RESERVOIR FLUID STUDY

SM ENERGY

WELL: RUSH

FINAL REPORT

Prepared for

SM ENERGY

By

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I - RESERVOIR FLUID STUDY

LIST OF TABLES

LIST OF FIGURES

RESULTS AND DISCUSSION

The reservoir fluid study was conducted on a recombined sample prepared from separator oil and separator gas collected from Well RUSH.

The sample collection data is provided in Table 1 and the sample validation data of the reservoir fluid used in this study is given in Appendix A.

Table 2 provides the compositional analysis of the RECOMBINED sample.

The PVT cell was charged with a portion of the live oil sample and a constant composition expansion experiment (CCE) was performed on the oil. Table 3 provides the CCE results of the average compressibility of the reservoir fluid at pressures above the bubblepoint. Table 4 contains the complete CCE results with the exception of the data already presented in Table 3. Figure 1 shows the relative total volume (V/Vsat) data and Y-function with respect to pressure.

Table 5 contains various property measurements performed on the differentially liberated oil below the bubblepoint including live oil density, oil formation volume factor and gas-oil ratios, which are shown in Figures 2 through 4, respectively.

Table 6 contains a summary of the properties of the differentially liberated gas including gas gravities, deviation factors, gas formation volume factors and gas expansion factors. The gas deviation factor (Z), gas formation volume factor and gas expansion factor, and gas gravity are shown in Figures 6 through 8, respectively.

Table 7 provides the results of the reservoir fluid viscosity measurements. This data is represented by Figures 5 and 9. Gas phase viscosity was calculated using the compositional data and the Lee, Gonzalez, Eakin correlation.

Table 8 summarizes the effluent gas compositions from each pressure stage during the differential liberation experiment. Figure 10 shows this data plotted on semi-log co-ordinates. Table 9 presents the compositional analysis of the residual oil at completion of the experiment.

Table 10 provides the correlations of the measured PVT Data. Table 11 provides the oil formation volume factor and solution gas-oil ratio from differential liberation corrected from single-stage separtor test parameters.

Appendix B contains the material balance check performed for this experiment. It is displayed as formation volume factors so that the balance can be checked on a point by point basis. Appendix C contains the compositional analyses of the liberated gases from the differential liberation test.

SUMMARY

MAIN PVT RESULTS

INITIAL RESERVOIR CONDITIONS

Reservoir Pressure	5866 psia	40.44 MPa
Reservoir Temperature:	248.0 F	120.0 C

CONSTANT COMPOSITION EXPANSION @ 248.0 F (120.0 C)

Saturation Pressure	3290 psia	22.68 MPa
Compressibility @ Reservoir Pressure	1.11004E-05 $psia^{-1}$	1.6100E-03 MPa^{-1}
Compressibility @ Saturation Pressure	2.15276E-05 $psia^{-1}$	3.1223E-03 MPa^{-1}

DIFFERENTIAL LIBERATION @ 248.0 F (120.0 C)

At Saturation Pressure		
Oil Formation Volume Factor	1.7373 res.bbl/STB	1.7373 res.m3/m3
Solution Gas-Oil Ratio	1255.22 scf/STB	223.56 m3/m3
Oil Density	0.6181 g/cm3	618.1 kg/m3
Oil Viscosity	0.438 cp	0.438 mPa.s
At Ambient Pressure		
Residual Oil Density	0.7938 g/cm3	793.8 kg/m3
Residual Oil Viscosity	1.185 cp	1.185 mPa.s
At Stock Tank Conditions		
Residual Oil Density	0.8341 g/cm3	834.1 kg/m3
API Gravity	38.1	38.1

SINGLE-STAGE SEPARATOR TEST

At Saturation Pressure		
Oil Formation Volume Factor	1.6648 res.bbl/STB	1.6648 res.m3/m3
Solution Gas-Oil Ratio	1020.61 scf/STB	181.77 m3/m3
At Stock Tank Conditions		
Residual Oil Density	0.8309 g/cm3	830.9 kg/m3
API Gravity	38.8	38.8

TABLE 1
SAMPLE COLLECTION DATA

Project File:	WTC-14-004429			
Operator Name:	SM ENERGY			
Pool or Zone:				
Field or Area:				
Well Location:	RUSH			
Fluid Sample:	RECOMBINED			
Sampling Company:	SM ENERGY			
Name of Sampler:	-			
Sampling Date:	-			
Sampling Point:	SEPARATOR			
Sampling Temperature:	160	F	71.1	C
Sampling Pressure:	35.00	psia	0.24	MPa
Reservoir Temperature:	248	F	120.0	C
Reservoir Pressure:	5866	psia	40.44	MPa
Initial Reservoir Pressure (Pi)	-	psia	-	MPa
Depth of Reported Pi	N/A	ft	N/A	m

TABLE 2
COMPOSITIONAL ANALYSIS OF RESERVOIR FLUID

Component Name	Chemical Symbol	Mole Fraction	Mass Fraction	Calculated Properties	
Nitrogen	N_2	0.0044	0.0014	**Total Sample**	
Carbon Dioxide	CO_2	0.0089	0.0045		
Hydrogen Sulphide	H_2S	0.0000	0.0000	Molecular Weight	87.04
Methane	C_1	0.4372	0.0806		
Ethane	C_2	0.0714	0.0247		
Propane	C_3	0.0541	0.0274	**C_{6+} Fraction**	
i-Butane	i-C_4	0.0084	0.0056		
n-Butane	n-C_4	0.0301	0.0201	Molecular Weight	199.58
i-Pentane	i-C_5	0.0141	0.0117	Mole Fraction	0.3525
n-Pentane	n-C_5	0.0189	0.0157	Density (g/cc)	0.8367
Hexanes	C_6	0.0257	0.0254		
Heptanes	C_7	0.0421	0.0482		
Octanes	C_8	0.0479	0.0615	**C_{7+} Fraction**	
Nonanes	C_9	0.0277	0.0409		
Decanes	C_{10}	0.0238	0.0389	Molecular Weight	208.50
Undecanes	C_{11}	0.0195	0.0330	Mole Fraction	0.3268
Dodecanes	C_{12}	0.0166	0.0307	Density (g/cc)	0.8427
Tridecanes	C_{13}	0.0170	0.0342		
Tetradecanes	C_{14}	0.0145	0.0317		
Pentadecanes	C_{15}	0.0128	0.0302	**C_{12+} Fraction**	
Hexadecanes	C_{16}	0.0106	0.0271		
Heptadecanes	C_{17}	0.0096	0.0263	Molecular Weight	294.32
Octadecanes	C_{18}	0.0091	0.0263	Mole Fraction	0.1657
Nonadecanes	C_{19}	0.0084	0.0252	Density (g/cc)	0.8817
Eicosanes	C_{20}	0.0066	0.0209		
Heneicosanes	C_{21}	0.0060	0.0199		
Docosanes	C_{22}	0.0053	0.0187		
Tricosanes	C_{23}	0.0048	0.0176		
Tetracosanes	C_{24}	0.0044	0.0167		
Pentacosanes	C_{25}	0.0039	0.0153		
Hexacosanes	C_{26}	0.0037	0.0154		
Heptacosanes	C_{27}	0.0031	0.0131		
Octacosanes	C_{28}	0.0030	0.0134		
Nonacosanes	C_{29}	0.0027	0.0124		
Tricontanes	C_{30}	0.0023	0.0112		
Hentriacontanes	C_{31}	0.0022	0.0107		
Dotriacontanes	C_{32}	0.0019	0.0098		
Tritriacontanes	C_{33}	0.0017	0.0091		
Tetratriacontanes	C_{34}	0.0016	0.0087		
Pentatriacontanes	C_{35}	0.0014	0.0081		
Hexatriacontanes plus	C_{36+}	0.0124	0.1076		
		1.0000	**1.0000**		

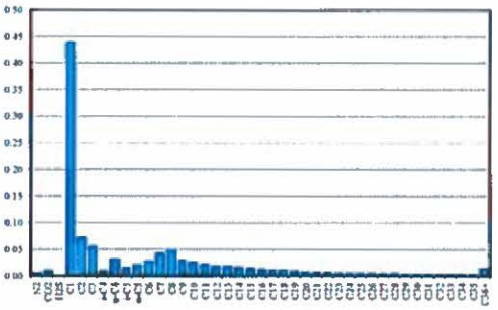


TABLE 3
OIL COMPRESSIBILITY @ 248.0 F (120.0 C)

Pressure Range		Average
From (psia)	To (psia)	Compressibility (psi^{-1})
8015	7015	1.0448E-05
7015	5866	1.1100E-05
5866	5015	1.2616E-05
5015	4515	1.4608E-05
4515	4015	1.5972E-05
4015	3515	1.8133E-05
3515	3290 Psat	2.1528E-05

Pressure Range		Average
From (MPa)	To (MPa)	Compressibility (MPa^{-1})
55.26	48.36	1.5153E-03
48.36	40.44	1.6100E-03
40.44	34.58	1.8299E-03
34.58	31.13	2.1187E-03
31.13	27.68	2.3166E-03
27.68	24.23	2.6300E-03
24.23	22.68 Psat	3.1223E-03

Psat - Saturation Pressure

TABLE 4
CONSTANT COMPOSITION EXPANSION @ 248.0 F (120.0 C)

Pressure (psia)	Pressure (MPa)	RelativeVolume [1]	Y-Function [2]	Fluid Density (g/cc)
8015	55.26	0.938523		0.6586
7015	48.36	0.948432		0.6517
5866	40.44	0.960685		0.6434
5015	34.58	0.971111		0.6365
4515	31.13	0.978256		0.6319
4015	27.68	0.986132		0.6268
3515	24.23	0.995154		0.6211
3290 Psat	**22.68**	**1.000000**		**0.6181**
3103	21.39	1.023293	2.5876	
2916	20.10	1.050628	2.5337	
2729	18.81	1.082912	2.4798	
2542	17.52	1.121321	2.4258	
2355	16.23	1.167417	2.3719	
2168	14.95	1.223310	2.3180	
1981	13.66	1.291918	2.2640	
1794	12.37	1.377394	2.2101	
1607	11.08	1.485841	2.1562	
1420	9.79	1.626606	2.1022	
1233	8.50	1.814737	2.0483	
1046	7.21	2.076095	1.9944	
859	5.92	2.459127	1.9404	
672	4.63	3.066328	1.8865	
485	3.34	4.158539	1.8326	

[1] Volume at indicated pressure per volume at saturation pressure
[2] Y Function = ((Psat-P)/P)/(Relative Volume - 1)
Psat - Saturation Pressure

TABLE 5
DIFFERENTIAL LIBERATION OIL PROPERTIES @ 248.0 F (120.0 C)

