Samples

Prepared for

Encana Corporation

Well: **13-05-043-06W5**
Field: **Duvernay**

By

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EXECUTIVE SUMMARY

Encana Corporation contacted Schlumberger DBR Technology Center, a division of Schlumberger Canada Limited, in Edmonton, Alberta, Canada to perform PVT studies on set of separator samples from gas condensate reservoir. DBR Technology Cender received 1 set of separator samples collected during flow back and 3 sets of separator samples collected during well stabilization from Well: 13-05-043-06W5 from Duvernay field. Sample restoration, sample validation, recombination, constant composition expansion (CCE) and constant volume depletion (CVD) tests were performed on these samples.

Main results are summarized as follows:

Table Summary of PVT Results

Properties	**Results**
Reservoir Conditions:	
Pressure (psia)	~ 7,542 psia (~ 52 MPa)[a]
Temperature (°C)	106 °C[a]
Dew Point Pressure at Tres (psia):	4,661 at 106 °C
Properties at Saturation Conditions:	
Z-factor	0.992
Density (g/cm^3)	0.334
Properties at 60 °F:	
Measured Stock Tank Condensate Density	0.777 g/cm^3

Note: "a" reservoir pressure and temperature were provided by Encana Corporation.

NOMENCLATURE

Symbols

API	American Petroleum Institute gravity of stock tank oil
C_g	gas compressibility
C_{n+}	group of components heavier than n-1 (paraffins with n carbon atoms)
C_o	liquid compressibility
C_{7+}	group of components heavier than hexanes
p	pressure
p_d	dew point pressure
p_{res}	reservoir pressure
T	temperature
T_{res}	reservoir temperature
V	volume
V_d	volume at dew point conditions
V_g	gas volume
V_{sat}	volume at saturation point
V_{tot}	total volume
Z	gas deviation factor
Z_2	two-phase deviation factor
ρ	density

Subscripts

b	bubble point
d	dew point
g	gas
L	liquid

RES	reservoir
sat	saturation point
sc	STP conditions
sep	separator condition
sto	stock tank condition
Tot	total
2	two-phase

Acronyms

CCE	Constant Composition Expansion
CVD	Constant Volume Depletion
PVT	Pressure-Volume-Temperature
STO	Stock Tank Oil
STP	Standard Temperature & Pressure
VLE	Vapor Liquid Equilibrium

Standard Conditions (STP)

Temperature: 15.56 °C or 60 °F

Pressure: 101.33 kPa or 14.696 psia

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1.0 INTRODUCTION

Encana Corporation required fluid property and phase behavior studies on gas condensate fluid samples collected from the Well: 13-05-043-06W5 in Duvernay field. DBR Technology Center, a division of Schlumberger Canada Limited, located in Edmonton, Alberta, Canada was commissioned to perform the scope of work outlined below on separator samples provided by Encana.

2.0 SCOPE OF WORK

2.1 Sample Preparation and Compositional Analysis

On all Separator Liquid samples:

- Determine opening pressure of each cylinder at ambient temperature.
- Restore surface condensate sample at sampling temperature and a pressure greater than sampling pressure for 24 hours.
- GOR, STO API, and compositional analysis of conditioned separator samples.

On all Separator Gas samples:

- Restore separator gas sample at a temperature slightly higher than sampling temperature and hand rock occasionally for 24 hours.
- Gas analysis of conditioned separator sample to C15+.
- Boost separator gas as needed.

For Separator Samples:

- Physically recombine separator fluid to a Separator GOR.
- Recombine live fluid equilibration and homogenization for 2 days.
- Single-stage flash of recombined fluid to ambient conditions to measure GOR, STO API, and composition of flashed gas to C15+ and liquid to C30+.

2.2 PVT Analysis

Conduct constant composition expansion (CCE) test at reservoir temperature: relative volume, Z-factor, and density, on both a selected Downhole Sample and Recombined Fluid.

Conduct constant volume depletion (CVD) test at reservoir temperature.

- Z-factor (gas and 2 -phase)
- Cumulative mole produced
- Retrograde liquid volume
- Gas molar mass, viscosity and density

- Hydrocarbon analysis of produced well stream from CVD
- Properties of plus fractions (mole%, molar mass and density).

3.0 SAMPLE INVENTORY

One set of separator samples (sample 1.01 and 1.02) were collected during flow back period and were received in DBR Technology Center on 06-Feb-2012. Three sets of separator samples (sample 2.01 to 2.09) were then collected after well stabilization. These samples were received on 21-Feb-2012. Upon arrival, opening pressure of each cylinder was measured. The following table lists the details of each cylinder received with measured opening pressure at ambient temperature, ~21.8 °C.

Table 1 Sample Inventory

Sample Type	Sample ID	Cylinder #	Opening Pressure (psia) @ 21 °C	Sampling Pressure, psia	Sampling Temperature, °C	Sample conditioned at psia/ °C
Separator Gas	1.01	A00015	130	170	33	170 / 50
Separator Liquid	1.02	16653-IB	100	160	33	3000 / 50
Separator Gas	2.01	5627	100	130	25	130 / 50
Separator Gas	2.02	5619	100	130	25	130 / 50
Separator Liquid	2.03	16347-IB	90	120	25	3000 / 50
Separator Gas	2.04	4929	100	130	25	130 / 50
Separator Gas	2.05	A00010	100	130	25	130 / 50
Separator Liquid	2.06	7686-QA	75	120	25	3000 / 50
Separator Gas	2.07	4923	100	130	25	130 / 50
Separator Gas	2.08	4932	100	130	25	130 / 50
Separator Liquid	2.09	16652-IB	115	120	25	3000 / 50

4.0 EXPERIMENTAL

A brief explanation of the experimental procedures used in this condensate study follows. A detailed description of experimental equipment and general experimental procedures can be found in the Appendix.

4.1 Cylinder Opening Pressure Check and Restoration

Upon arrival at in the laboratory, sample cylinders were connected to a 20,000 psia pump from the water side to check opening pressure at ambient temperature. Surface condensate samples were heated to separator sampling temperature, pressurized to pressures higher than sampling pressure and allowed to equilibrate at those conditions for 24 hours under continuous rocking. This process aids in dispersing any precipitated/coagulated wax and/or asphaltene particles that may be present into solution. The separator gas sample cylinders were heated to a temperature slightly higher than sampling temperature, pressured to slightly higher than opening pressure and allowed to equilibrate at those conditions for 24 hours under continuous rocking. Sample conditioning details are listed in Table 1.

4.2 Sample Validation and Integrity Check

Following sample preparation and conditioning, a sub-sample of each condensate was then flashed to ambient conditions (~13.6 psia and 21.8 °C) to measure its GOR and to analyze its C_{30+} composition. The separator gas samples were sampled directly and analyzed to C_{15+}.

The flashed liquid composition was analyzed with a temperature programmed GC equipped with a capillary column and a FID (flame ionization detector) detector with helium as the carrier gas. The detection range covered C_1 to C_{29} and was lumped for C_{30+}.

Compositional analysis of the gas phase was performed with a gas chromatograph (GC) configured for extended gas analysis. The GC is consisted of packed columns, a TCD (thermal conductivity detector) detector and used helium as a carrier gas. Detection range covers N_2, CO_2 and C_1 to C_2. The extended gas configuration consisted of a capillary column, a FID detector and used helium as a carrier gas. The detection range covered C_1 to C_{15} including associated common isomers and were as lumped for C_{16+}.

The GCs, which are maintained weekly, were proper calibrated before the tests to ensure quality. Additional details on GC analysis are provided in the Appendix.

4.3 Reservoir Fluid Recombination

Recombined reservoir fluid with a specified GOR was produced by charging a pre-calculated amount of separator oil into a high-pressure cylinder and then adding a pre-calculated amount of separator gas which had been boosted to 4,500 psia at ambient temperature prior to its addition to the cylinder. The mixture was then homogenized for approximately 5 days under continuous rocking. Following recombination, a sub sample was taken for compositional analysis.

In this study surface samples were recombined to an overall GOR as agreed to by Encana Corporation representative. In the calculation, gas flow rate and condensate flow rates were used to determine the recombination GOR and subsequently the amount of separator gas to be added.

4.4 Standard PVT Analyses

PVT analyses, including constant composition expansion (CCE) and constant volume depletion (CVD), were performed using a standardized procedure as described in the Appendix.

A mini-separator test (single-stage) was also performed as per Encana request. The single-stage separator condition was decided to be 800 kPag (130.7 psia) and 10^{o}C. A known mass of homogenized fluid is transferred into the PVT cell and first equilibrated at the dew point pressure and reservoir temperature. The pressure and temperature are then set to the first specified separator condition and the system is allowed to equilibrate. Subsequently, the equilibrium vapor is displaced at these conditions. The composition of and volume of this displaced vapor were not measured. Next, equilibrium liquid sample is isobarically flashed (very slowly) to atmospheric pressure and the GOR was measured. This GOR was then corrected to tank condition in scf/stb from atmospheric conditions.

4.5 Other Analyses

A sub-sample from conditioned separator condensate sample was flashed to atmospheric pressure to obtain dead condensate for various analyses.

Stock Tank Condensate Viscosity Measurements

The stock tank condensate viscosity was measured using electromagnetic viscometer (EMV). The details of EMV can be found in the Appendix.

Stock Tank Condensate Wax Appearance Temperature (WAT)

The stock tank condensate wax appearance temperature (WAT) was measured using cross polar microscope (CPM).

Stock Tank Condensate Asphaltene Content

The asphaltene content of stock tank oil was measured using IP-143 method.

4.6 Hydrate Formation Locus with DBRHydrate

The hydrate formation locus was generated using DBRHydrate software using reservoir fluid compositions from recombined sample. First, the vapor liquid phase envelop was generated using Peng-Robinson (1978) equation of state (EoS) with volume translition. Lee-Kesler (1976) correlation was used for Tc, Pc and omega. Exponential (Pedersen, 1988) distribution function was used in the tuning. The EoS model was first tuned to experimental dew point pressure data at reservoir temperature. The Tuned VLE data was then used in DBRHydrate software to predict the hydrate phase boundaries under various conditions with water and thermodynamic hydrate inhibitors i.e. pure water, saline water with 4 wt% (40,000 ppmw) NaCl and 10 wt% - 20 wt% - 30 wt% - 40 wt% methanol solutions (all with pure water).

5.0 RESULTS AND DISCUSSION

5.1 Results of Initial Sample Validation

A free water check was performed on the separator samples following conditioning and no water was detected in the sample cylinders. Separator liquid samples were validated by a GOR measurement and the Separator gas samples were analyzed directly by GC. The results of initial sample validation are presented from Table 2 to Table 13.

5.2 Separator Sample Recombination

One separator gas (sample no. 2.08, cylinder # 4932) and one separator liquid (sample no. 2.09, cylinder # 16552-IB) were recombined using a field separator GOR of 10,740 scf/sep bbl, which was provided by Encana. The result of mathematically recombined fluid composition is shown in Table 14.

After physical recombination and conditioning, the recombined sample was verified by a GOR test and the results. The results of physically recombined fluid compositions are shown in Table 15 and Table 16. The measured recombined fluid composition was very close to the mathematically computed values.

5.3 Phase Behavior (PVT) Measurements

The CCE and CVD tests were performed on Recombined Samples at the reservoir temperature of 106 °C. The results of CCE test at reservoir temperature are presented in Table 17 and Figure 2 to Figure 5.

The measured dew point, 4,661 psia, was below to reservoir pressure = ~ 52 MPa (7542 psia) indicating that the reservoir fluid was above the saturation pressure inside the reservoir while separator sampling. The maximum retrograde liquid dropout (RLD) from CCE test at reservoir temperature was found to be 16.96 % Vliq/Vsat.

The results of CVD test at reservoir temperature are presented in Table 18 and Table 20 and Figure 6 to Figure 10.

A mini-separartor test (single-stage) was performed to measure the GOR of the equilibrium liquid at 800 kPag (130.7 psia) and 10^{o}C. The GOR of this equilibrium liquid sample is experimentally found to be 231.7 scf/stb.

5.4 Other Analyses

Stock Tank Condensate Viscosity Measurements

The stock tank condensate viscosity was measured using electromagnetic viscometer (EMV). The results of stock tank condensate viscosity measurements are shown in Table 21. As expected the viscosity of dead condensate increased with decrease in temperature.

Stock Tank Condensate Wax Appearance Temperature (WAT)

The stock tank condensate wax appearance temperature (WAT) was measured using cross polar microscope (CPM). The WAT of dead condensate was found to be 9.4 ^{o}C. The result of WAT are presented in Table 22 and Figure 11.

Stock Tank Condensate Asphaltene Content

The asphaltene content of stock tank oil was measured using IP-143 method and was found to be < 0.1 wt%.

5.5 Hydrate Formation Locus with DBRHydrate

The hydrate formation locus was generated using DBRHydrate software using reservoir fluid compositions from recombined sample. The results of VLE phase boundary and hydrate phase boundaries under various scenarios are presented in Table 24 and Table 25 and also depicted in Figure 12 and Figure 13. It can be seen that hydrate phase boundary can be shifted left with methanol as thermodynamic hydrate inhibitor.

TABLES AND FIGURES

Table 2 Compositions of Separator Gas Sample 1.01 (cylinder # A00015)

Component	MW (g/mol)	Separator Gas wt %	Separator Gas mole %
CO2	44.01	0.978	0.490
H2S	34.08	0.000	0.000
N2	28.01	0.993	0.781
C1	16.04	54.123	74.340
C2	30.07	19.011	13.931
C3	44.10	12.314	6.154
i-C4	58.12	2.703	1.025
n-C4	58.12	4.968	1.883
i-C5	72.15	1.488	0.454
n-C5	72.15	1.530	0.467
C6	84.00	1.078	0.283
Mcyclo-C5	84.16	0.114	0.030
Benzene	78.11	0.021	0.006
Cyclo-C6	84.16	0.105	0.028
C7	96.00	0.321	0.074
Mcyclo-C6	98.19	0.126	0.028
Toluene	92.14	0.027	0.007
C8	107.00	0.071	0.015
C2-Benzene	106.17	0.002	0.000
m&p-Xylene	106.17	0.006	0.001
o-Xylene	106.17	0.001	0.000
C9	121.00	0.017	0.003
C10	134.00	0.001	0.000
C11	147.00	0.000	0.000
C12	161.00	0.000	0.000
MW			22.040

Table 3 Compositions of Separator Liquid Sample 1.02 (cylinder # 16653-IB)

Component	MW	Flashed Gas		Flashed Oil		Separator Liquid	
	(g/mol)	wt %	mole %	wt %	mole %	wt %	mole %
CO2	44.01	0.350	0.316	0.000	0.000	0.023	0.058
H2S	34.08	0.000	0.000	0.000	0.000	0.000	0.000
N2	28.01	0.449	0.636	0.000	0.000	0.029	0.117
C1	16.04	10.038	24.815	0.000	0.000	0.646	4.559
C2	30.07	17.060	22.500	0.000	0.000	1.098	4.134
C3	44.10	26.925	24.217	0.903	2.656	2.577	6.617
i-C4	58.12	8.706	5.941	0.695	1.552	1.211	2.359
n-C4	58.12	17.364	11.848	2.221	4.959	3.196	6.225
i-C5	72.15	5.782	3.178	1.996	3.590	2.240	3.514
n-C5	72.15	5.833	3.206	2.776	4.993	2.973	4.664
C6	84.00	4.007	1.892	5.699	8.803	5.590	7.534
Mcyclo-C5	84.16	0.424	0.200	0.901	1.390	0.871	1.171
Benzene	78.11	0.072	0.036	0.132	0.220	0.129	0.186
Cyclo-C6	84.16	0.397	0.187	1.047	1.614	1.005	1.352
C7	96.00	1.280	0.529	6.772	9.153	6.418	7.569
Mcyclo-C6	98.19	0.538	0.217	3.338	4.411	3.158	3.641
Toluene	92.14	0.100	0.043	0.846	1.191	0.798	0.980
C8	107.00	0.416	0.154	9.080	11.012	8.523	9.017
C2-Benzene	106.17	0.017	0.007	0.317	0.387	0.298	0.317
m&p-Xylene	106.17	0.011	0.004	1.380	1.686	1.292	1.377
o-Xylene	106.17	0.006	0.002	0.276	0.337	0.259	0.276
C9	121.00	0.181	0.059	6.700	7.185	6.280	5.876
C10	134.00	0.038	0.011	7.158	6.932	6.700	5.660
C11	147.00	0.005	0.001	5.189	4.580	4.855	3.739
C12	161.00	0.000	0.000	4.056	3.269	3.795	2.669
C13	175.00	0.000	0.000	4.170	3.092	3.902	2.524
C14	190.00	0.000	0.000	3.810	2.602	3.564	2.124
C15	206.00	0.000	0.000	4.132	2.603	3.866	2.124
C16	222.00	0.000	0.000	3.681	2.152	3.445	1.757
C17	237.00	0.000	0.000	3.409	1.867	3.190	1.524
C18	251.00	0.000	0.000	3.094	1.600	2.895	1.306
C19	263.00	0.000	0.000	2.576	1.271	2.410	1.037
C20	275.00	0.000	0.000	1.938	0.914	1.813	0.746
C21	291.00	0.000	0.000	1.560	0.695	1.459	0.568
C22	305.00	0.000	0.000	1.248	0.531	1.168	0.434
C23	318.00	0.000	0.000	1.055	0.430	0.987	0.351
C24	331.00	0.000	0.000	0.909	0.356	0.851	0.291
C25	345.00	0.000	0.000	0.807	0.304	0.755	0.248
C26	359.00	0.000	0.000	0.728	0.263	0.681	0.215
C27	374.00	0.000	0.000	0.645	0.224	0.604	0.183
C28	388.00	0.000	0.000	0.569	0.190	0.532	0.155
C29	402.00	0.000	0.000	0.505	0.163	0.472	0.133
C30+	580.00	0.000	0.000	3.685	0.825	3.448	0.673
MW			39.660		129.760		113.208
Mole %			18.371		81.629		

Table 4 Composition Properties of Separator Liquid Sample 1.02 (cylinder # 16653-IB)

Stock Tank Oil Properties at Standard Condition			C30+ Properties
	Measured	Calculated	
MW		129.8	580.0
Density (g/cc)	0.761	0.775	0.925

Single Stage Flash Data	
	Original STO
GOR (Vol/Vol)	31.3
STO Density (g/cc)	0.761
STO API Gravity	54.3

Properties	Flashed Gas	Flashed Oil	Monophasic
Mole %			
C7+	1.03	70.22	57.51
C10+	0.01	34.86	28.46
C12+	0.00	23.35	19.06
C20+	0.00	4.90	4.00
C30+	0.00	0.82	0.67
Mass %			
C7+	2.59	83.63	78.41
C10+	0.04	54.92	51.39
C12+	0.00	42.58	39.84
C20+	0.00	13.65	12.77
C30+	0.00	3.69	3.45
Molar Mass			
C7+	100.01	154.53	154.35
C10+	135.92	204.43	204.43
C12+	181.55	236.60	236.60
C20+		361.75	361.75
C30+		580.00	580.00
Density (g/cc)			
C7+	0.745	0.805	0.804
C10+	0.780	0.832	0.832
C12+	0.816	0.848	0.848
C20+		0.889	0.889
C30+		0.925	0.925
Fluid Density at STP Condition (g/cc)		0.761	
Gas Gravity (Air=1)	1.370		
Dry Gross Heating Content (KJ/m^3)	84376.0		
Wet Gross Heating Content (KJ/m^3)	82904.1		

Table 5 Compositions of Separator Gas Sample 2.01 (cylinder # 5627) and Sample 2.02 (cylinder # 5619)

Component	MW (g/mol)	Separator Gas, 2.01		Separator Gas, 2.02	
		wt %	mole %	wt %	mole %
CO2	44.01	1.031	0.528	1.044	0.531
H2S	34.08	0.000	0.000	0.000	0.000
N2	28.01	1.161	0.935	0.927	0.741
C1	16.04	51.985	73.106	52.651	73.503
C2	30.07	18.746	14.065	18.891	14.071
C3	44.10	12.412	6.350	12.480	6.339
i-C4	58.12	2.830	1.099	2.810	1.083
n-C4	58.12	5.275	2.047	5.272	2.032
i-C5	72.15	1.740	0.544	1.706	0.530
n-C5	72.15	1.834	0.573	1.790	0.556
C6	84.00	1.476	0.396	1.354	0.361
Mcyclo-C5	84.16	0.165	0.044	0.147	0.039
Benzene	78.11	0.031	0.009	0.027	0.008
Cyclo-C6	84.16	0.163	0.044	0.137	0.037
C7	96.00	0.551	0.130	0.414	0.097
Mcyclo-C6	98.19	0.236	0.054	0.165	0.038
Toluene	92.14	0.053	0.013	0.036	0.009
C8	107.00	0.186	0.039	0.096	0.020
C2-Benzene	106.17	0.008	0.002	0.002	0.001
m&p-Xylene	106.17	0.005	0.001	0.001	0.000
o-Xylene	106.17	0.003	0.001	0.001	0.000
C9	121.00	0.083	0.016	0.037	0.007
C10	134.00	0.020	0.003	0.004	0.001
C11	147.00	0.002	0.000	0.002	0.000
C12+	161.00	0.000	0.000	0.000	0.000
MW			22.6		22.4

Table 6 Compositions of Separator Liquid Sample 2.03 (cylinder # 16347-IB)

Component	MW	Flashed Gas		Flashed Oil		Monophasic	
	(g/mol)	wt %	mole %	wt %	mole %	wt %	mole %
CO2	44.01	0.621	0.481	0.000	0.000	0.005	0.016
H2S	34.08	0.000	0.000	0.000	0.000	0.000	0.000
N2	28.01	0.832	1.013	0.000	0.000	0.007	0.033
C1	16.04	17.436	37.076	0.000	0.000	0.143	1.198
C2	30.07	21.994	24.951	0.000	0.000	0.181	0.806
C3	44.10	23.516	18.192	0.585	1.823	0.773	2.352
i-C4	58.12	6.284	3.688	0.319	0.755	0.368	0.850
n-C4	58.12	12.408	7.283	0.991	2.345	1.085	2.505
i-C5	72.15	4.476	2.116	0.935	1.783	0.964	1.794
n-C5	72.15	4.780	2.260	1.383	2.637	1.411	2.625
C6	84.00	4.063	1.650	3.765	6.166	3.768	6.020
Mcyclo-C5	84.16	0.448	0.182	0.669	1.094	0.667	1.064
Benzene	78.11	0.079	0.035	0.103	0.181	0.103	0.176
Cyclo-C6	84.16	0.424	0.172	0.856	1.398	0.852	1.359
C7	96.00	1.378	0.490	6.151	8.813	6.112	8.544
Mcyclo-C6	98.19	0.526	0.183	3.266	4.576	3.244	4.434
Toluene	92.14	0.102	0.038	0.862	1.287	0.856	1.247
C8	107.00	0.348	0.111	9.969	12.815	9.890	12.405
C2-Benzene	106.17	0.019	0.006	0.384	0.498	0.381	0.482
m&p-Xylene	106.17	0.012	0.004	1.604	2.078	1.591	2.011
o-Xylene	106.17	0.007	0.002	0.359	0.465	0.356	0.450
C9	121.00	0.166	0.047	8.066	9.169	8.001	8.874
C10	134.00	0.072	0.018	8.956	9.193	8.883	8.896
C11	147.00	0.007	0.002	6.479	6.063	6.426	5.867
C12	161.00	0.001	0.000	5.110	4.366	5.068	4.225
C13	175.00	0.000	0.000	5.209	4.094	5.166	3.962
C14	190.00	0.000	0.000	4.392	3.179	4.356	3.077
C15	206.00	0.001	0.000	4.355	2.908	4.320	2.814
C16	222.00	0.000	0.000	3.570	2.212	3.540	2.140
C17	237.00	0.000	0.000	3.266	1.895	3.239	1.834
C18	251.00	0.000	0.000	2.977	1.631	2.952	1.579
C19	263.00	0.000	0.000	2.511	1.313	2.490	1.271
C20	275.00	0.000	0.000	1.916	0.958	1.900	0.927
C21	291.00	0.000	0.000	1.613	0.762	1.599	0.738
C22	305.00	0.000	0.000	1.345	0.606	1.334	0.587
C23	318.00	0.000	0.000	1.138	0.492	1.129	0.477
C24	331.00	0.000	0.000	0.972	0.404	0.964	0.391
C25	345.00	0.000	0.000	0.856	0.341	0.849	0.330
C26	359.00	0.000	0.000	0.760	0.291	0.753	0.282
C27	374.00	0.000	0.000	0.664	0.244	0.659	0.236
C28	388.00	0.000	0.000	0.566	0.201	0.561	0.194
C29	402.00	0.000	0.000	0.499	0.171	0.495	0.165
C30+	448.29	0.000	0.000	2.583	0.793	2.562	0.767
MW			34.1		137.5		134.2
Mole %			3.23		96.77		

Table 7 Composition Properties of Separator Liquid Sample 2.03 (cylinder # 16347-IB)

Stock Tank Oil Properties at Standard Condition	Measured	Calculated	C30+ Properties
MW		137.6	448.3
Density (g/cc)	0.775	0.786	0.925

Single Stage Flash Data	Original STO
GOR (Vol/Vol)	4.5
STO Density (g/cc)	0.775
STO API Gravity	50.9

Properties	Flashed Gas	Flashed Oil	Monophasic
Mole %			
C7+	0.90	81.82	79.20
C10+	0.02	42.12	40.76
C12+	0.00	26.86	25.99
C20+	0.00	5.26	5.09
C30+	0.00	0.79	0.77
Mass %			
C7+	2.64	90.39	89.67
C10+	0.08	59.73	59.24
C12+	0.00	44.30	43.93
C20+	0.00	12.91	12.80
C30+	0.00	2.58	2.56
Molar Mass			
C7+	99.98	151.97	151.95
C10+	136.09	195.08	195.08
C12+	179.53	226.84	226.84
C20+		337.39	337.39
C30+		448.29	448.29
Density (g/cc)			
C7+	0.744	0.802	0.802
C10+	0.780	0.827	0.827
C12+	0.815	0.844	0.844
C20+		0.886	0.886
C30+		0.925	0.925
Fluid Density at STP Condition (g/cc)		0.775	
Gas Gravity (Air=1)	1.178		
Dry Gross Heating Content (KJ/m^3)	72904.7		
Wet Gross Heating Content (KJ/m^3)	71632.9		

Table 8 Compositions of Separator Gas Sample 2.04 (cylinder # 4929) and Sample 2.05 (cylinder # A00010)

Component	MW	Separator Gas, 2.04		Separator Gas, 2.05	
	(g/mol)	wt %	mole %	wt %	mole %
CO2	44.01	0.994	0.514	1.019	0.528
H2S	34.08	0.000	0.000	0.000	0.000
N2	28.01	0.966	0.785	1.082	0.880
C1	16.04	51.239	72.717	51.180	72.681
C2	30.07	18.700	14.159	18.591	14.085
C3	44.10	12.560	6.485	12.507	6.462
i-C4	58.12	2.879	1.128	2.855	1.119
n-C4	58.12	5.504	2.156	5.519	2.163
i-C5	72.15	1.862	0.588	1.867	0.590
n-C5	72.15	1.986	0.627	2.003	0.633
C6	84.00	1.637	0.444	1.684	0.457
Mcyclo-C5	84.16	0.183	0.050	0.188	0.051
Benzene	78.11	0.034	0.010	0.035	0.010
Cyclo-C6	84.16	0.181	0.049	0.186	0.050
C7	96.00	0.619	0.147	0.637	0.151
Mcyclo-C6	98.19	0.263	0.061	0.266	0.062
Toluene	92.14	0.060	0.015	0.059	0.015
C8	107.00	0.205	0.044	0.201	0.043
C2-Benzene	106.17	0.008	0.002	0.007	0.002
m&p-Xylene	106.17	0.005	0.001	0.004	0.001
o-Xylene	106.17	0.003	0.001	0.003	0.001
C9	121.00	0.089	0.017	0.081	0.015
C10	134.00	0.017	0.003	0.011	0.002
C11	147.00	0.002	0.000	0.000	0.000
C12+	161.00	0.000	0.000	0.000	0.000
MW			22.8		22.8