Pressure		Oil Density	Oil Formation Volume Factor	Total Formation Volume Factor	Gas-Oil Ratio		Gas-Oil Ratio	
(psia)	(MPa)	(g/cm³)	[1]	[2]	Solution (scf/STB)	Liberated (scf/STB)	Solution (m³/m³)	Liberated (m³/m³)
8015	55.26	0.6586	1.6305	1.6305	1255.22	0.00	223.56	0.00
7015	48.36	0.6517	1.6477	1.6477	1255.22	0.00	223.56	0.00
5866	40.44	0.6434	1.6690	1.6690	1255.22	0.00	223.56	0.00
5015	34.58	0.6365	1.6871	1.6871	1255.22	0.00	223.56	0.00
4515	31.13	0.6319	1.6995	1.6995	1255.22	0.00	223.56	0.00
4015	27.68	0.6268	1.7132	1.7132	1255.22	0.00	223.56	0.00
3515	24.23	0.6211	1.7289	1.7289	1255.22	0.00	223.56	0.00
3290 Psat	22.68	0.6181	1.7373	1.7373	1255.22	0.00	223.56	0.00
2915	20.10	0.6410	1.6172	1.8487	1040.67	214.55	185.34	38.21
2515	17.34	0.6565	1.5404	1.9921	891.69	363.53	158.81	64.74
2115	14.58	0.6729	1.4675	2.2170	748.72	506.49	133.35	90.21
1715	11.82	0.6909	1.3962	2.5888	609.04	646.18	108.47	115.08
1315	9.06	0.7087	1.3311	3.2076	481.54	773.68	85.76	137.79
915	6.31	0.7283	1.2654	4.4608	352.81	902.41	62.84	160.72
615	4.24	0.7432	1.2192	6.5281	262.39	992.83	46.73	176.82
315	2.17	0.7601	1.1667	12.4645	166.07	1089.15	29.58	193.98
15	0.10	0.7938	1.0578	152.4026	0.00	1255.22	0.00	223.56

Density of Residual Oil = 0.8341 g/cm3 (834.1 kg/m3) @ 60 F (288.7K)
API Gravity of Residual Oil = 38.1

[1] Barrels (Cubic meters) of oil at indicated pressure and temperature per barrel (cubic meter) of residual oil @ 60 F (288.7 K).
[2] Total barrels (cubic meters) of oil and liberated gas at the indicated pressure and temperature per barrel (cubic meter) of residual oil @ 60 F (288.7 K).
Psat - Saturation Pressure
- Standard conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa).

TABLE 6
DIFFERENTIAL LIBERATION GAS PROPERTIES @ 248.0 F (120.0 C)

Pressure		Gas Gravity		Gas Density (g/cm^3)	Gas Deviation Factor (-)	Gas Formation Volume Factor [1]	Gas Expansion Factor [2]
(psia)	(MPa)	Incremental (Air = 1)	Cumulative (Air = 1)				
8015	55.26						
7015	48.36						
5866	40.44						
5015	34.58						
4515	31.13						
4015	27.68						
3515	24.23						
3290 Psat	22.68						
2915	20.10	0.7899	0.7899	0.1586	0.8867	0.0061	165.079
2515	17.34	0.7788	0.7854	0.1357	0.8817	0.0070	143.344
2115	14.58	0.7664	0.7800	0.1120	0.8841	0.0083	120.349
1715	11.82	0.7472	0.7729	0.0874	0.8955	0.0104	96.501
1315	9.06	0.7611	0.7710	0.0676	0.9046	0.0136	73.431
915	6.31	0.7769	0.7718	0.0470	0.9233	0.0199	50.296
615	4.24	0.7823	0.7728	0.0311	0.9442	0.0300	33.307
315	2.17	0.9125	0.7851	0.0183	0.9586	0.0582	17.170
15	0.10	1.5163	0.8819	0.0014	0.9944	0.6770	1.477

[1] Cubic feet (meters) of gas at indicated pressure and temperature per cubic feet (meter) @ standard conditions
[2] Cubic feet (meters) of gas @ standard conditions per cubic feet (meter) @ indicated pressure and temperature.
Psat - Saturation pressure
- Standard conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

TABLE 7
DIFFERENTIAL LIBERATION FLUID VISCOSITY @ 248.0 F (120.0 C)

Pressure (psia)	Pressure (MPa)	Oil Viscosity (cp=mPa.s)	Gas Viscosity (cp=mPa.s)	Oil - Gas Viscosity Ratio
5851	40.34	0.491		
5000	34.47	0.469		
4000	27.58	0.438		
3500	24.13	0.423		
3290 Psat	22.68	0.415		
2915	20.10	0.464	0.02063	22.47
2515	17.34	0.502	0.01914	26.23
2115	14.58	0.545	0.01780	30.59
1715	11.82	0.597	0.01666	35.82
1315	9.06	0.653	0.01573	41.50
915	6.31	0.715	0.01489	47.99
615	4.24	0.787	0.01438	54.75
315	2.17	0.897	0.01347	66.59
15	0.10	1.185	0.01106	107.07

Psat - Saturation Pressure

TABLE 8
COMPOSITIONAL ANALYSIS OF LIBERATED GAS @ 248.0 F (120.0 C)

Component	Differential Liberation Stage Pressure (psia/MPa)													
	2915	2515	2115	1715	1315	915	615	315	15					
	20.10	17.34	14.58	11.82	9.06	6.31	4.24	2.17	0.10					
N2	0.0121	0.0116	0.0092	0.0073	0.0064	0.0055	0.0047	0.0013	0.0001					
CO2	0.0116	0.0115	0.0120	0.0125	0.0133	0.0142	0.0144	0.0168	0.0110					
H2S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
C1	0.7892	0.7944	0.8010	0.8071	0.7859	0.7641	0.7476	0.6233	0.2558					
C2	0.0761	0.0780	0.0798	0.0815	0.0947	0.1079	0.1178	0.1689	0.1887					
C3	0.0453	0.0438	0.0431	0.0446	0.0511	0.0576	0.0668	0.1044	0.2101					
i-C4	0.0058	0.0054	0.0051	0.0051	0.0057	0.0063	0.0071	0.0117	0.0337					
n-C4	0.0181	0.0167	0.0156	0.0153	0.0169	0.0184	0.0201	0.0342	0.1126					
i-C5	0.0066	0.0059	0.0051	0.0047	0.0050	0.0052	0.0052	0.0094	0.0401					
n-C5	0.0080	0.0072	0.0061	0.0054	0.0057	0.0059	0.0055	0.0104	0.0470					
C6	0.0079	0.0075	0.0059	0.0044	0.0046	0.0048	0.0037	0.0072	0.0378					
C7+	0.0192	0.0179	0.0170	0.0120	0.0108	0.0100	0.0071	0.0125	0.0630					
Total	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**					
Calculated Properties of Total Sample @ Standard Conditions														
MW (g/mol)	22.88	22.56	22.20	21.64	22.04	22.50	22.66	26.43	43.92					
Gravity (Air=1.0)	0.7899	0.7788	0.7664	0.7472	0.7611	0.7769	0.7823	0.9125	1.5163					
Calculated Properties of C7+ @ Standard Conditions														
MW (g/mol)	101.78	101.84	102.27	101.55	101.25	102.27	103.74	101.08	100.61					
Density (g/cc)	0.7338	0.7338	0.7347	0.7336	0.7329	0.7348	0.7370	0.7324	0.7315					

TABLE 9
COMPOSITIONAL ANALYSIS OF RESIDUAL OIL

Component Name	Chemical Symbol	Mole Fraction	Mass Fraction	Calculated Properties	
Nitrogen	N_2	0.0000	0.0000	**Total Sample**	
Carbon Dioxide	CO_2	0.0000	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000	Molecular Weight	197.37
Methane	C_1	0.0000	0.0000		
Ethane	C_2	0.0023	0.0004		
Propane	C_3	0.0131	0.0029	**C_{6+} Fraction**	
i-Butane	i-C_4	0.0050	0.0015		
n-Butane	n-C_4	0.0247	0.0073	Molecular Weight	209.93
i-Pentane	i-C_5	0.0196	0.0072	Mole Fraction	0.9062
n-Pentane	n-C_5	0.0291	0.0106	Density (g/cc)	0.8445
Hexanes	C_6	0.0503	0.0220		
Heptanes	C_7	0.0949	0.0479		
Octanes	C_8	0.1202	0.0685	**C_{7+} Fraction**	
Nonanes	C_9	0.0742	0.0482		
Decanes	C_{10}	0.0642	0.0463	Molecular Weight	217.20
Undecanes	C_{11}	0.0527	0.0393	Mole Fraction	0.8559
Dodecanes	C_{12}	0.0448	0.0365	Density (g/cc)	0.8491
Tridecanes	C_{13}	0.0456	0.0404		
Tetradecanes	C_{14}	0.0390	0.0375		
Pentadecanes	C_{15}	0.0340	0.0355	**C_{12+} Fraction**	
Hexadecanes	C_{16}	0.0283	0.0318		
Heptadecanes	C_{17}	0.0253	0.0304	Molecular Weight	303.62
Octadecanes	C_{18}	0.0242	0.0307	Mole Fraction	0.4496
Nonadecanes	C_{19}	0.0221	0.0294	Density (g/cc)	0.8871
Eicosanes	C_{20}	0.0174	0.0243		
Heneicosanes	C_{21}	0.0158	0.0233		
Docosanes	C_{22}	0.0140	0.0217		
Tricosanes	C_{23}	0.0127	0.0205		
Tetracosanes	C_{24}	0.0115	0.0193		
Pentacosanes	C_{25}	0.0103	0.0180		
Hexacosanes	C_{26}	0.0090	0.0165		
Heptacosanes	C_{27}	0.0085	0.0162		
Octacosanes	C_{28}	0.0079	0.0155		
Nonacosanes	C_{29}	0.0071	0.0144		
Tricontanes	C_{30}	0.0062	0.0131		
Hentriacontanes	C_{31}	0.0057	0.0124		
Dotriacontanes	C_{32}	0.0051	0.0115		
Tritriacontanes	C_{33}	0.0045	0.0105		
Tetratriacontanes	C_{34}	0.0043	0.0103		
Pentatriacontanes	C_{35}	0.0037	0.0091		
Hexatriacontanes plus	C_{36+}	0.0425	0.1691		
		1.0000	**1.0000**		

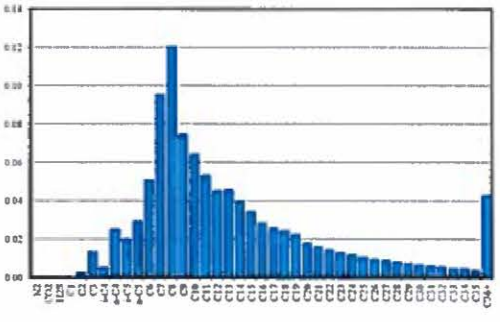


TABLE 10
CORRELATIONS OF MEASURED PVT LABORATORY DATA

CONSTANT COMPOSITION EXPANSION @ 248.0 F (120.0 C)

Relative Volume (V/Vsat)	(P ≥ Psat)	y=(-0.024833*x^2 + 0.968804*x + 1.041243)/(1.031856*x + 0.956503) R Squared = 0.986075
Relative Volume (V/Vsat)	(P ≤ Psat)	y=(0.494648*x^2 + 0.544879*x + 1.314038)/(2.358709*x + -0.009661) R Squared = 0.999994

DIFFERENTIAL LIBERATION @ 248.0 F (120.0 C)