Table 9 Compositions of Separator Liquid Sample 2.06 (cylinder # 7686-QA)

Component	MW	Flashed Gas		Flashed Oil		Monophasic	
	(g/mol)	wt %	mole %	wt %	mole %	wt %	mole %
CO2	44.01	0.590	0.464	0.000	0.000	0.005	0.017
H2S	34.08	0.000	0.000	0.000	0.000	0.000	0.000
N2	28.01	0.960	1.186	0.000	0.000	0.009	0.042
C1	16.04	16.394	35.382	0.000	0.000	0.149	1.262
C2	30.07	21.855	25.165	0.000	0.000	0.198	0.898
C3	44.10	24.013	18.854	0.625	1.980	0.837	2.582
i-C4	58.12	6.443	3.838	0.328	0.789	0.383	0.897
n-C4	58.12	12.870	7.667	1.004	2.414	1.111	2.602
i-C5	72.15	4.575	2.195	0.935	1.811	0.968	1.825
n-C5	72.15	4.861	2.333	1.374	2.662	1.405	2.650
C6	84.00	4.005	1.651	3.684	6.131	3.687	5.972
Mcyclo-C5	84.16	0.434	0.179	0.652	1.084	0.650	1.051
Benzene	78.11	0.075	0.033	0.102	0.183	0.102	0.177
Cyclo-C6	84.16	0.401	0.165	0.832	1.382	0.828	1.338
C7	96.00	1.245	0.449	5.959	8.679	5.916	8.385
Mcyclo-C6	98.19	0.466	0.164	3.127	4.453	3.103	4.300
Toluene	92.14	0.377	0.142	0.834	1.265	0.830	1.225
C8	107.00	0.248	0.080	9.629	12.583	9.544	12.137
C2-Benzene	106.17	0.013	0.004	0.395	0.520	0.391	0.501
m&p-Xylene	106.17	0.022	0.007	1.602	2.110	1.588	2.035
o-Xylene	106.17	0.005	0.002	0.345	0.454	0.341	0.438
C9	121.00	0.093	0.027	7.719	8.920	7.650	8.602
C10	134.00	0.048	0.012	8.696	9.074	8.618	8.750
C11	147.00	0.007	0.002	6.324	6.015	6.267	5.800
C12	161.00	0.000	0.000	5.028	4.366	4.982	4.211
C13	175.00	0.000	0.000	5.141	4.107	5.094	3.961
C14	190.00	0.000	0.000	4.346	3.198	4.307	3.084
C15	206.00	0.000	0.000	4.327	2.937	4.288	2.832
C16	222.00	0.000	0.000	3.570	2.249	3.538	2.168
C17	237.00	0.000	0.000	3.265	1.926	3.235	1.857
C18	251.00	0.000	0.000	3.001	1.672	2.974	1.612
C19	263.00	0.000	0.000	2.556	1.359	2.533	1.310
C20	275.00	0.000	0.000	1.972	1.002	1.954	0.967
C21	291.00	0.000	0.000	1.676	0.805	1.660	0.776
C22	305.00	0.000	0.000	1.397	0.640	1.384	0.617
C23	318.00	0.000	0.000	1.198	0.527	1.187	0.508
C24	331.00	0.000	0.000	1.035	0.437	1.025	0.422
C25	345.00	0.000	0.000	0.922	0.374	0.913	0.360
C26	359.00	0.000	0.000	0.809	0.315	0.802	0.304
C27	374.00	0.000	0.000	0.726	0.271	0.720	0.262
C28	388.00	0.000	0.000	0.625	0.225	0.619	0.217
C29	402.00	0.000	0.000	0.563	0.196	0.558	0.189
C30+	580.00	0.000	0.000	3.681	0.887	3.647	0.856
MW			34.6		139.8		136.1
Mole %			3.57		96.43		

Table 10 Composition Properties of Separator Liquid Sample 2.06 (cylinder # 7686-QA)

Stock Tank Oil Properties at Standard Condition			**C30+ Properties**
	Measured	Calculated	
MW		139.8	580.0
Density (g/cc)	0.774	0.788	0.925

Single Stage Flash Data	
	Original STO
GOR (Vol/Vol)	4.9
STO Density (g/cc)	0.774
STO API Gravity	51.1

Properties	**Flashed Gas**	**Flashed Oil**	**Monophasic**
Mole %			
C7+	0.89	81.56	78.69
C10+	0.01	42.58	41.06
C12+	0.00	27.49	26.51
C20+	0.00	5.68	5.48
C30+	0.00	0.89	0.86
Mass %			
C7+	2.52	90.47	89.67
C10+	0.05	60.86	60.30
C12+	0.00	45.84	45.42
C20+	0.00	14.60	14.47
C30+	0.00	3.68	3.65
Molar Mass			
C7+	98.30	155.07	155.05
C10+	135.43	199.82	199.82
C12+		233.09	233.09
C20+		359.44	359.44
C30+		580.00	580.00
Density (g/cc)			
C7+	0.756	0.805	0.805
C10+	0.779	0.830	0.830
C12+		0.846	0.846
C20+		0.889	0.889
C30+		0.925	0.925
Fluid Density at STP Condition (g/cc)		0.774	
Gas Gravity (Air=1)	1.196		
Dry Gross Heating Content (KJ/m^3)	73801.0		
Wet Gross Heating Content (KJ/m^3)	72513.6		

Table 11 Compositions of Separator Gas Sample 2.07(cylinder # 4923) and Sample 2.08 (cylinder # 4932)

Component	MW	Separator Gas, 2.07		Separator Gas, 2.08	
	(g/mol)	wt %	mole %	wt %	mole %
CO2	44.01	0.993	0.512	0.989	0.512
H2S	34.08	0.000	0.000	0.000	0.000
N2	28.01	1.067	0.864	0.922	0.749
C1	16.04	51.565	72.919	51.361	72.874
C2	30.07	18.644	14.066	18.587	14.070
C3	44.10	12.448	6.404	12.449	6.426
i-C4	58.12	2.846	1.111	2.896	1.134
n-C4	58.12	5.446	2.126	5.454	2.136
i-C5	72.15	1.814	0.570	1.871	0.590
n-C5	72.15	1.925	0.605	1.999	0.631
C6	84.00	1.582	0.427	1.654	0.448
Mcyclo-C5	84.16	0.178	0.048	0.186	0.050
Benzene	78.11	0.033	0.010	0.035	0.010
Cyclo-C6	84.16	0.177	0.048	0.186	0.050
C7	96.00	0.612	0.145	0.652	0.155
Mcyclo-C6	98.19	0.264	0.061	0.284	0.066
Toluene	92.14	0.060	0.015	0.065	0.016
C8	107.00	0.215	0.046	0.240	0.051
C2-Benzene	106.17	0.009	0.002	0.011	0.002
m&p-Xylene	106.17	0.006	0.001	0.006	0.001
o-Xylene	106.17	0.004	0.001	0.004	0.001
C9	121.00	0.095	0.018	0.114	0.021
C10	134.00	0.018	0.003	0.028	0.005
C11	147.00	0.001	0.000	0.003	0.001
C12+	161.00	0.000	0.000	0.000	0.000
MW			22.7		22.8

Table 12 Compositions of Separator Liquid Sample 2.09 (cylinder # 16552-IB)

Component	MW	Flashed Gas		Flashed Oil		Monophasic	
	(g/mol)	wt %	mole %	wt %	mole %	wt %	mole %
CO2	44.01	0.597	0.468	0.000	0.000	0.006	0.019
H2S	34.08	0.000	0.000	0.000	0.000	0.000	0.000
N2	28.01	0.906	1.117	0.000	0.000	0.009	0.045
C1	16.04	16.510	35.543	0.000	0.000	0.171	1.442
C2	30.07	21.897	25.151	0.000	0.000	0.227	1.020
C3	44.10	24.241	18.986	0.672	2.122	0.917	2.806
i-C4	58.12	6.528	3.879	0.351	0.840	0.415	0.963
n-C4	58.12	12.738	7.569	1.073	2.568	1.194	2.771
i-C5	72.15	4.522	2.165	0.986	1.903	1.023	1.913
n-C5	72.15	4.777	2.287	1.443	2.783	1.477	2.763
C6	84.00	3.920	1.612	3.786	6.272	3.787	6.083
Mcyclo-C5	84.16	0.428	0.176	0.677	1.120	0.675	1.082
Benzene	78.11	0.075	0.033	0.104	0.185	0.104	0.179
Cyclo-C6	84.16	0.400	0.164	0.844	1.395	0.839	1.345
C7	96.00	1.284	0.462	5.991	8.685	5.942	8.351
Mcyclo-C6	98.19	0.495	0.174	3.143	4.455	3.115	4.281
Toluene	92.14	0.094	0.035	0.835	1.262	0.828	1.212
C8	107.00	0.323	0.104	9.600	12.487	9.504	11.985
C2-Benzene	106.17	0.018	0.006	0.376	0.493	0.373	0.473
m&p-Xylene	106.17	0.010	0.003	1.616	2.119	1.599	2.033
o-Xylene	106.17	0.007	0.002	0.326	0.428	0.323	0.410
C9	121.00	0.152	0.043	7.668	8.820	7.590	8.464
C10	134.00	0.067	0.017	8.622	8.955	8.533	8.593
C11	147.00	0.013	0.003	6.274	5.940	6.209	5.699
C12	161.00	0.000	0.000	4.985	4.310	4.934	4.135
C13	175.00	0.000	0.000	5.100	4.056	5.047	3.891
C14	190.00	0.000	0.000	4.309	3.157	4.265	3.029
C15	206.00	0.000	0.000	4.291	2.899	4.247	2.782
C16	222.00	0.000	0.000	3.536	2.217	3.499	2.127
C17	237.00	0.000	0.000	3.236	1.900	3.202	1.823
C18	251.00	0.000	0.000	2.972	1.648	2.941	1.581
C19	263.00	0.000	0.000	2.523	1.335	2.496	1.281
C20	275.00	0.000	0.000	1.951	0.987	1.931	0.947
C21	291.00	0.000	0.000	1.662	0.795	1.645	0.763
C22	305.00	0.000	0.000	1.378	0.629	1.363	0.603
C23	318.00	0.000	0.000	1.188	0.520	1.175	0.499
C24	331.00	0.000	0.000	1.026	0.431	1.015	0.414
C25	345.00	0.000	0.000	0.907	0.366	0.898	0.351
C26	359.00	0.000	0.000	0.812	0.315	0.804	0.302
C27	374.00	0.000	0.000	0.724	0.269	0.716	0.259
C28	388.00	0.000	0.000	0.624	0.224	0.618	0.215
C29	402.00	0.000	0.000	0.555	0.192	0.549	0.184
C30+	580.00	0.000	0.000	3.836	0.921	3.796	0.883
MW			34.5		139.2		134.9
Mole %			4.06		95.94		

Table 13 Composition Properties of Separator Liquid Sample 2.09 (cylinder # 16552-IB)

Stock Tank Oil Properties at Standard Condition			C30+ Properties
	Measured	Calculated	
MW		139.180	580.000
Density (g/cc)	0.773	0.787	0.925

OBM Contamination Level (wt%)		1.730	STO Basis
		1.712	Live Oil Basis
OBM Density @ STP Condition (g/cc)			

Single Stage Flash Data		
	Original STO	De-Contaminated
GOR (Vol/Vol)	5.562	
STO Density (g/cc)	0.773	
STO API Gravity	51.396	

Properties	Flashed Gas	Flashed Oil	Monophasic
Mole %			
C7+	0.85	80.81	77.57
C10+	0.02	42.06	40.36
C12+	0.00	27.17	26.07
C20+	0.00	5.65	5.42
C30+	0.00	0.92	0.88
Mass %			
C7+	2.46	90.06	89.15
C10+	0.08	60.51	59.88
C12+	0.00	45.61	45.14
C20+	0.00	14.66	14.51
C30+	0.00	3.84	3.80
Molar Mass			
C7+	100.02	155.11	155.09
C10+	136.24	200.21	200.20
C12+	166.62	233.66	233.66
C20+		361.26	361.26
C30+		580.00	580.00
Density (g/cc)			
C7+	0.744	0.805	0.805
C10+	0.780	0.830	0.830
C12+	0.805	0.847	0.847
C20+		0.889	0.889
C30+		0.925	0.925
Fluid Density at STP Condition (g/cc)		0.773	
Gas Gravity (Air=1)	1.193		
Dry Gross Heating Content (KJ/m^3)	73699.7		
Wet Gross Heating Content (KJ/m^3)	72414.1		

Table 14 Composition of Mathematically Recombined Fluid (recombination GOR = 10,740 scf / sep bbl, sample pair 2.08 and 2.09)

Component	MW (g/mol)	Separator Gas mole %	Separator liquid mole %	Recombined Fluid mole %
CO2	44.01	0.512	0.019	0.480
H2S	34.08	0.000	0.000	0.000
N2	28.01	0.749	0.045	0.704
C1	16.04	72.874	1.442	68.331
C2	30.07	14.070	1.020	13.240
C3	44.10	6.426	2.806	6.196
i-C4	58.12	1.134	0.963	1.123
n-C4	58.12	2.136	2.771	2.176
i-C5	72.15	0.590	1.913	0.675
n-C5	72.15	0.631	2.763	0.766
C6	84.00	0.448	6.083	0.806
Mcyclo-C5	84.16	0.050	1.082	0.116
Benzene	78.11	0.010	0.179	0.021
Cyclo-C6	84.16	0.050	1.345	0.133
C7	96.00	0.155	8.351	0.676
Mcyclo-C6	98.19	0.066	4.281	0.334
Toluene	92.14	0.016	1.212	0.092
C8	107.00	0.051	11.985	0.810
C2-Benzene	106.17	0.002	0.473	0.032
m&p-Xylene	106.17	0.001	2.033	0.131
o-Xylene	106.17	0.001	0.410	0.027
C9	121.00	0.021	8.464	0.558
C10	134.00	0.005	8.593	0.551
C11	147.00	0.001	5.699	0.363
C12	161.00	0.000	4.135	0.263
C13	175.00		3.891	0.247
C14	190.00		3.029	0.193
C15	206.00		2.782	0.177
C16	222.00		2.127	0.135
C17	237.00		1.823	0.116
C18	251.00		1.581	0.101
C19	263.00		1.281	0.081
C20	275.00		0.947	0.060
C21	291.00		0.763	0.048
C22	305.00		0.603	0.038
C23	318.00		0.499	0.032
C24	331.00		0.414	0.026
C25	345.00		0.351	0.022
C26	359.00		0.302	0.019
C27	374.00		0.259	0.016
C28	388.00		0.215	0.014
C29	402.00		0.184	0.012
C30+	580.00		0.883	0.056
MW		22.8	134.9	
Mole %		93.64	6.36	

Table 15 Composition of Physically Recombined Fluid (recombination GOR = 10,740 scf / sep bbl, sample pair 2.08 and 2.09)

Component	MW	Flashed Gas		Flashed Oil		Monophasic	
	(g/mol)	wt %	mole %	wt %	mole %	wt %	mole %
CO2	44.01	0.941	0.500	0.000	0.000	0.691	0.474
H2S	34.08	0.000	0.000	0.000	0.000	0.000	0.000
N2	28.01	1.205	1.006	0.000	0.000	0.885	0.953
C1	16.04	49.158	71.668	0.000	0.000	36.088	67.882
C2	30.07	18.065	14.051	0.000	0.000	13.262	13.309
C3	44.10	12.387	6.570	0.520	1.792	9.232	6.318
i-C4	58.12	2.880	1.159	0.152	0.398	2.155	1.119
n-C4	58.12	5.743	2.311	0.407	1.064	4.324	2.245
i-C5	72.15	2.096	0.679	0.289	0.609	1.616	0.676
n-C5	72.15	2.338	0.758	0.455	0.958	1.837	0.769
C6	84.00	2.182	0.608	2.261	4.088	2.203	0.791
Mcyclo-C5	84.16	0.255	0.071	0.458	0.827	0.309	0.111
Benzene	78.11	0.048	0.014	0.072	0.139	0.054	0.021
Cyclo-C6	84.16	0.263	0.073	0.645	1.164	0.364	0.131
C7	96.00	0.941	0.229	5.029	7.958	2.028	0.638
Mcyclo-C6	98.19	0.392	0.093	2.744	4.246	1.017	0.313
Toluene	92.14	0.099	0.025	0.749	1.235	0.272	0.089
C8	107.00	0.422	0.092	8.974	12.741	2.696	0.760
C2-Benzene	106.17	0.004	0.001	0.365	0.523	0.100	0.028
m&p-Xylene	106.17	0.013	0.003	1.587	2.270	0.432	0.123
o-Xylene	106.17	0.006	0.001	0.325	0.465	0.091	0.026
C9	121.00	0.206	0.040	7.548	9.476	2.158	0.538
C10	134.00	0.049	0.009	8.761	9.932	2.366	0.533
C11	147.00	0.036	0.006	6.511	6.728	1.758	0.361
C12	161.00	0.022	0.003	5.282	4.984	1.420	0.266
C13	175.00	0.023	0.003	5.462	4.741	1.469	0.253
C14	190.00	0.025	0.003	4.694	3.753	1.267	0.201
C15	206.00	0.203	0.023	4.721	3.482	1.404	0.206
C16	222.00	0.000	0.000	3.952	2.704	1.051	0.143
C17	237.00	0.000	0.000	3.645	2.336	0.969	0.123
C18	251.00	0.000	0.000	3.405	2.061	0.905	0.109
C19	263.00	0.000	0.000	2.955	1.707	0.786	0.090
C20	275.00	0.000	0.000	2.314	1.278	0.615	0.068
C21	291.00	0.000	0.000	2.004	1.046	0.533	0.055
C22	305.00	0.000	0.000	1.719	0.856	0.457	0.045
C23	318.00	0.000	0.000	1.503	0.718	0.400	0.038
C24	331.00	0.000	0.000	1.316	0.604	0.350	0.032
C25	345.00	0.000	0.000	1.180	0.520	0.314	0.027
C26	359.00	0.000	0.000	1.066	0.451	0.284	0.024
C27	374.00	0.000	0.000	0.950	0.386	0.253	0.020
C28	388.00	0.000	0.000	0.834	0.327	0.222	0.017
C29	402.00	0.000	0.000	0.737	0.278	0.196	0.015
C30+	580.00	0.000	0.000	4.411	1.155	1.173	0.061
MW			23.4		151.9		30.2
Mole %			94.72		5.28		

Table 16 Compositional Properties of Physically Recombined Fluid (recombination GOR = 10,740 scf / sep bbl, sample pair 2.08 and 2.09)

Stock Tank Oil Properties at Standard Condition	Measured	Calculated	C30+ Properties
MW		151.9	580.0
Density (g/cc)	0.777	0.801	0.925

Single Stage Flash Data	Original STO
GOR (SCF/STB)	12200.8
STO Density (g/cc)	0.777
STO API Gravity	50.4

Properties	Flashed Gas	Flashed Oil	Monophasic
Mole %			
C7+	0.53	88.96	5.20
C10+	0.05	50.05	2.69
C12+	0.03	33.39	1.79
C20+	0.00	7.62	0.40
C30+	0.00	1.16	0.06
Mass %			
C7+	2.44	94.74	26.98
C10+	0.36	67.42	18.19
C12+	0.27	52.15	14.07
C20+	0.00	18.03	4.79
C30+	0.00	4.41	1.17
Molar Mass			
C7+	107.38	161.78	156.52
C10+	179.34	204.65	204.23
C12+	197.22	237.28	236.60
C20+		359.55	359.55
C30+		580.00	580.00
Density (g/cc)			
C7+	0.755	0.810	0.806
C10+	0.816	0.833	0.832
C12+	0.827	0.848	0.848
C20+		0.889	0.889
C30+		0.925	0.925
Fluid Density at STP Condition (g/cc)		0.777	
Gas Gravity (Air=1)	0.808		
Dry Gross Heating Content (KJ/m^3)	51384.6		
Wet Gross Heating Content (KJ/m^3)	50488.3		

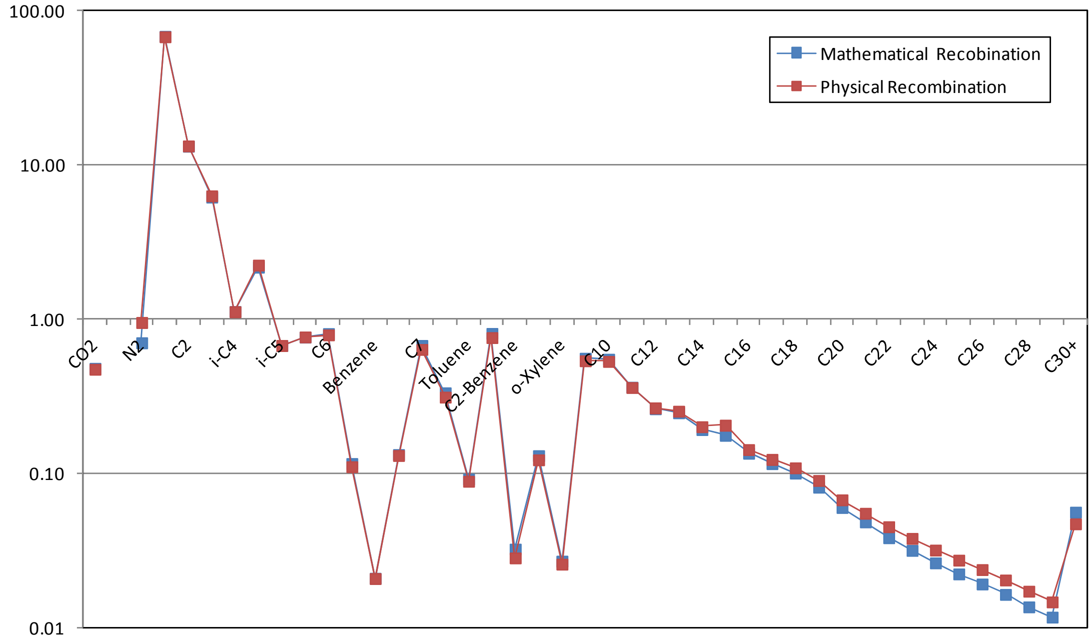

Figure 1 Comparison of Mathematically and Physically Recombined Fluid Compositions

Table 17 CCE Results of Bottomhole Fluid at Tres=106 °C

	Pressure psia	Relative Vol Vtot/Vsat	% Liq/Tot Vliq/Vtot	% Liq/Sat Vliq/Vsat	Bulk Density g/cc	Compressibility 10^-6/psia	Z Factor
Step 1	9000	0.790			0.422	26.6	1.407
Step 2	8001	0.817			0.409	36.3	1.292
Step 3	7542	0.830			0.402	41.7	1.238
Step 4	6998	0.852			0.392	48.9	1.179
Step 5	5996	0.898			0.372	65.1	1.065
Step 6	5502	0.932			0.358	74.5	1.015
Step 7	5301	0.947			0.352	78.5	0.993
Step 8	5201	0.957			0.349	80.6	0.984
Step 9	5100	0.964			0.346	82.8	0.972
Step 10	4999	0.970			0.344	84.9	0.959
Step 11	4898	0.979			0.341	87.2	0.949
Step 12	4800	0.987			0.338	89.4	0.937
Step 13	4702	0.995			0.335	91.6	0.925
* Dew Point	4661	1.000	0.00	0.00	0.334	92.5	0.922
Step 15	4601	0.991	0.44	0.44			
Step 16	4500	0.999	1.07	1.07			
Step 17	4251	1.031	3.20	3.30			
Step 18	4008	1.061	5.46	5.79			
Step 19	3506	1.166	9.00	10.49			
Step 20	3255	1.233	10.35	12.77			
Step 21	3011	1.315	10.93	14.37			
Step 22	2757	1.419	10.79	15.31			
Step 23	2503	1.553	10.37	16.11			
Step 24	2251	1.723	9.70	16.71			
Step 25	1999	1.943	8.73	16.96			
Step 26	1749	2.242	7.54	16.91			
Step 27	1500	2.642	6.16	16.29			