Live Oil Density (g/cc)	(P ≥ Psat)	y=(0.025927*x^2 + 0.760329*x + 0.702912)/(1.190159*x + 1.210596) R Squared = 0.994970
Live Oil Density (g/cc)	(P ≤ Psat)	y=(-0.198838*x^2 + 1.045431*x + 0.055006)/(1.382887*x + 0.068979) R Squared = 0.999173
Oil FVF [1]	(P ≥ Psat)	y=(-0.028047*x^2 + 1.355188*x + 1.346279)/(1.190159*x + 1.210596) R Squared = 0.986075
Oil FVF [1]	(P ≤ Psat)	y=(0.494727*x^2 + 0.828654*x + -0.047454)/(0.794263*x + -0.044923) R Squared = 0.994520
GOR [2]	(P ≤ Psat)	y=(651.752832*x^2 + -42.179461*x + 0.358224)/(3.080190*x + -0.218130) R Squared = 0.995781
Oil Viscosity (cp=mPa.s)	(P ≥ Psat)	y=(0.090184*x^2 + 0.886312*x + 0.343334)/(1.678630*x + 1.501444) R Squared = 0.999870
Oil Viscosity (cp=mPa.s)	(P ≤ Psat)	y=(-0.722154*x^2 + 1.562558*x + 0.229496)/(2.366382*x + 0.189006) R Squared = 0.999863

y is the measured parameter and x = P/Psat, dimensionless
[1] Barrels (Cubic meters) of oil at indicated pressure and temperature per barrel (cubic meter) of residual oil @ 60 F (288.7 K).
[2] Cubic feet (meters) of gas at indicated pressure and temperature per cubic feet (meter) @ standard conditions

TABLE 11
SEPARATOR TEST CORRECTED DL OIL PROPERTIES @ 248.0 F (120.0 C)

Pressure		Oil Formation Volume Factor		Gas-Oil Ratio		Gas-Oil Ratio	
		Measured	Corrected	Measured	Corrected	Measured	Corrected
(psia)	(MPa)	[1]	[1]	(scf/STB)	(scf/STB)	(m^3/m^3)	(m^3/m^3)
8015	55.26	1.6305	1.5625	1255.22	1020.61	223.56	181.77
7015	48.36	1.6477	1.5790	1255.22	1020.61	223.56	181.77
5866	40.44	1.6690	1.5994	1255.22	1020.61	223.56	181.77
5015	34.58	1.6871	1.6167	1255.22	1020.61	223.56	181.77
4515	31.13	1.6995	1.6286	1255.22	1020.61	223.56	181.77
4015	27.68	1.7132	1.6417	1255.22	1020.61	223.56	181.77
3515	24.23	1.7289	1.6567	1255.22	1020.61	223.56	181.77
3290 Psat	22.68	1.7373	1.6648	1255.22	1020.61	223.56	181.77
2915	20.10	1.6172	1.5498	1040.67	815.00	185.34	145.15
2515	17.34	1.5404	1.4762	891.69	672.24	158.81	119.73
2115	14.58	1.4675	1.4063	748.72	535.24	133.35	95.33
1715	11.82	1.3962	1.3379	609.04	401.38	108.47	71.49
1315	9.06	1.3311	1.2756	481.54	279.20	85.76	49.73
915	6.31	1.2654	1.2126	352.81	155.84	62.84	27.76
615	4.24	1.2192	1.1684	262.39	69.19	46.73	12.32
315	2.17	1.1667	1.1180	166.07	0.00	29.58	0.00
15	0.10	1.0578	1.0136	0.00	0.00	0.00	0.00

Density of Residual Oil = 0.8341 g/cm3 (834.1 kg/m3) @ 60 F (288.7K)
API Gravity of Residual Oil = 38.1

[1] Barrels (Cubic meters) of oil at indicated pressure and temperature per barrel (cubic meter) of residual oil @ 60 F (288.7 K).
[2] Total barrels (cubic meters) of oil and liberated gas at the indicated pressure and temperature per barrel (cubic meter) of residual oil @ 60 F (288.7 K).
Psat - Saturation Pressure
- Standard conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa).

FIGURE 1
CONSTANT COMPOSITION EXPANSION @ 248.0 F (120.0 C)

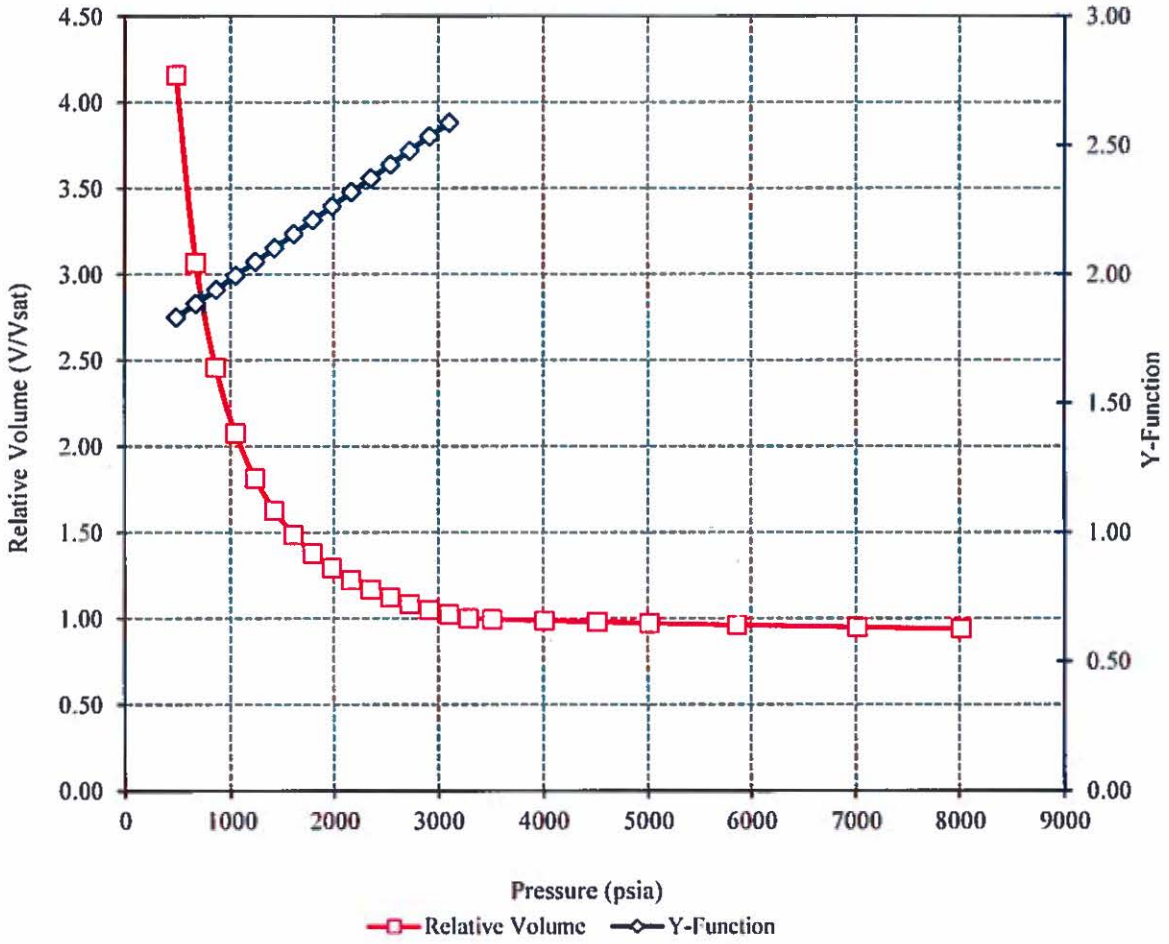


FIGURE 2
DIFFERENTIAL LIBERATION OIL DENSITY @ 248.0 F (120.0 C)

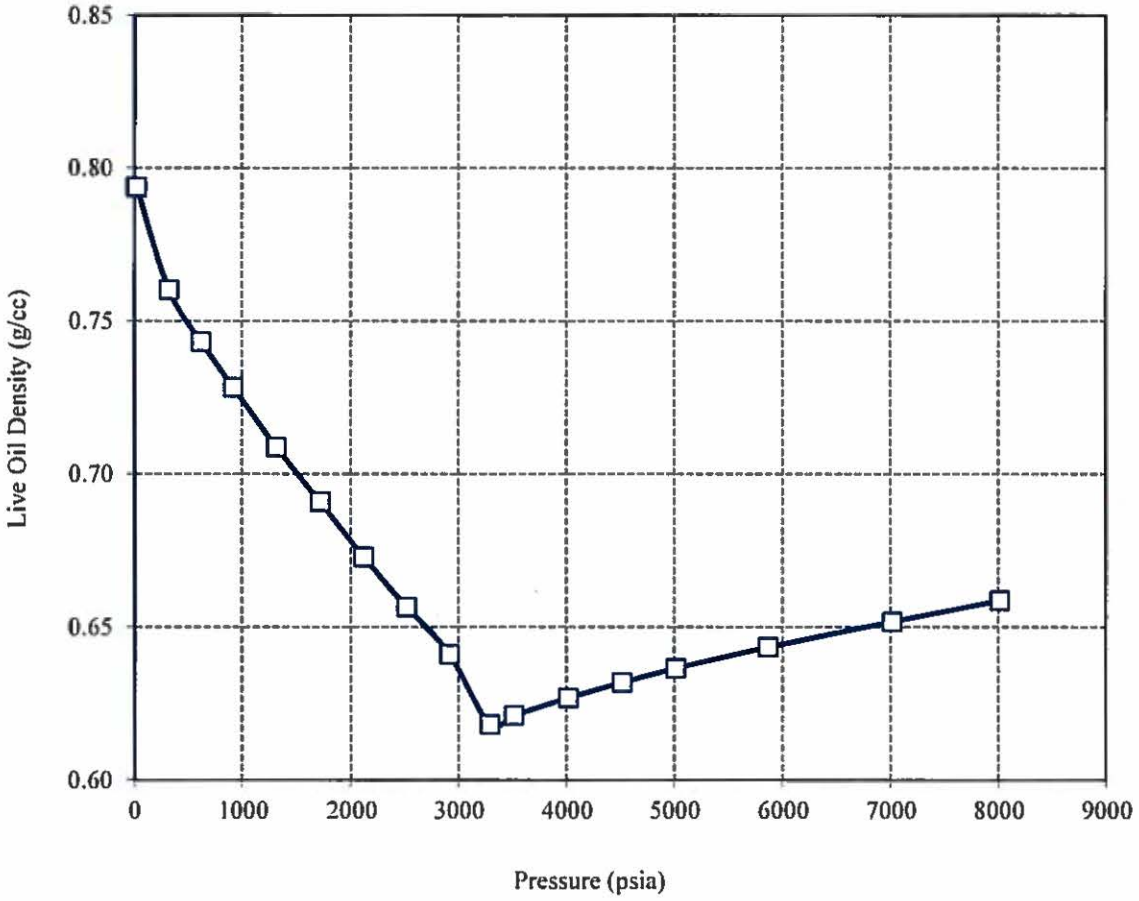


FIGURE 3
DIFFERENTIAL LIBERATION OIL FORMATION VOLUME FACTOR @ 248.0 F (120.0 C)

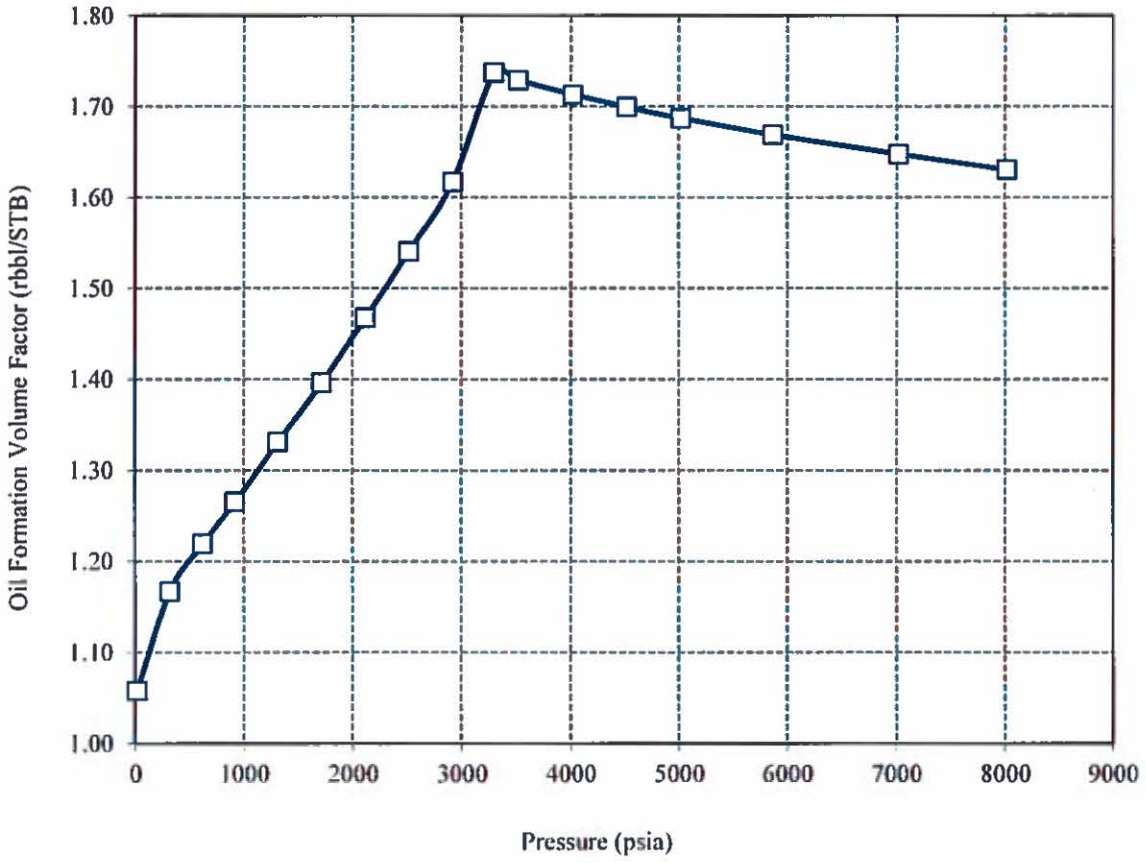


FIGURE 4
DIFFERENTIAL LIBERATION GAS-OIL RATIOS @ 248.0 F (120.0 C)

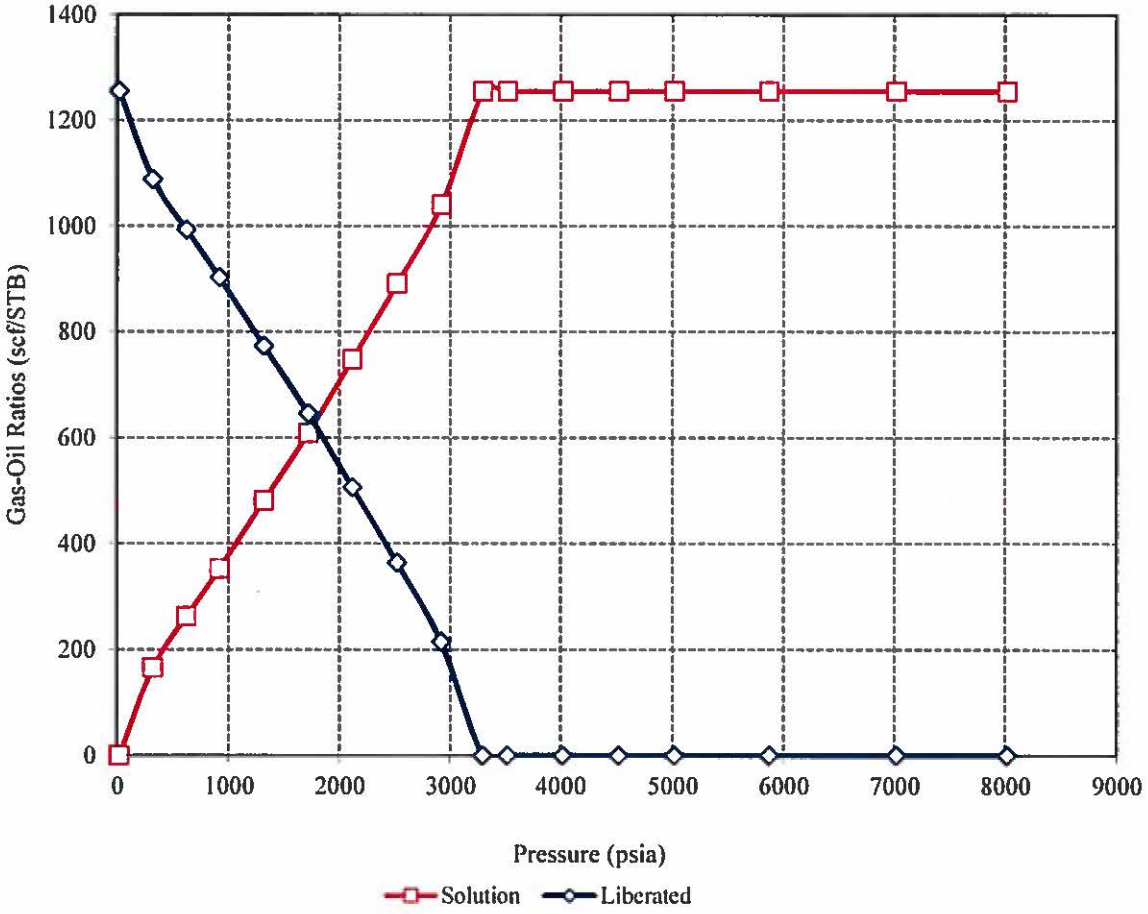


FIGURE 5
DIFFERENTIAL LIBERATION OIL VISCOSITY @ 248.0 F (120.0 C)

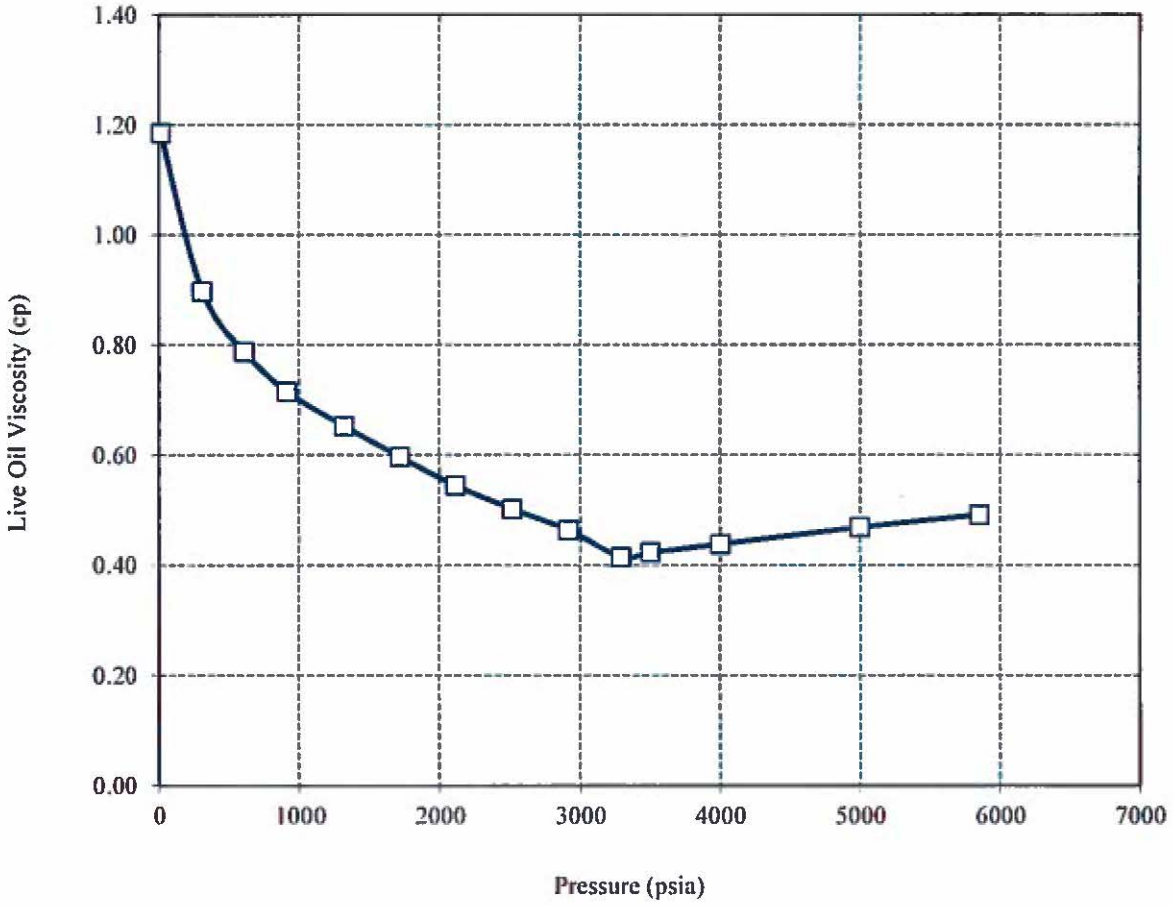


FIGURE 6
DIFFERENTIAL LIBERATION GAS DEVIATION FACTOR @ 248.0 F (120.0 C)