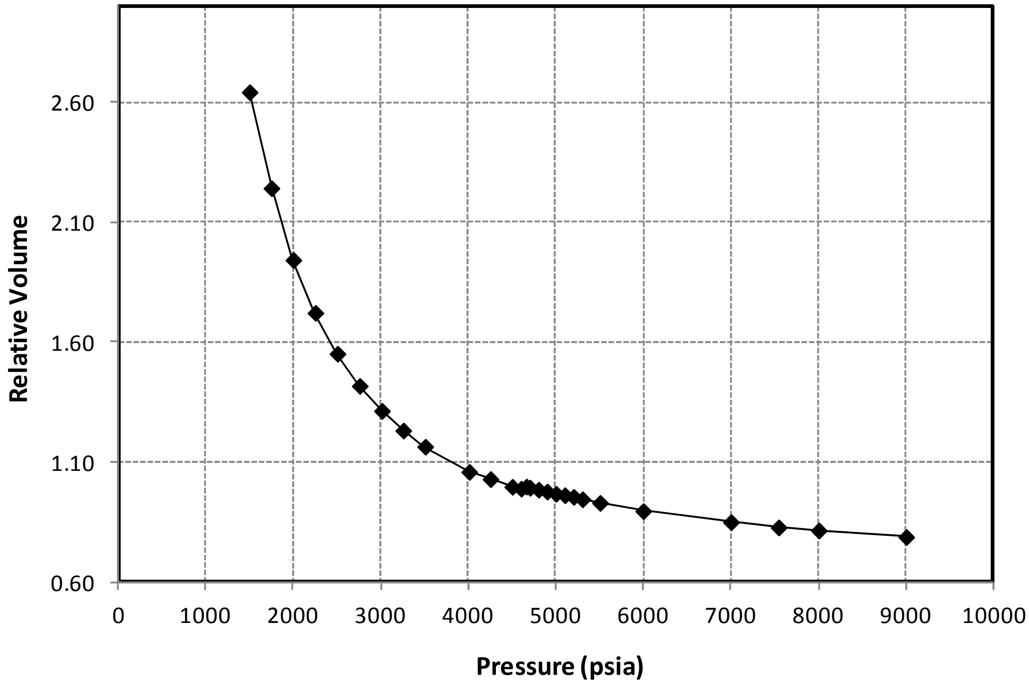

Figure 2 Relative volume
CCE test of Bottomhole Fluid at T_{res}=106 °C

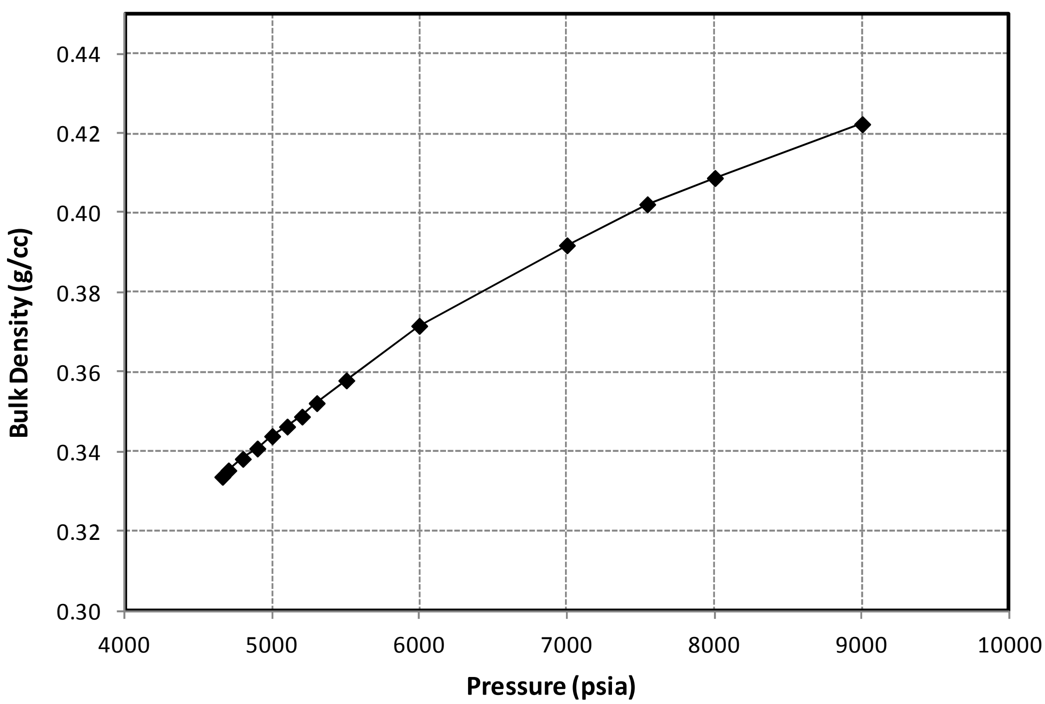

Figure 3 Bulk Density
CCE test of Bottomhole Fluid at Tres=106 °C

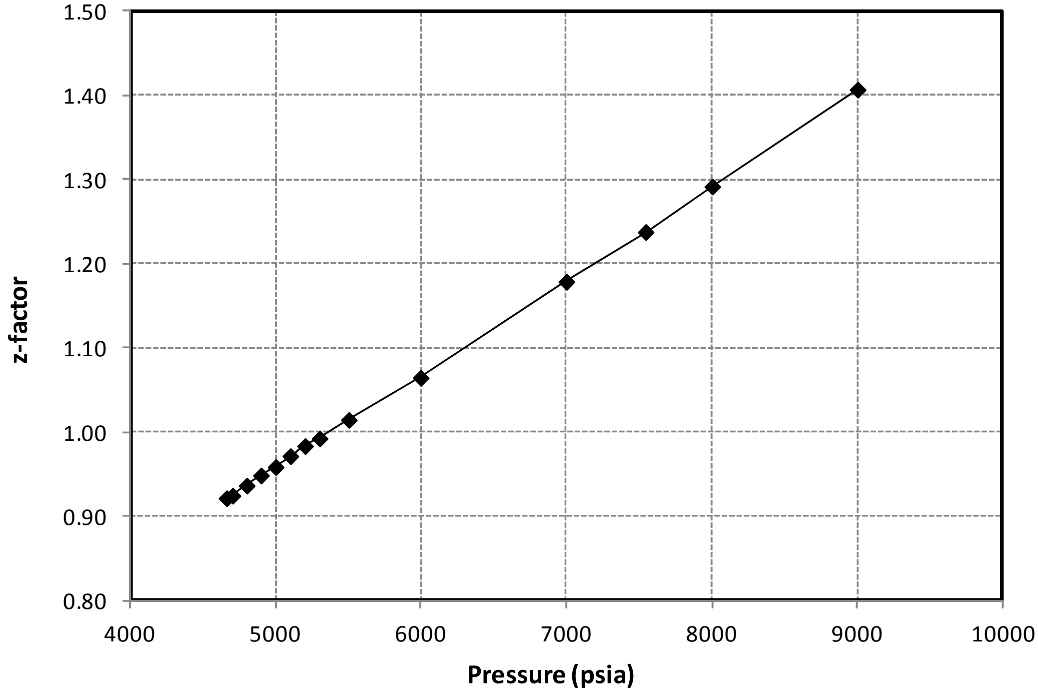

Figure 4 z-factor
CCE test of Bottomhole Fluid at Tres=106 °C

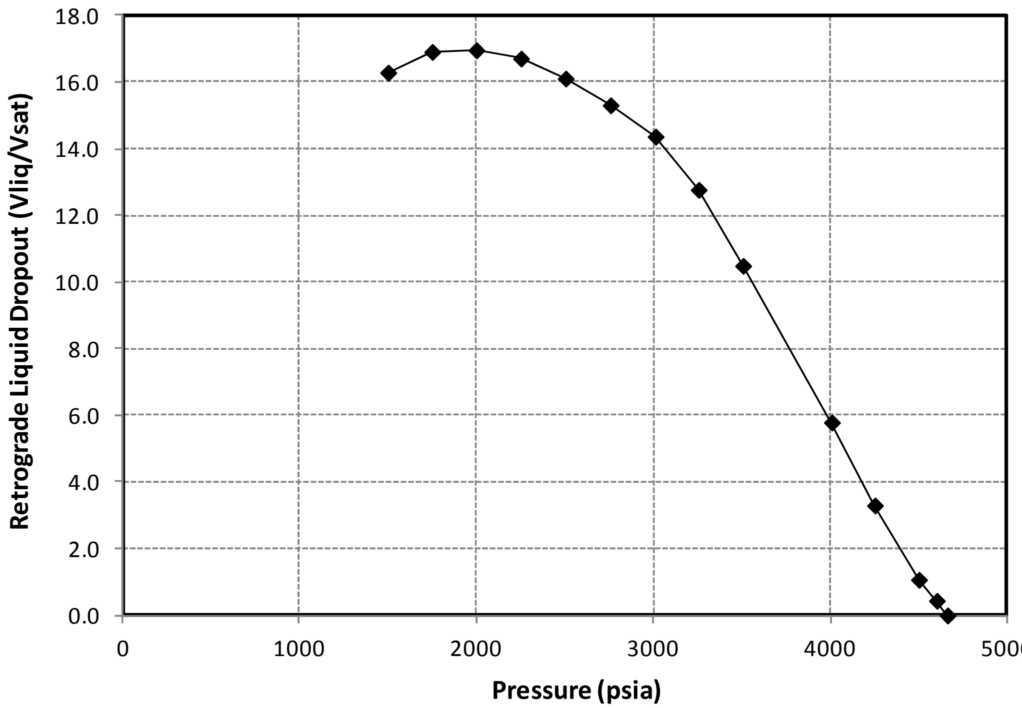

Figure 5 Liquid drop out
CCE test of Bottomhole Fluid at Tres=106 °C

Table 18 Summary of CVD Test on Recombined Fluid at Tres=106 °C and Psat = 4661 psia

	Pressure	Total Recovery	Gas Z Factor	Vapor MW	Vap. Density	Gas Viscosity	Liq. Volume %	Liq. Density	2P Z Factor
	psia	mole %		g/mol	g/cc	cP		g/cc	
Psat	4661	0.00	0.922	30.18	0.339	0.042	0.00		0.907
Step 1	4451	0.78	0.897	29.87	0.324	0.040	1.53	0.415	0.903
Step 2	4100	6.56	0.861	28.93	0.302	0.036	4.32	0.438	0.883
Step 3	3701	13.88	0.828	27.55	0.270	0.032	7.81	0.481	0.865
Step 4	3201	23.55	0.813	25.95	0.224	0.026	11.92	0.524	0.843
Step 5	2600	36.31	0.813	24.56	0.172	0.021	14.15	0.556	0.820
Step 6	2100	47.64	0.826	23.84	0.133	0.019	14.38	0.581	0.807
Step 7	1650	58.49	0.848	23.11	0.098	0.017	13.90	0.615	0.798
Step 8	1300	67.06	0.874	23.14	0.075	0.015	13.18	0.630	0.793