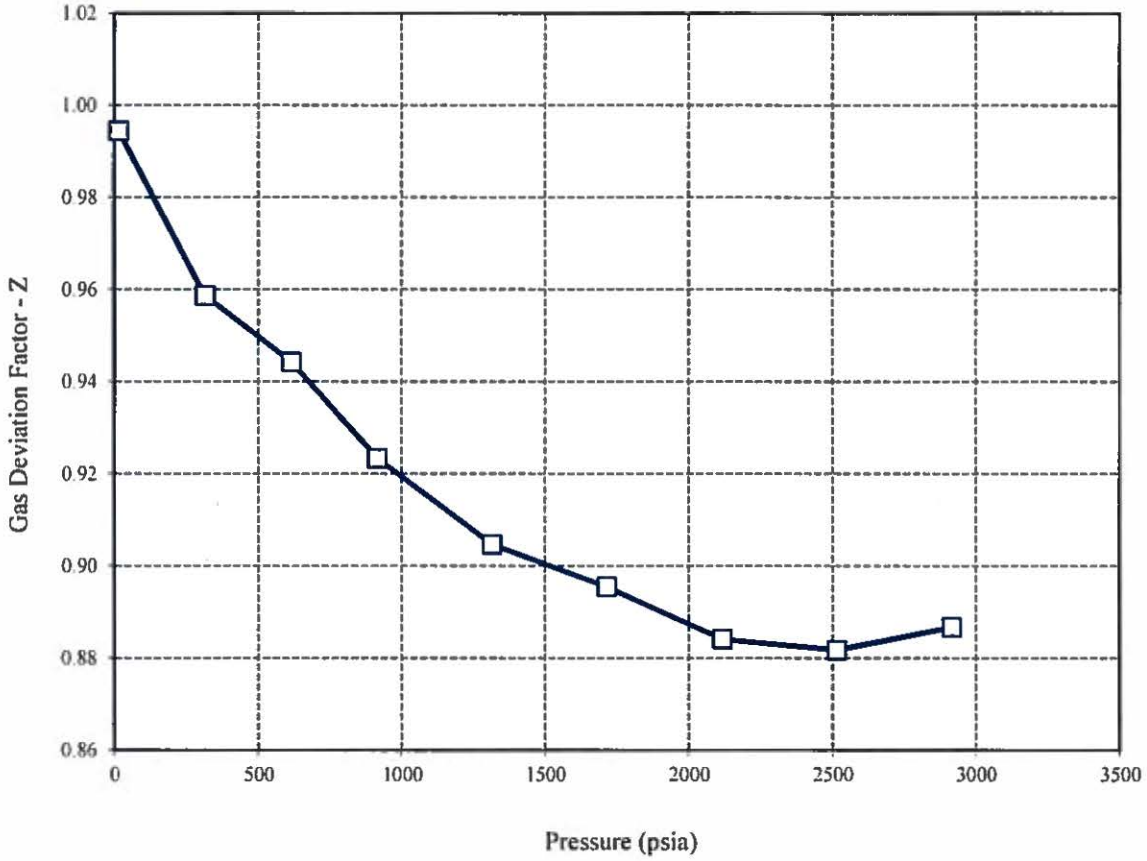


FIGURE 7
DIFFERENTIAL LIBERATION GAS VOLUME FACTORS @ 248.0 F (120.0 C)

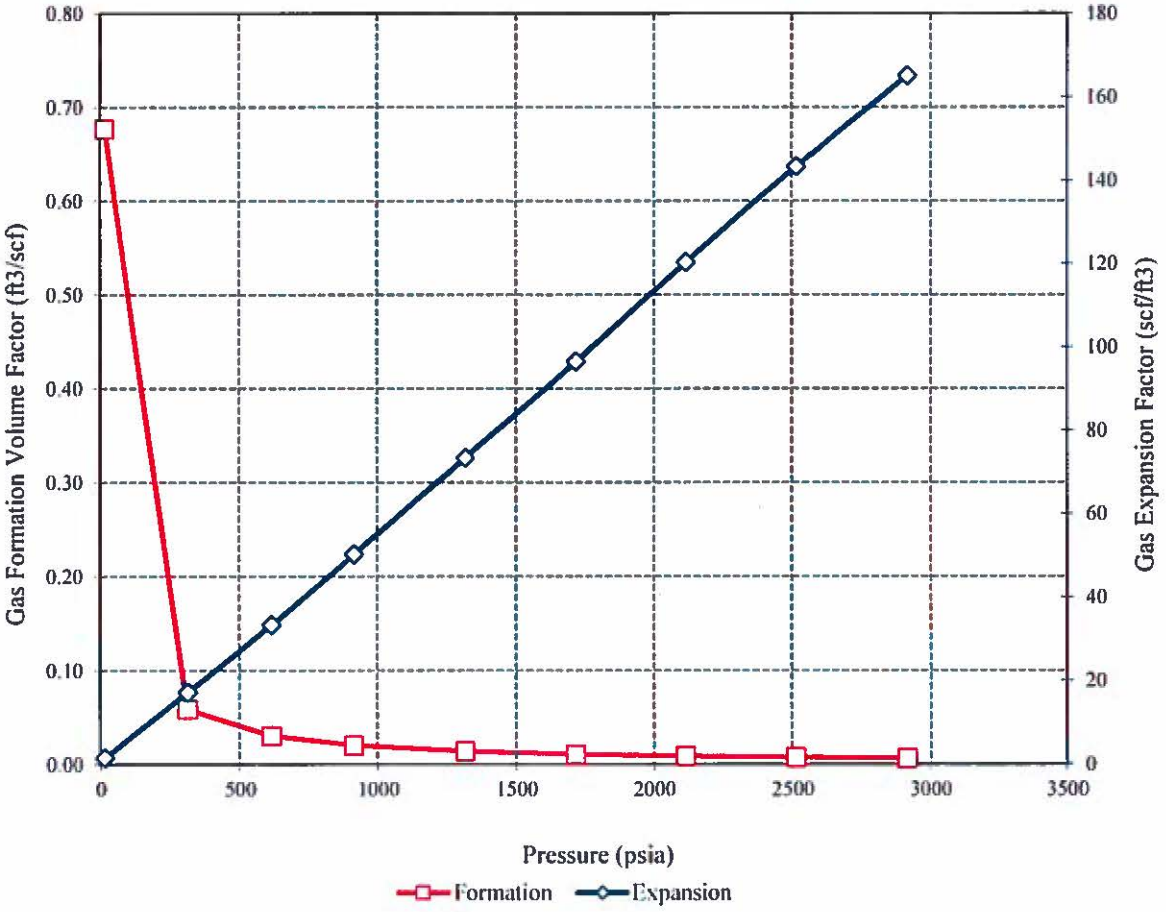


FIGURE 8
DIFFERENTIAL LIBERATION GAS GRAVITY @ 248.0 F (120.0 C)

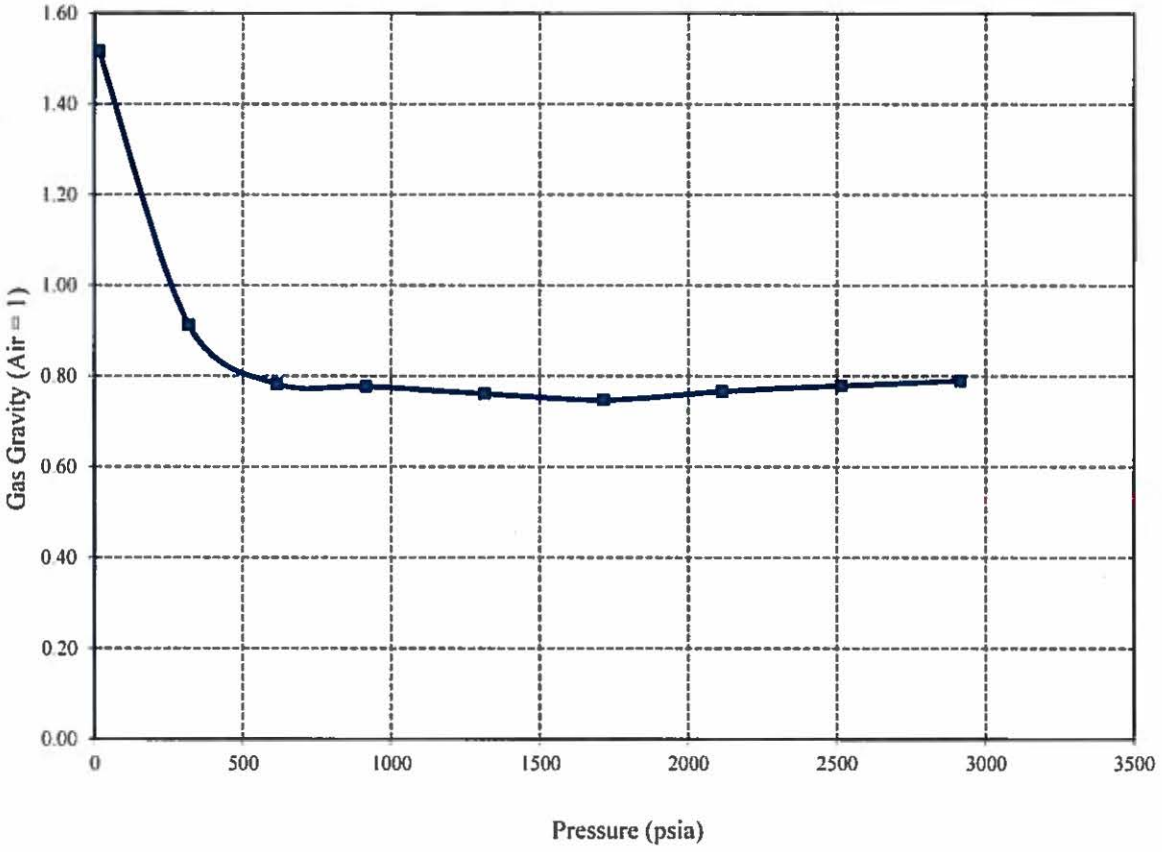


FIGURE 9
DIFFERENTIAL LIBERATION GAS VISCOSITY @ 248.0 F (120.0 C)

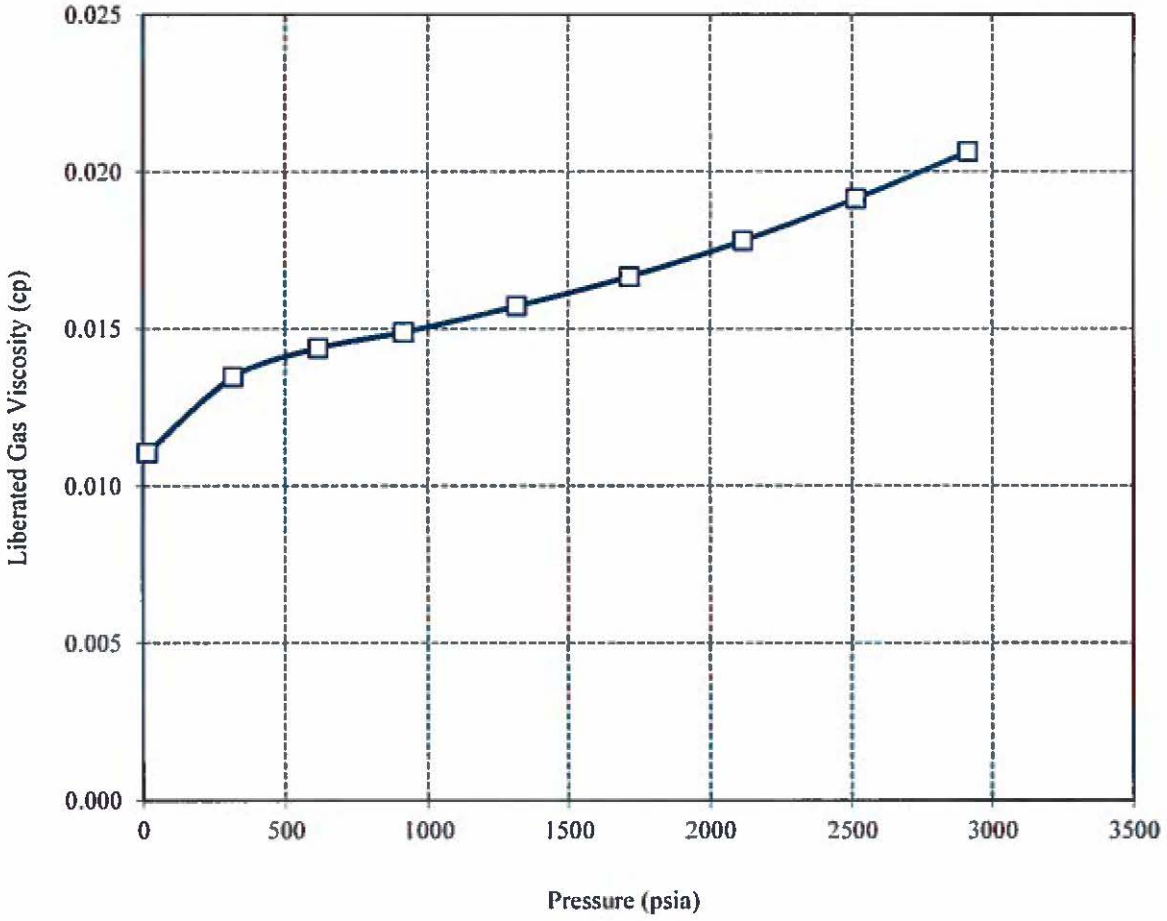
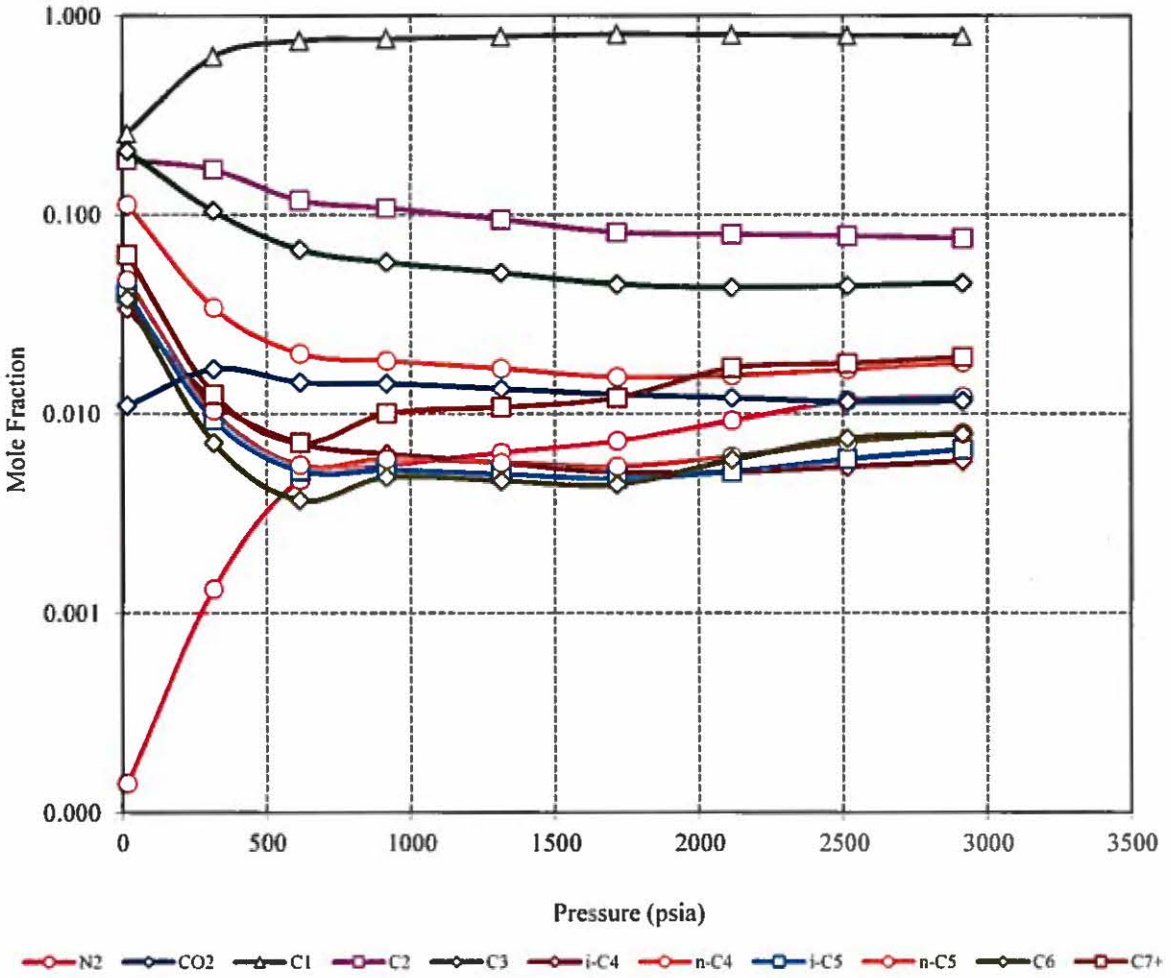


FIGURE 10
LIBERATED GAS COMPOSITION PROFILE @ 248.0 F (120.0 C)



APPENDIX A

SAMPLE VALIDATION

TABLE A1
COMPOSITIONAL ANALYSIS OF RESERVOIR FLUID

Component Name	Chemical Symbol	Mole Fraction	Mass Fraction	Calculated Properties	
Nitrogen	N_2	0.0044	0.0014	**Total Sample**	
Carbon Dioxide	CO_2	0.0089	0.0045		
Hydrogen Sulphide	H_2S	0.0000	0.0000	Molecular Weight	87.04
Methane	C_1	0.4372	0.0806		
Ethane	C_2	0.0714	0.0247		
Propane	C_3	0.0541	0.0274	**C_{6+} Fraction**	
i-Butane	i-C_4	0.0084	0.0056		
n-Butane	n-C_4	0.0301	0.0201	Molecular Weight	199.58
i-Pentane	i-C_5	0.0141	0.0117	Mole Fraction	0.3525
n-Pentane	n-C_5	0.0189	0.0157	Density (g/cc)	0.8367
Hexanes	C_6	0.0257	0.0254		
Heptanes	C_7	0.0421	0.0482	**C_{7+} Fraction**	
Octanes	C_8	0.0479	0.0615		
Nonanes	C_9	0.0277	0.0409	Molecular Weight	208.50
Decanes	C_{10}	0.0238	0.0389	Mole Fraction	0.3268
Undecanes	C_{11}	0.0195	0.0330	Density (g/cc)	0.8427
Dodecanes	C_{12}	0.0166	0.0307		
Tridecanes	C_{13}	0.0170	0.0342	**C_{12+} Fraction**	
Tetradecanes	C_{14}	0.0145	0.0317		
Pentadecanes	C_{15}	0.0128	0.0302	Molecular Weight	294.32
Hexadecanes	C_{16}	0.0106	0.0271	Mole Fraction	0.1657
Heptadecanes	C_{17}	0.0096	0.0263	Density (g/cc)	0.8817
Octadecanes	C_{18}	0.0091	0.0263		
Nonadecanes	C_{19}	0.0084	0.0252	**C_{30+} Fraction**	
Eicosanes	C_{20}	0.0066	0.0209		
Heneicosanes	C_{21}	0.0060	0.0199	Molecular Weight	609.34
Docosanes	C_{22}	0.0053	0.0187	Mole Fraction	0.0236
Tricosanes	C_{23}	0.0048	0.0176	Density (g/cc)	0.9674
Tetracosanes	C_{24}	0.0044	0.0167		
Pentacosanes	C_{25}	0.0039	0.0153	**C_{36+} Fraction**	
Hexacosanes	C_{26}	0.0037	0.0154		
Heptacosanes	C_{27}	0.0031	0.0131	Molecular Weight	755.98
Octacosanes	C_{28}	0.0030	0.0134	Mole Fraction	0.0124
Nonacosanes	C_{29}	0.0027	0.0124	Density (g/cc)	1.0015
Tricontanes	C_{30}	0.0023	0.0112		
Hentriacontanes	C_{31}	0.0022	0.0107		
Dotriacontanes	C_{32}	0.0019	0.0098	**Recombination Parameters**	
Tritriacontanes	C_{33}	0.0017	0.0091		
Tetratriacontanes	C_{34}	0.0016	0.0087	Gas-Oil Ratio (cc/cc)	181.77
Pentatriacontanes	C_{35}	0.0014	0.0081	Dead Oil Density (g/cc)	0.8309
Hexatriacontanes plus	C_{36+}	0.0124	0.1076	Dead Oil MW (g/mol)	197.29
		1.0000	**1.0000**		

Physical Properties calculated based on GPA 2145-00 physical constants

TABLE A2
COMPOSITIONAL ANALYSIS OF FLASHED OIL

Component Name	Chemical Symbol	Mole Fraction	Mass Fraction	Calculated Properties	
Nitrogen	N_2	0.0000	0.0000	**Total Sample**	
Carbon Dioxide	CO_2	0.0000	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000	Molecular Weight	197.29
Methane	C_1	0.0000	0.0000		
Ethane	C_2	0.0010	0.0002		
Propane	C_3	0.0051	0.0011	**C_{6+} Fraction**	
i-Butane	i-C_4	0.0024	0.0007		
n-Butane	n-C_4	0.0137	0.0040	Molecular Weight	205.71
i-Pentane	i-C_5	0.0144	0.0053	Mole Fraction	0.9400
n-Pentane	n-C_5	0.0235	0.0086	Density (g/cc)	0.8403
Hexanes	C_6	0.0489	0.0214		
Heptanes	C_7	0.0974	0.0492	**C_{7+} Fraction**	
Octanes	C_8	0.1256	0.0717		
Nonanes	C_9	0.0780	0.0507	Molecular Weight	212.28
Decanes	C_{10}	0.0672	0.0485	Mole Fraction	0.8910
Undecanes	C_{11}	0.0551	0.0411	Density (g/cc)	0.8445
Dodecanes	C_{12}	0.0469	0.0383		
Tridecanes	C_{13}	0.0480	0.0426	**C_{12+} Fraction**	
Tetradecanes	C_{14}	0.0410	0.0395		
Pentadecanes	C_{15}	0.0360	0.0376	Molecular Weight	294.32
Hexadecanes	C_{16}	0.0300	0.0338	Mole Fraction	0.4676
Heptadecanes	C_{17}	0.0272	0.0327	Density (g/cc)	0.8817
Octadecanes	C_{18}	0.0258	0.0328		
Nonadecanes	C_{19}	0.0236	0.0314	**C_{30+} Fraction**	
Eicosanes	C_{20}	0.0187	0.0261		
Heneicosanes	C_{21}	0.0168	0.0248	Molecular Weight	609.34
Docosanes	C_{22}	0.0150	0.0232	Mole Fraction	0.0666
Tricosanes	C_{23}	0.0136	0.0219	Density (g/cc)	0.9674
Tetracosanes	C_{24}	0.0124	0.0207		
Pentacosanes	C_{25}	0.0109	0.0191	**C_{36+} Fraction**	
Hexacosanes	C_{26}	0.0106	0.0192		
Heptacosanes	C_{27}	0.0086	0.0163	Molecular Weight	755.98
Octacosanes	C_{28}	0.0085	0.0166	Mole Fraction	0.0350
Nonacosanes	C_{29}	0.0076	0.0154	Density (g/cc)	1.0015
Tricontanes	C_{30+}	0.0066	0.0139		
Hentriacontanes	C_{31}	0.0061	0.0133		
Dotriacontanes	C_{32}	0.0054	0.0122		
Tritriacontanes	C_{33}	0.0049	0.0113		
Tetratriacontanes	C_{34}	0.0045	0.0108		
Pentatriacontanes	C_{35}	0.0041	0.0101		
Hexatriacontanes plus	C_{36+}	0.0350	0.1340		
		1.0000	**1.0000**		