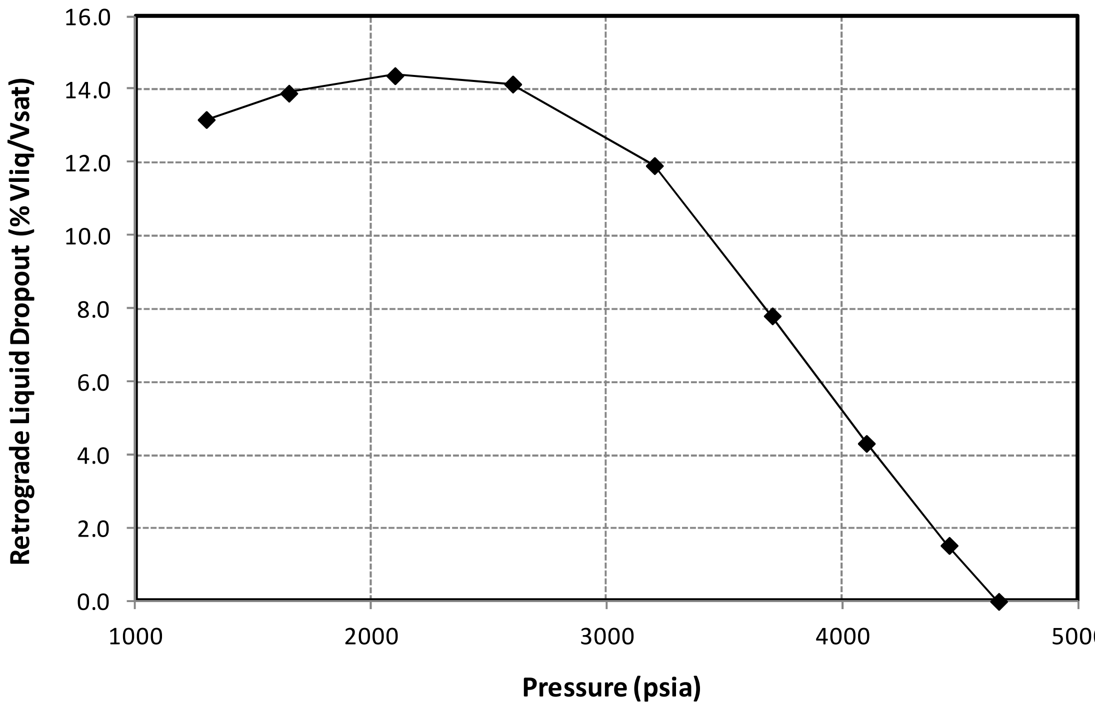

Figure 6 Liquid drop out
CVD test of Reservoir Fluid at T_{res}=106 °C

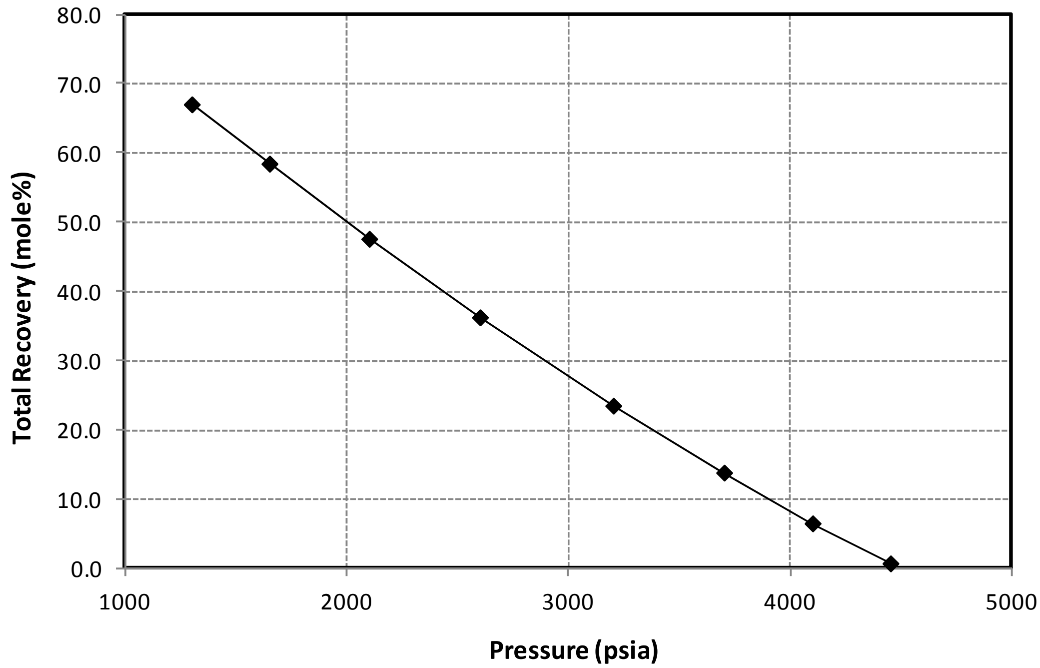

Figure 7 Total Recovery %
CVD test of Reservoir Fluid at T_{res}=106 °C

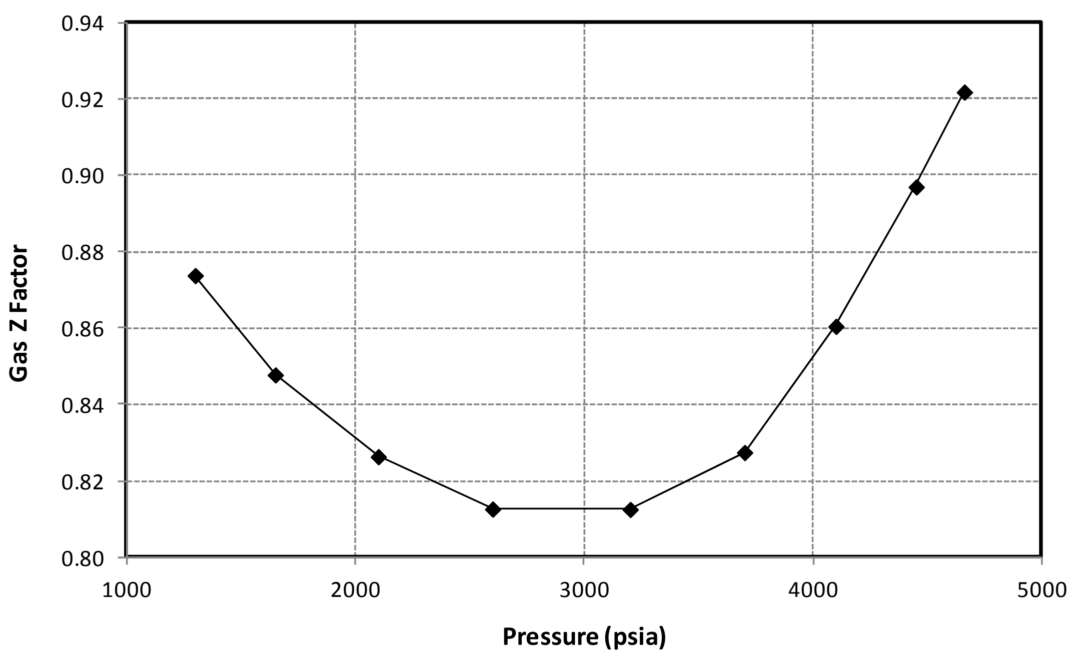

Figure 8 Z-Factor
CVD test of Reservoir Fluid at T_{res}=106 °C

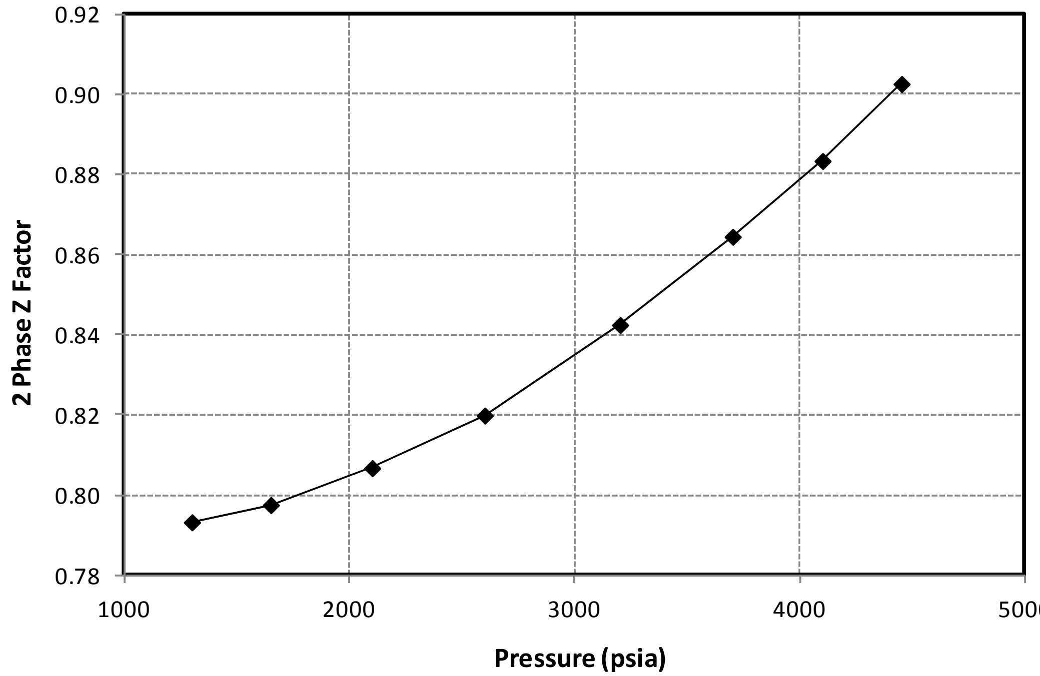

Figure 9 2-Phase Z-Factor
CVD test of Reservoir Fluid at T_{res}=106 °C

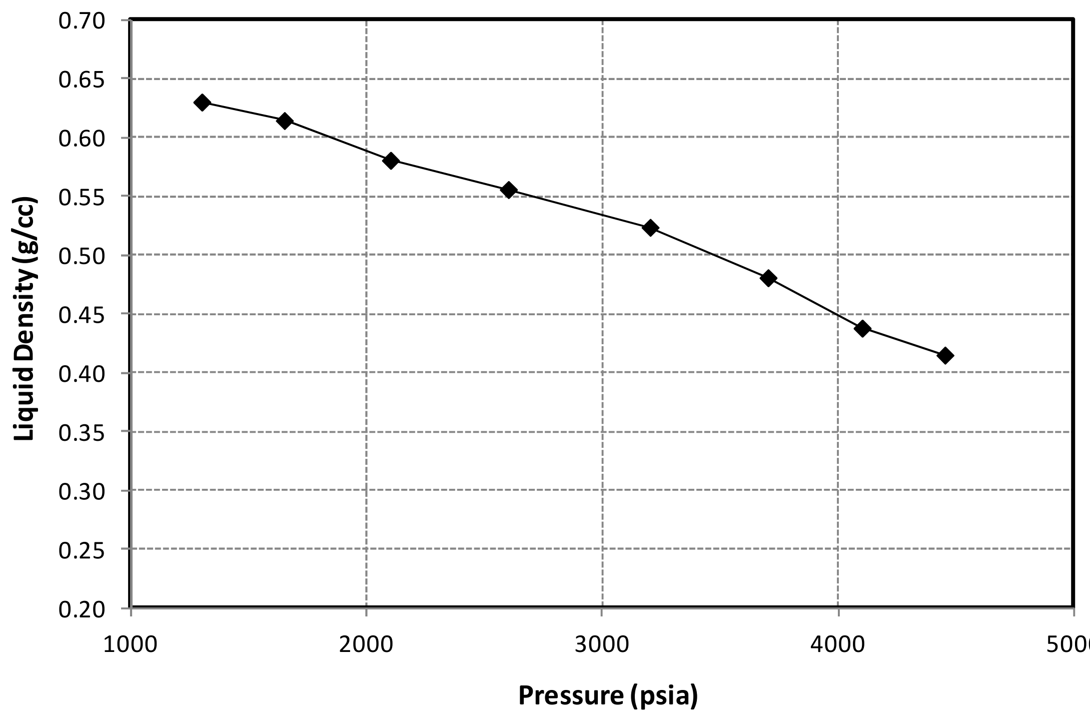

Figure 10 Liquid Density
CVD test of Reservoir Fluid at T_{res}=106 °C

Table 19 Results of CVD Test on Recombined Fluid at Tres=106 °C and Psat= 4661 psia: Vapor Compositions

Pressure	MW	4661	4451	4100	3701	3201
Component	g/mol	mole %	mole %	mole %	mole %	mole %
CO2	44.01	0.474	0.473	0.497	0.482	0.487
H2S	34.08	0.000	0.000	0.000	0.000	0.000
N2	28.01	0.953	0.952	1.005	0.972	0.944
C1	16.04	67.892	68.261	68.584	69.901	71.104
C2	30.07	13.311	13.242	13.412	13.238	13.314
C3	44.10	6.319	6.245	6.259	6.139	6.005
i-C4	58.12	1.119	1.106	1.100	1.067	1.031
n-C4	58.12	2.246	2.241	2.190	2.093	2.009
i-C5	72.15	0.676	0.654	0.642	0.609	0.570
n-C5	72.15	0.769	0.766	0.731	0.681	0.635
C6	84.00	0.792	0.783	0.764	0.691	0.634
Mcyclo-C5	84.16	0.111	0.109	0.105	0.095	0.087
Benzene	78.11	0.021	0.021	0.019	0.017	0.015
Cyclo-C6	84.16	0.131	0.128	0.119	0.106	0.095
C7	96.00	0.638	0.622	0.618	0.565	0.506
Mcyclo-C6	98.19	0.313	0.305	0.275	0.268	0.231
Toluene	92.14	0.089	0.087	0.083	0.074	0.064
C8	107.00	0.760	0.736	0.728	0.662	0.571
C2-Benzene	106.17	0.028	0.027	0.026	0.024	0.020
m&p-Xylene	106.17	0.123	0.118	0.108	0.096	0.083
o-Xylene	106.17	0.026	0.025	0.023	0.021	0.017
C9	121.00	0.538	0.520	0.503	0.443	0.377
C10	134.00	0.533	0.514	0.483	0.418	0.348
C11	147.00	0.361	0.348	0.305	0.246	0.195
C12	161.00	0.266	0.257	0.223	0.183	0.147
C13	175.00	0.253	0.244	0.211	0.173	0.129
C14	190.00	0.201	0.194	0.166	0.130	0.091
C15	206.00	0.206	0.199	0.151	0.119	0.076
C16	222.00	0.143	0.138	0.117	0.096	0.053
C17	237.00	0.123	0.119	0.103	0.080	0.042
C18	251.00	0.109	0.105	0.088	0.068	0.033
C19	263.00	0.090	0.087	0.072	0.053	0.024
C20	275.00	0.068	0.065	0.054	0.040	0.017
C21	291.00	0.055	0.053	0.044	0.031	0.012
C22	305.00	0.045	0.044	0.036	0.025	0.009
C23	318.00	0.038	0.037	0.029	0.020	0.007
C24	331.00	0.032	0.031	0.025	0.017	0.005
C25	345.00	0.027	0.026	0.022	0.014	0.004
C26	359.00	0.024	0.023	0.019	0.012	0.003
C27	374.00	0.020	0.020	0.016	0.010	0.002
C28	388.00	0.017	0.017	0.013	0.007	0.001
C29	402.00	0.015	0.014	0.011	0.005	0.000
C30+	750.00	0.047	0.045	0.023	0.010	0.002
Total		100.000	100.000	100.000	100.000	100.000
MW		30.18	29.87	28.93	27.55	25.95

Table 20 Results of CVD Test on Recombined Fluid at Tres=106 °C and Psat= 4661 psia: Vapor Compositions and Last Stage Liquid Composition — Con't

Pressure	MW	2600	2100	1650	1300	Residual Oil @ 1300 psi
Component	g/mol	mole %	mole %	mole %	mole %	mole %
CO2	44.01	0.496	0.499	0.514	0.504	0.213
H2S	34.08	0.000	0.000	0.000	0.000	0.000
N2	28.01	0.941	0.932	0.931	0.910	0.148
C1	16.04	72.224	72.744	72.964	72.910	20.726
C2	30.07	13.461	13.558	13.947	13.849	9.121
C3	44.10	5.928	6.004	6.161	6.231	7.153
i-C4	58.12	0.975	0.968	0.982	1.000	1.748
n-C4	58.12	1.880	1.893	1.857	1.963	4.134
i-C5	72.15	0.521	0.501	0.500	0.507	1.888
n-C5	72.15	0.580	0.552	0.545	0.551	2.367
C6	84.00	0.577	0.523	0.487	0.473	3.608
Mcyclo-C5	84.16	0.078	0.069	0.048	0.059	0.606
Benzene	78.11	0.013	0.012	0.010	0.012	0.098
Cyclo-C6	84.16	0.084	0.073	0.064	0.064	0.736
C7	96.00	0.443	0.379	0.288	0.283	4.138
Mcyclo-C6	98.19	0.198	0.165	0.097	0.123	2.195
Toluene	92.14	0.053	0.044	0.038	0.037	0.591
C8	107.00	0.472	0.377	0.242	0.212	6.062
C2-Benzene	106.17	0.015	0.012	0.002	0.002	0.249
m&p-Xylene	106.17	0.069	0.047	0.011	0.013	1.082
o-Xylene	106.17	0.013	0.010	0.005	0.006	0.226
C9	121.00	0.288	0.220	0.157	0.155	4.565
C10	134.00	0.249	0.172	0.093	0.073	5.026
C11	147.00	0.142	0.090	0.030	0.037	3.569
C12	161.00	0.087	0.051	0.015	0.015	2.743
C13	175.00	0.069	0.038	0.010	0.009	2.681
C14	190.00	0.044	0.023	0.003	0.003	2.167
C15	206.00	0.034	0.018	0.001	0.000	2.053
C16	222.00	0.022	0.010	0.000	0.000	1.678
C17	237.00	0.016	0.006	0.000	0.000	1.518
C18	251.00	0.011	0.005	0.000	0.000	1.326
C19	263.00	0.007	0.003	0.000	0.000	1.070
C20	275.00	0.005	0.001	0.000	0.000	0.800
C21	291.00	0.003	0.000	0.000	0.000	0.643
C22	305.00	0.001	0.000	0.000	0.000	0.523
C23	318.00	0.001	0.000	0.000	0.000	0.433
C24	331.00	0.000	0.000	0.000	0.000	0.369
C25	345.00	0.000	0.000	0.000	0.000	0.314
C26	359.00	0.000	0.000	0.000	0.000	0.272
C27	374.00	0.000	0.000	0.000	0.000	0.235
C28	388.00	0.000	0.000	0.000	0.000	0.203
C29	402.00	0.000	0.000	0.000	0.000	0.169
C30+	750.00	0.000	0.001	0.000	0.000	0.553
Total		100.000	100.000	100.000	100.000	100.000
MW		24.56	23.84	23.11	23.14	100.14

Table 21 Results of Stock Tank Condensate Viscosity Measurements

Temperature (°C)	Viscosity (cP)
40	0.88
25	1.16
15	1.35

Table 22 Results of Stock Tank Condensate Wax Appearance Temperature (WAT)

Sample	Wax Appearance Temperature, WAT (°C)
Dead condensate flashed from separator sample	9.4

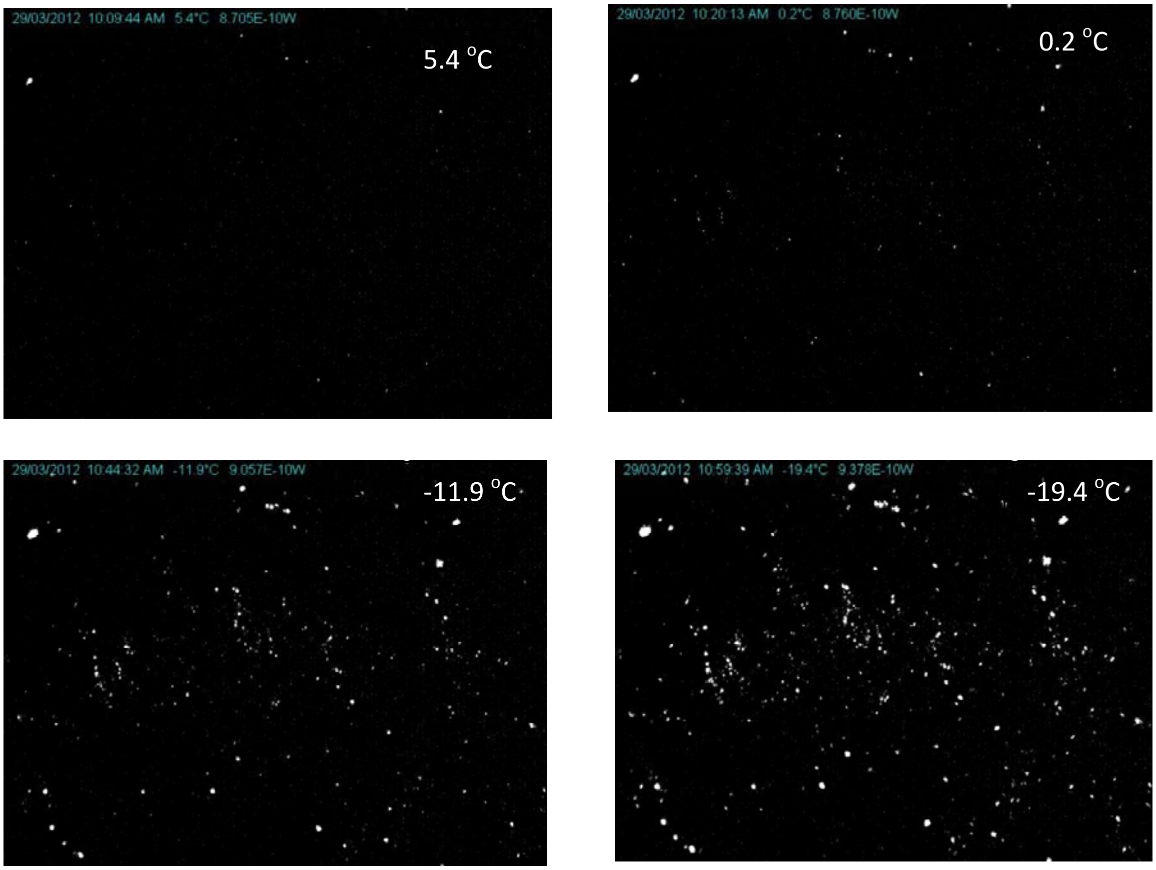

Figure 11 Photo Micrographs from Stock Tank Condensate Wax Appearance Temperature (WAT) Measurements

Table 23 Results of Stock Tank Condensate Wax Appearance Temperature (WAT)

Sample	Asphaltene Content (wt%)
Dead condensate flashed from separator sample	< 0.1

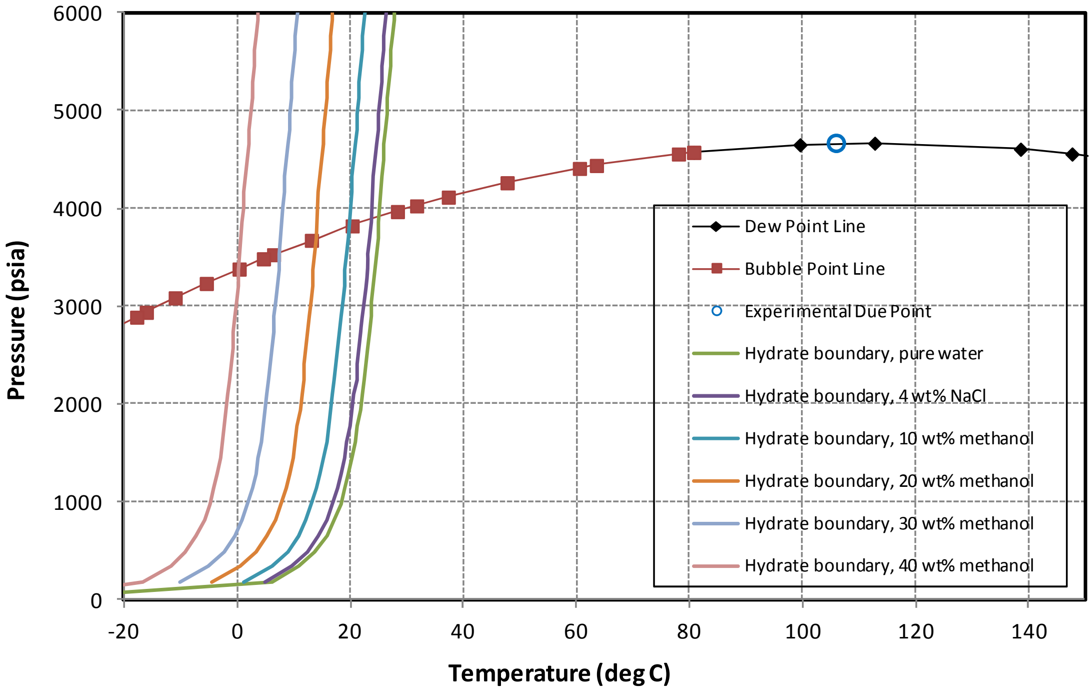

Figure 12 Hydrate Phase Boundary Predictions with Various Scenarios

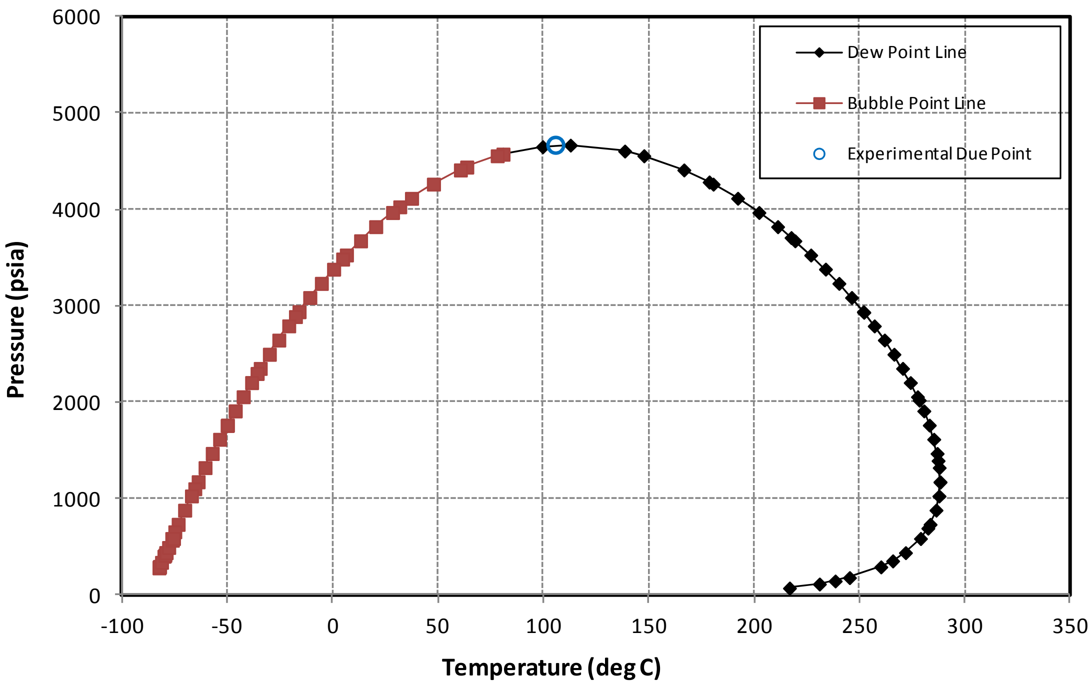

Figure 13 VLE Phase Envelop

Table 24 VLE Phase Boundary Data

Pressure psia	Temperature C	Phase	Pressure psia	Temperature C	Phase	Pressure psia	Temperature C	Phase
74	216.7	Dew Point	4409	60.5	Bubble Point	715	-72.4	Bubble Point
116	230.9	Dew Point	4262	47.7	Bubble Point	735	-71.9	Bubble Point
147	238.4	Dew Point	4115	37.3	Bubble Point	769	-70.9	Bubble Point
182	245.2	Dew Point	4026	31.7	Bubble Point	802	-69.9	Bubble Point
294	260.1	Dew Point	3968	28.3	Bubble Point	818	-69.4	Bubble Point
356	265.7	Dew Point	3821	20.3	Bubble Point	822	-69.2	Bubble Point
441	271.8	Dew Point	3674	13.1	Bubble Point	822	-69.2	Bubble Point
588	278.9	Dew Point	3527	6.4	Bubble Point	822	-69.2	Bubble Point
695	282.4	Dew Point	3485	4.6	Bubble Point	816	-69.5	Bubble Point
735	283.5	Dew Point	3380	0.3	Bubble Point	802	-70.0	Bubble Point
882	286.3	Dew Point	3233	-5.5	Bubble Point	784	-70.7	Bubble Point
1029	287.7	Dew Point	3086	-11.0	Bubble Point	748	-72.3	Bubble Point
1172	288.2	Dew Point	2939	-16.1	Bubble Point	735	-72.9	Bubble Point
1176	288.2	Dew Point	2889	-17.8	Bubble Point	687	-75.2	Bubble Point
1323	287.8	Dew Point	2792	-21.0	Bubble Point	621	-78.7	Bubble Point
1394	287.3	Dew Point	2645	-25.7	Bubble Point	588	-80.6	Bubble Point
1470	286.8	Dew Point	2498	-30.2	Bubble Point	556	-82.5	Bubble Point
1617	285.2	Dew Point	2351	-34.5	Bubble Point	467	-88.4	Bubble Point
1764	283.1	Dew Point	2299	-36.0	Bubble Point	441	-90.3	Bubble Point
1911	280.5	Dew Point	2204	-38.6	Bubble Point	387	-94.5	Bubble Point
2022	278.3	Dew Point	2057	-42.6	Bubble Point	318	-100.6	Bubble Point
2057	277.5	Dew Point	1911	-46.4	Bubble Point	294	-102.9	Bubble Point
2204	274.1	Dew Point	1764	-50.1	Bubble Point	259	-106.7	Bubble Point
2351	270.4	Dew Point	1760	-50.2	Bubble Point	209	-112.6	Bubble Point
2498	266.3	Dew Point	1617	-53.8	Bubble Point	168	-118.3	Bubble Point
2645	261.8	Dew Point	1470	-57.3	Bubble Point	147	-121.7	Bubble Point
2792	257.0	Dew Point	1323	-60.7	Bubble Point	135	-123.9	Bubble Point
2933	252.0	Dew Point	1176	-64.0	Bubble Point	108	-129.1	Bubble Point
2939	251.8	Dew Point	1104	-65.6	Bubble Point	86	-134.2	Bubble Point
3086	246.2	Dew Point	1029	-67.2	Bubble Point			
3233	240.2	Dew Point	882	-70.4	Bubble Point			
3380	233.8	Dew Point	735	-73.5	Bubble Point			
3527	226.8	Dew Point	657	-75.1	Bubble Point			
3674	219.3	Dew Point	588	-76.5	Bubble Point			
3708	217.5	Dew Point	441	-79.4	Bubble Point			
3821	211.1	Dew Point	404	-80.2	Bubble Point			
3968	202.2	Dew Point	298	-82.3	Bubble Point			
4115	192.1	Dew Point	294	-82.4	Bubble Point			
4262	180.5	Dew Point	285	-82.6	Bubble Point			
4284	178.6	Dew Point	285	-82.6	Bubble Point			
4409	166.6	Dew Point	292	-82.4	Bubble Point			
4556	147.6	Dew Point	294	-82.4	Bubble Point			
4605	138.5	Dew Point	340	-81.4	Bubble Point			
4666	112.7	Dew Point	415	-79.8	Bubble Point			
4650	99.5	Dew Point	441	-79.2	Bubble Point			
4573	80.7	Critical Point	495	-78.0	Bubble Point			
4573	80.7	Bubble Point	571	-76.2	Bubble Point			
4556	78.0	Bubble Point	588	-75.7	Bubble Point			
4439	63.5	Bubble Point	637	-74.5	Bubble Point			

Table 25 Hydrate Phase Boundary Data

Pure water		4 wt% NaCl		10 wt% Methanol - pure water	
Pressure psia	Temperature C	Pressure psia	Temperature C	Pressure psia	Temperature C
8000	30.0	8000	28.7	8000	24.9
7840	29.9	7840	28.5	7840	24.7
7681	29.7	7681	28.3	7681	24.6
7521	29.5	7521	28.1	7521	24.4
7361	29.3	7361	28.0	7361	24.2
7202	29.2	7202	27.8	7202	24.0
7042	29.0	7042	27.6	7042	23.8
6882	28.8	6882	27.4	6882	23.7
6722	28.6	6722	27.2	6722	23.5
6563	28.4	6563	27.0	6563	23.3
6403	28.3	6403	26.9	6403	23.1
6243	28.1	6243	26.7	6243	22.9
6084	27.9	6084	26.5	6084	22.7
5924	27.7	5924	26.3	5924	22.5
5764	27.5	5764	26.1	5764	22.3
5604	27.3	5604	25.9	5604	22.1
5445	27.1	5445	25.7	5445	21.9
5285	26.9	5285	25.5	5285	21.7
5125	26.7	5125	25.3	5125	21.5
4966	26.5	4966	25.1	4966	21.3
4806	26.3	4806	24.9	4806	21.1
4646	26.1	4646	24.7	4646	20.9
4487	25.9	4487	24.4	4487	20.7
4327	25.6	4327	24.2	4327	20.4
3848	25.1	3848	23.6	4167	20.2
3688	24.9	3688	23.4	3688	19.7
3528	24.6	3528	23.2	3528	19.4
3369	24.4	3369	23.0	3369	19.2
3209	24.2	3209	22.7	3209	19.0
3049	23.9	3049	22.5	3049	18.7
2889	23.6	2889	22.2	2889	18.5
2730	23.4	2730	21.9	2730	18.2
2570	23.1	2570	21.7	2570	17.9
2410	22.8	2410	21.4	2410	17.6
2251	22.5	2251	21.1	2251	17.3
2091	22.1	2091	20.7	2091	17.0
1931	21.8	1931	20.4	1931	16.7
1772	21.4	1772	20.0	1772	16.3
1612	20.9	1612	19.5	1612	15.9
1452	20.4	1452	19.0	1452	15.4
1292	19.8	1292	18.4	1292	14.8
1133	19.1	1133	17.7	1133	14.1
973	18.3	973	16.9	973	13.2
813	17.2	813	15.8	813	12.2
654	15.8	654	14.4	654	10.8
494	13.8	494	12.5	494	8.9
334	11.0	334	9.7	334	6.1
174	6.2	174	4.8	174	1.2
15	-34.7				