Physical Properties calculated based on GPA 2145-00 physical constants

TABLE A3
COMPOSITIONAL ANALYSIS OF FLASHED GAS

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0068	0.0069		
Carbon Dioxide	CO_2	0.0137	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.6771	0.6865		
Ethane	C_2	0.1100	0.1115		
Propane	C_3	0.0811	0.0822	52.948	297.276
i-Butane	i-C_4	0.0118	0.0119	9.119	51.197
n-Butane	n-C_4	0.0391	0.0397	29.275	164.367
i-Pentane	i-C_5	0.0140	0.0142	12.179	68.379
n-Pentane	n-C_5	0.0163	0.0166	14.036	78.806
Hexanes	C_6	0.0129	0.0131	12.631	70.915
Heptanes	C_7	0.0118	0.0120	12.942	72.662
Octanes	C_8	0.0052	0.0052	6.271	35.206
Nonanes	C_9	0.0002	0.0002	0.200	1.125
Decanes	C_{10}	0.0000	0.0000	0.000	0.000
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		**1.0000**	**1.0000**	**149.601**	**839.933**
Propanes Plus	C_{3+}	0.1924	0.1950	149.601	839.933
Butanes Plus	C_{4+}	0.1113	0.1128	96.653	542.657
Pentanes Plus	C_{5+}	0.0604	0.0612	58.258	327.093

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	26.51 kg/kmol	26.51 lb/lb-mol	Ppc	652.9 psia	4.50 MPa
Specific Gravity	0.9152 (Air = 1)	0.9152 (Air = 1)	Tpc	448.6 R	249.2 K
MW of C7+	1.70 kg/kmol	1.70 lb/lbmol	Ppc*	649.4 psia	4.48 MPa
Density of C7+	0.7293 g/cc	729.3 kg/m3	Tpc*	446.2 R	247.9 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,529.5 Btu/scf	57.09 MJ/m3	Dry	1,394.7 Btu/scf	52.06 MJ/m3
Wet	1,502.8 Btu/scf	56.10 MJ/m3	Wet	1,370.4 Btu/scf	51.15 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

APPENDIX B

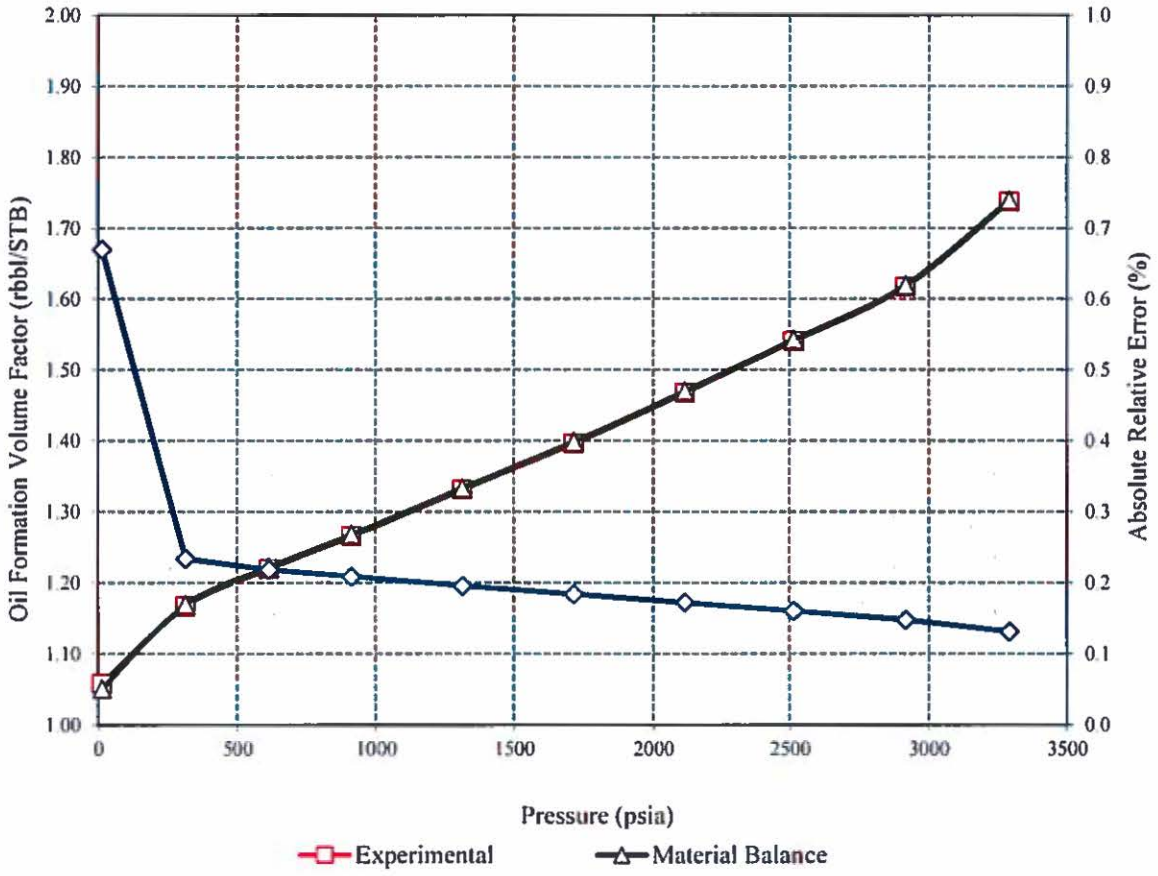
DIFFERENTIAL LIBERATION - MATERIAL BALANCE

TABLE B1
DIFFERENTIAL LIBERATION @ 248.0 F (120.0 C) - MATERIAL BALANCE

Pressure		Measured Oil FVF	Calculated Oil FVF	Absolute Relative Error
(psia)	(MPa)	[1]	[1]	(%)
3290 Psat	22.68	1.7373	1.7396	0.1310
2915	20.10	1.6172	1.6196	0.1475
2515	17.34	1.5404	1.5429	0.1599
2115	14.58	1.4675	1.4700	0.1720
1715	11.82	1.3962	1.3987	0.1837
1315	9.06	1.3311	1.3337	0.1955
915	6.31	1.2654	1.2680	0.2085
615	4.24	1.2192	1.2219	0.2183
315	2.17	1.1667	1.1694	0.2338
15	0.10	1.0578	1.0507	0.6697

[1] (res bbl/STB) (res m3/m3)
Psat - Saturation Pressure
- Standard conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

FIGURE B1
DIFFERENTIAL LIBERATION @ 248.0 F (120.0 C) - MATERIAL BALANCE



APPENDIX C

DIFFERENTIAL LIBERATION - COMPOSITIONAL ANALYSES OF LIBERATED GAS

TABLE C1
DIFFERENTIAL LIBERATION GAS COMPOSITION @ 2,915 psia (20.10 MPa)

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0121	0.0123		
Carbon Dioxide	CO_2	0.0116	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.7892	0.7985		
Ethane	C_2	0.0761	0.0770		
Propane	C_3	0.0453	0.0458	29.556	165.944
i-Butane	i-C_4	0.0058	0.0059	4.493	25.228
n-Butane	n-C_4	0.0181	0.0183	13.557	76.114
i-Pentane	i-C_5	0.0066	0.0067	5.746	32.262
n-Pentane	n-C_5	0.0080	0.0081	6.868	38.558
Hexanes	C_6	0.0079	0.0080	7.711	43.294
Heptanes	C_7	0.0098	0.0099	10.686	59.998
Octanes	C_8	0.0090	0.0091	10.925	61.338
Nonanes	C_9	0.0005	0.0005	0.655	3.676
Decanes	C_{10}	0.0000	0.0000	0.000	0.000
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		1.0000	1.0000	90.197	506.412
Propanes Plus	C_{3+}	0.1109	0.1122	90.197	506.412
Butanes Plus	C_{4+}	0.0657	0.0664	60.641	340.468
Pentanes Plus	C_{5+}	0.0417	0.0422	42.591	239.126

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	22.88 kg/kmol	22.88 lb/lb-mol	Ppc	658.2 psia	4.54 MPa
Specific Gravity	0.7899 (Air = 1)	0.7899 (Air = 1)	Tpc	408.7 R	227.1 K
MW of C7+	101.78 kg/kmol	101.78 lb/lbmol	Ppc*	654.9 psia	4.52 MPa
Density of C7+	0.7338 g/cc	733.8 kg/m3	Tpc*	406.6 R	225.9 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,332.0 Btu/scf	49.72 MJ/m3	Dry	1,210.6 Btu/scf	45.19 MJ/m3
Wet	1,308.8 Btu/scf	48.86 MJ/m3	Wet	1,189.5 Btu/scf	44.40 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

TABLE C2
DIFFERENTIAL LIBERATION GAS COMPOSITION @ 2,515 psia (17.34 MPa)

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0116	0.0118		
Carbon Dioxide	CO_2	0.0115	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.7944	0.8036		
Ethane	C_2	0.0780	0.0789		
Propane	C_3	0.0438	0.0443	28.617	160.668
i-Butane	i-C_4	0.0054	0.0055	4.198	23.571
n-Butane	n-C_4	0.0167	0.0169	12.488	70.115
i-Pentane	i-C_5	0.0059	0.0060	5.149	28.906
n-Pentane	n-C_5	0.0072	0.0073	6.197	34.793
Hexanes	C_6	0.0075	0.0076	7.351	41.274
Heptanes	C_7	0.0093	0.0094	10.206	57.301
Octanes	C_8	0.0078	0.0079	9.507	53.376
Nonanes	C_9	0.0007	0.0007	0.981	5.507
Decanes	C_{10}	0.0000	0.0000	0.000	0.000
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		**1.0000**	**1.0000**	**84.693**	**475.511**
Propanes Plus	C_{3+}	0.1045	0.1057	84.693	475.511
Butanes Plus	C_{4+}	0.0606	0.0613	56.077	314.843
Pentanes Plus	C_{5+}	0.0385	0.0390	39.390	221.157