20 wt% Methanol - pure water		30 wt% Methanol - pure water		40 wt% Methanol - pure water	
Pressure psia	Temperature C	Pressure psia	Temperature C	Pressure psia	Temperature C
8000	19.2	8000	13.0	8000	6.1
7840	19.1	7840	12.8	7840	5.9
7681	18.9	7681	12.7	7681	5.7
7521	18.7	7521	12.5	7521	5.5
7361	18.5	7361	12.3	7361	5.4
7202	18.3	7202	12.1	7202	5.2
7042	18.2	7042	11.9	7042	5.0
6882	18.0	6882	11.7	6882	4.8
6722	17.8	6722	11.6	6722	4.6
6563	17.6	6563	11.4	6563	4.4
6403	17.4	6403	11.2	6403	4.2
6243	17.2	6243	11.0	6243	4.0
6084	17.0	6084	10.8	6084	3.8
5924	16.8	5924	10.6	5924	3.6
5764	16.6	5764	10.4	5764	3.4
5604	16.4	5604	10.2	5604	3.2
5445	16.2	5445	10.0	5445	3.0
5285	16.0	5285	9.8	5285	2.8
5125	15.8	5125	9.6	5125	2.6
4966	15.6	4966	9.4	4966	2.4
4806	15.4	4806	9.2	4806	2.2
4646	15.2	4646	9.0	4646	2.0
4487	15.0	4487	8.8	4487	1.8
4327	14.8	4327	8.5	4327	1.6
4167	14.5	4167	8.3	4167	1.3
3688	14.0	4007	8.1	4007	1.1
3528	13.8	3528	7.5	3848	0.9
3369	13.5	3369	7.3	3369	0.3
3209	13.3	3209	7.1	3209	0.1
3049	13.1	3049	6.9	3049	-0.1
2889	12.8	2889	6.6	2889	-0.3
2730	12.6	2730	6.4	2730	-0.6
2570	12.3	2570	6.1	2570	-0.8
2410	12.0	2410	5.8	2410	-1.1
2251	11.7	2251	5.6	2251	-1.3
2091	11.4	2091	5.3	2091	-1.6
1931	11.1	1931	5.0	1931	-1.9
1772	10.7	1772	4.6	1772	-2.2
1612	10.3	1612	4.3	1612	-2.6
1452	9.9	1452	3.8	1452	-3.0
1292	9.3	1292	3.3	1292	-3.4
1133	8.6	1133	2.7	1133	-4.1
973	7.8	973	1.9	973	-4.8
813	6.8	813	0.8	813	-5.8
654	5.4	654	-0.5	654	-7.2
494	3.5	494	-2.4	494	-9.0
334	0.7	334	-5.2	334	-11.8
174	-4.3	174	-10.2	174	-16.8
				15	-36.6

APPENDIX

Compositional Analyses

Following the sample restoration, a sample of equilibrated live fluid is isobarically displaced into a pre-cleaned and evacuated pycnometer for density, GOR, and C30+ compositional analysis using a flash procedure. With this technique, an accurately measured volume of single-phase fluid is isobarically displaced into a pycnometer where its density and mass are evaluated. The pycnometer is then connected to a GOR single stage flash apparatus where the condensate is flashed to ambient pressure and temperature conditions. The evolved gas phase is then circulated through the residual liquid to equilibrate the phases. Following circulation, the volume of equilibrium vapor and the mass of liquid remaining in the pycnometer are measured.

The vapor phase is resolved to C15 by natural gas GC and the residual liquid is analyzed to C30+. The composition of the original live condensate is then calculated by mass balance from the measured composition and total mass of each phase.

The compositional analysis of gaseous mixtures is performed gas chromatograph with a natural an extended gas configuration. It consists of packed columns and a TCD detector, and a capillary column and an FID detector and uses helium as a carrier gas. Temperature programming is isothermal (i.e. single step @ 160 oF), and the detection range covers N2, CO2, H2S, C1 to C5, and a grouped C6+ peak. It also uses helium as a carrier gas. The temperature programming is non-isothermal (in cycles from 0 to 390 o F) and the detection range covers C1 to C10 including the associated common isomers.

Compositional analysis of liquid samples is performed on a temperature programmed GC equipped with a different capillary column, an FID detector and helium as a carrier gas. The temperature programming is also non-isothermal (in cycles from 50 to 570 oF), and the detection range covers C5 to C29 and lumped C30+. The analysis includes the associated common isomers.

The liquid GC utilizes a proprietary technology to determine hydrocarbon liquid carbon number distribution. For low C30+ fraction concentration (< 5 mass %), the GC is calibrated against ASTM D-2887 Reference Gas Condensate #1. The tuning parameter for this calibration is the C30+ fraction mass percent. A mean value of 2.5 mass % within a deviation of ± 0.4 mass % is considered acceptable as a control limit. A warning limit is set at 2.5 ± 0.6 mass %, and the GC is completely serviced and recalibrated if the measured ASTM standard C30+ concentration is registered outside these limits.

Internal standard reference crude is used for calibration in the high C30+ region. This standard has a mean C30+ mass percent of 35.2 and a deviation of 1.8 mass % is considered an acceptable control limit. The warning limit for the reference crude is ± 2.7 mass %. All standards are run on a regular basis and detailed records of GC performance and servicing are maintained and are available to clients upon request.

Only n-alkane peaks are identified and components between these peaks are lumped together into an overall carbon number grouping.

Standard PVT Analyses

PVT CELL

The main body of a PVT cell consists of a Pyrex tube housed inside a steel shell fitted with vertical tempered glass plates that permit visual observation of the internal tube contents. The Pyrex glass tube is 15.2 cm long with an internal diameter of 3.2 cm which provides an effective working volume of approximately 120 cm3. A specially designed floating piston and a magnetically coupled impeller mixer are mounted inside the Pyrex tube to allow for a mercury-free operation.

Volume and pressure of the fluids under investigation are controlled by a variable volume displacement pump which allows for the injection or the removal of a transparent hydraulic fluid. The transparent displacement fluid is also connected to the outer steel shell to maintain a balanced (minimal) differential pressure on the Pyrex tube. Equilibration of the fluid under investigation is achieved by means of a magnetically coupled impeller mixer mounted on the bottom end cap. It should be noted that the bottom end cap was designed to achieve two main goals: (i) shield the cell contents from any magnetic effects/flux and (ii) provide for charging and sampling the test fluid.

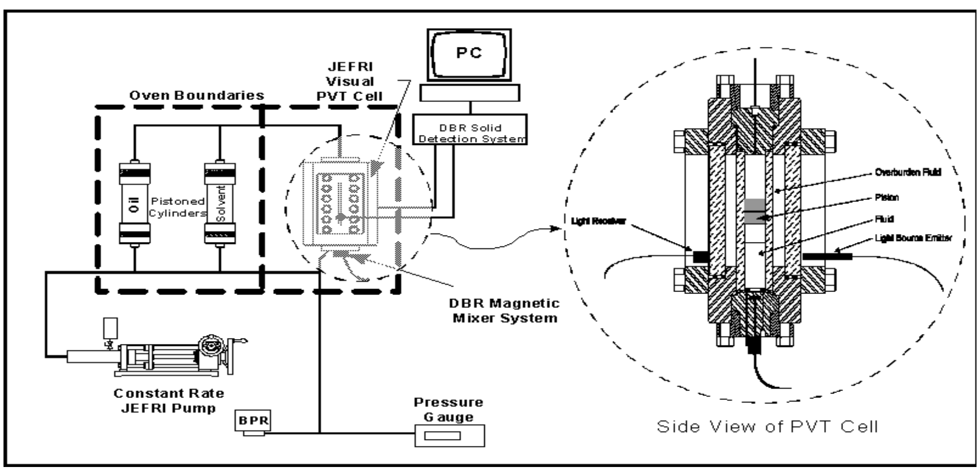

Figure A 1 Schematic diagram of Schlumberger PVT Cell equipped with SDS

A PVT cell is housed inside a temperature controlled, forced air circulation oven on a bracket which allows the cell to be rotated through 360°. The cell can be completely inverted to sample any liberated gas when/if required and the cell is kept inverted at all times when carrying out gas diluent studies. In the inverted position the floating piston is on the bottom of the cell and the magnetic mixer is at the top.

Cell temperature is measured with platinum RTD and is displayed on a digital indicator that has an accuracy of 0.2°F or 0.1°C. Cell pressure is monitored with a calibrated digital Heise pressure gauge accurate to ± 0.1 % of full scale. Maximum operating pressure and temperature for this PVT system is 15,000 psia and 392° F.

Constant Composition Expansion (CCE)

CCE tests are carried out by charging a known volume of an equilibrated fluid to a PVT cell at Tres and pres. Fluid density is measured and the initial mass of the fluid in the cell is calculated. The fluid is then isothermally expanded to a lower pressure which is still in the single-phase region. Total system volume is measured after equilibration at this pressure and the volume is used to calculate the single-phase density at this pressure.

This procedure is repeated until the dew point pressure is reached. Pressure is then further reduced by selected intervals until the two-phase region is reached. The vapor and liquid phases are equilibrated at each pressure point; phase volumes are measured and plotted as a function of pressure. Dew point pressure is determined through visual observation and liquid drop out is measured.

Constant Volume Depletion (CVD)

Constant Volume Depletion (CVD) tests, performed on gas condensates, are carried out by charging a known volume of an equilibrated fluid to a PVT cell at Tres and Pres. Volume measurement is important as it is used to establish the reservoir volume to which the PVT cell contents are returned after each depletion step.

CVD tests involve reducing the system pressure from Pres to the first specified pressure step at which the fluid is equilibrated. The resulting vapor and liquid volumes are then determined and a portion of the equilibrium vapor is displaced from the top of the PVT cell and analyzed for C30+ composition and density. Additional vapor is displaced to return the fluid system to the initial single-phase reservoir volume as defined above. The system pressure is then reduced to the next specified depletion pressure step and measurements are repeated. Complete CVD tests may require 6 to 10 depletion steps.

Viscosity Measurements

For the viscosity measurement of the reservoir fluid at selected pressures in single phase above the saturation pressure, and liquid phase during the DL test. Either a capillary viscometer or a Cambridge Electromagnetic Viscometer is used.

Electromagnetic Viscometer (EMV)

Schlumberger laboratories use a EMV model SPL440 (See Figure A.2). Such a High Pressure Viscometer is a precision instrument designed to accurately measure the viscosity of petroleum fluids. It was developed in cooperation with Cambridge Applied Systems and capable of continuous operation to 138 MPa (20,000 psia) and 190oC (374oF). The SPL440 system can be configured as a stand-alone system or as an in-line component with the visual PVT phase behavior system. Performing viscosity measurements over the range of 0.1 to 10,000 cP on very small volumes of fluid makes this instrument an ideal component for petroleum fluid laboratory studies.

A number of electronics options are available for operating the SPL440 Viscometer, including the ViscoPro2000, a device that is able to provide unparalleled accuracy over the greatest measurement range. Even with this outstanding degree of precision, accuracy and functionality, the SPL440 Viscometer is still easy to install, operate and service. It has only one moving part, a small magnetic stainless steel piston located inside the sensor that is driven up and down using coils, simplifying installation and servicing. The measurement chamber, connected to both top and bottom system lines, allows for easy introduction, measurement, and removal of a fluid from the Viscometer.

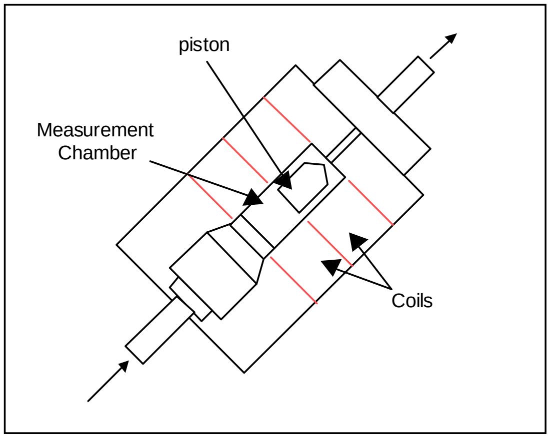

Figure A.2 - Schematic Diagram of Cambridge Electromagnetic Viscometer

The test fluid is charged to the vessel and the piston is surrounded by fluid. Subsequently, the piston is moved inside the vessel by imparting a force on the piston using two electromagnetic coils inside the sensor body. After traveling the length of the test vessel, the piston is returned to its starting location by reversing the magnetic field of the electromagnet. The motion of the piston inside the vessel is impeded by viscous flow around the annulus between the piston and the measurement chamber wall. Viscosity is determined by measuring the piston transit time for a complete cycle of piston movement and comparing this to times obtained using calibrated standards.