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	22.56 kg/kmol	22.56 lb/lb-mol	Ppc	659.4 psia	4.55 MPa
Specific Gravity	0.7788 (Air = 1)	0.7788 (Air = 1)	Tpc	406.1 R	225.6 K
MW of C7+	101.84 kg/kmol	101.84 lb/lbmol	Ppc*	656.0 psia	4.52 MPa
Density of C7+	0.7338 g/cc	733.8 kg/m3	Tpc*	404.0 R	224.5 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,315.0 Btu/scf	49.09 MJ/m3	Dry	1,194.8 Btu/scf	44.60 MJ/m3
Wet	1,292.2 Btu/scf	48.23 MJ/m3	Wet	1,174.0 Btu/scf	43.82 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

TABLE C3
DIFFERENTIAL LIBERATION GAS COMPOSITION @ 2,115 psia (14.58 MPa)

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0092	0.0093		
Carbon Dioxide	CO_2	0.0120	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.8010	0.8108		
Ethane	C_2	0.0798	0.0808		
Propane	C_3	0.0431	0.0436	28.142	158.001
i-Butane	i-C_4	0.0051	0.0052	3.950	22.175
n-Butane	n-C_4	0.0156	0.0158	11.656	65.441
i-Pentane	i-C_5	0.0051	0.0052	4.450	24.987
n-Pentane	n-C_5	0.0061	0.0062	5.246	29.453
Hexanes	C_6	0.0059	0.0060	5.742	32.237
Heptanes	C_7	0.0082	0.0083	9.012	50.601
Octanes	C_8	0.0081	0.0082	9.856	55.339
Nonanes	C_9	0.0006	0.0006	0.791	4.443
Decanes	C_{10}	0.0001	0.0001	0.102	0.575
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		**1.0000**	**1.0000**	**78.948**	**443.253**
Propanes Plus	C_{3+}	0.0979	0.0991	78.948	443.253
Butanes Plus	C_{4+}	0.0548	0.0554	50.806	285.251
Pentanes Plus	C_{5+}	0.0341	0.0345	35.201	197.635

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	22.20 kg/kmol	22.20 lb/lb-mol	Ppc	661.2 psia	4.56 MPa
Specific Gravity	0.7664 (Air = 1)	0.7664 (Air = 1)	Tpc	403.6 R	224.2 K
MW of C7+	102.27 kg/kmol	102.27 lb/lbmol	Ppc*	657.7 psia	4.53 MPa
Density of C7+	0.7347 g/cc	734.7 kg/m3	Tpc*	401.4 R	223.0 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,298.5 Btu/scf	48.47 MJ/m3	Dry	1,179.3 Btu/scf	44.02 MJ/m3
Wet	1,276.0 Btu/scf	47.63 MJ/m3	Wet	1,158.8 Btu/scf	43.26 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

TABLE C4
DIFFERENTIAL LIBERATION GAS COMPOSITION @ 1,715 psia (11.82 MPa)

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0073	0.0074		
Carbon Dioxide	CO_2	0.0125	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.8071	0.8173		
Ethane	C_2	0.0815	0.0826		
Propane	C_3	0.0446	0.0452	29.123	163.513
i-Butane	i-C_4	0.0051	0.0051	3.930	22.068
n-Butane	n-C_4	0.0153	0.0155	11.435	64.199
i-Pentane	i-C_5	0.0047	0.0048	4.117	23.117
n-Pentane	n-C_5	0.0054	0.0055	4.678	26.266
Hexanes	C_6	0.0044	0.0045	4.312	24.211
Heptanes	C_7	0.0060	0.0060	6.526	36.639
Octanes	C_8	0.0061	0.0062	7.388	41.480
Nonanes	C_9	0.0000	0.0000	0.000	0.000
Decanes	C_{10}	0.0000	0.0000	0.000	0.000
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		**1.0000**	**1.0000**	**71.510**	**401.494**
Propanes Plus	C_{3+}	0.0916	0.0927	71.510	401.494
Butanes Plus	C_{4+}	0.0470	0.0476	42.387	237.981
Pentanes Plus	C_{5+}	0.0266	0.0270	27.022	151.714

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	21.64 kg/kmol	21.64 lb/lb-mol	Ppc	663.8 psia	4.58 MPa
Specific Gravity	0.7472 (Air = 1)	0.7472 (Air = 1)	Tpc	399.9 R	222.2 K
MW of C7+	101.55 kg/kmol	101.55 lb/lbmol	Ppc*	660.1 psia	4.55 MPa
Density of C7+	0.7336 g/cc	733.6 kg/m3	Tpc*	397.7 R	221.0 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,270.4 Btu/scf	47.42 MJ/m3	Dry	1,153.0 Btu/scf	43.04 MJ/m3
Wet	1,248.3 Btu/scf	46.60 MJ/m3	Wet	1,132.9 Btu/scf	42.29 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

TABLE C5
DIFFERENTIAL LIBERATION GAS COMPOSITION @ 1,315 psia (9.06 MPa)

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0064	0.0065		
Carbon Dioxide	CO_2	0.0133	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.7859	0.7965		
Ethane	C_2	0.0947	0.0960		
Propane	C_3	0.0511	0.0518	33.361	187.303
i-Butane	i-C_4	0.0057	0.0058	4.404	24.727
n-Butane	n-C_4	0.0169	0.0171	12.618	70.844
i-Pentane	i-C_5	0.0050	0.0050	4.322	24.264
n-Pentane	n-C_5	0.0057	0.0058	4.891	27.459
Hexanes	C_6	0.0046	0.0047	4.502	25.275
Heptanes	C_7	0.0058	0.0059	6.356	35.684
Octanes	C_8	0.0049	0.0049	5.908	33.169
Nonanes	C_9	0.0001	0.0001	0.160	0.899
Decanes	C_{10}	0.0000	0.0000	0.007	0.041
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		**1.0000**	**1.0000**	**76.528**	**429.665**
Propanes Plus	C_{3+}	0.0997	0.1010	76.528	429.665
Butanes Plus	C_{4+}	0.0486	0.0493	43.167	242.362
Pentanes Plus	C_{5+}	0.0261	0.0264	26.145	146.791

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	22.04 kg/kmol	22.04 lb/lb-mol	Ppc	664.4 psia	4.58 MPa
Specific Gravity	0.7611 (Air = 1)	0.7611 (Air = 1)	Tpc	405.4 R	225.2 K
MW of C7+	101.25 kg/kmol	101.25 lb/lbmol	Ppc*	660.6 psia	4.55 MPa
Density of C7+	0.7329 g/cc	732.9 kg/m3	Tpc*	403.1 R	223.9 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,290.9 Btu/scf	48.18 MJ/m3	Dry	1,172.1 Btu/scf	43.75 MJ/m3
Wet	1,268.4 Btu/scf	47.35 MJ/m3	Wet	1,151.7 Btu/scf	42.99 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

TABLE C6
DIFFERENTIAL LIBERATION GAS COMPOSITION @ 915 psia (6.31 MPa)

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0055	0.0055		
Carbon Dioxide	CO_2	0.0142	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.7641	0.7751		
Ethane	C_2	0.1079	0.1095		
Propane	C_3	0.0576	0.0584	37.607	211.142
i-Butane	i-C_4	0.0063	0.0064	4.879	27.391
n-Butane	n-C_4	0.0184	0.0187	13.802	77.494
i-Pentane	i-C_5	0.0052	0.0053	4.525	25.405
n-Pentane	n-C_5	0.0059	0.0060	5.102	28.646
Hexanes	C_6	0.0048	0.0049	4.690	26.332
Heptanes	C_7	0.0046	0.0047	5.085	28.552
Octanes	C_8	0.0051	0.0052	6.240	35.036
Nonanes	C_9	0.0002	0.0002	0.321	1.802
Decanes	C_{10}	0.0000	0.0000	0.015	0.082
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		1.0000	1.0000	82.266	461.882
Propanes Plus	C_{3+}	0.1083	0.1099	82.266	461.882
Butanes Plus	C_{4+}	0.0507	0.0514	44.659	250.740
Pentanes Plus	C_{5+}	0.0260	0.0263	25.978	145.856

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	22.50 kg/kmol	22.50 lb/lb-mol	Ppc	664.9 psia	4.58 MPa
Specific Gravity	0.7769 (Air = 1)	0.7769 (Air = 1)	Tpc	411.3 R	228.5 K
MW of C7+	102.27 kg/kmol	102.27 lb/lbmol	Ppc*	660.9 psia	4.56 MPa
Density of C7+	0.7348 g/cc	734.8 kg/m3	Tpc*	408.9 R	227.2 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,314.6 Btu/scf	49.07 MJ/m3	Dry	1,194.3 Btu/scf	44.58 MJ/m3
Wet	1,291.8 Btu/scf	48.22 MJ/m3	Wet	1,173.5 Btu/scf	43.80 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

TABLE C7
DIFFERENTIAL LIBERATION GAS COMPOSITION @ 615 psia (4.24 MPa)

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0047	0.0047		
Carbon Dioxide	CO_2	0.0144	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.7476	0.7585		
Ethane	C_2	0.1178	0.1195		
Propane	C_3	0.0668	0.0678	43.616	244.883
i-Butane	i-C_4	0.0071	0.0072	5.518	30.980
n-Butane	n-C_4	0.0201	0.0203	15.001	84.221
i-Pentane	i-C_5	0.0052	0.0053	4.503	25.282
n-Pentane	n-C_5	0.0055	0.0056	4.762	26.735
Hexanes	C_6	0.0037	0.0037	3.592	20.167
Heptanes	C_7	0.0031	0.0032	3.427	19.241
Octanes	C_8	0.0033	0.0033	3.998	22.447
Nonanes	C_9	0.0007	0.0007	0.882	4.952
Decanes	C_{10}	0.0001	0.0001	0.102	0.573
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		1.0000	1.0000	85.400	479.481
Propanes Plus	C_{3+}	0.1155	0.1172	85.400	479.481
Butanes Plus	C_{4+}	0.0487	0.0494	41.784	234.599
Pentanes Plus	C_{5+}	0.0216	0.0219	21.266	119.398

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	22.66 kg/kmol	22.66 lb/lb-mol	Ppc	665.9 psia	4.59 MPa
Specific Gravity	0.7823 (Air = 1)	0.7823 (Air = 1)	Tpc	414.8 R	230.4 K
MW of C7+	103.74 kg/kmol	103.74 lb/lbmol	Ppc*	661.9 psia	4.56 MPa
Density of C7+	0.7370 g/cc	737.0 kg/m3	Tpc*	412.3 R	229.0 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,322.3 Btu/scf	49.36 MJ/m3	Dry	1,201.4 Btu/scf	44.85 MJ/m3
Wet	1,299.3 Btu/scf	48.50 MJ/m3	Wet	1,180.5 Btu/scf	44.07 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

TABLE C8
DIFFERENTIAL LIBERATION GAS COMPOSITION @ 315 psia (2.17 MPa)

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0013	0.0013		
Carbon Dioxide	CO_2	0.0168	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.6233	0.6340		
Ethane	C_2	0.1689	0.1718		
Propane	C_3	0.1044	0.1062	68.177	382.778
i-Butane	$i\text{-}C_4$	0.0117	0.0119	9.049	50.805
n-Butane	$n\text{-}C_4$	0.0342	0.0347	25.557	143.491
i-Pentane	$i\text{-}C_5$	0.0094	0.0095	8.128	45.635
n-Pentane	$n\text{-}C_5$	0.0104	0.0106	8.931	50.140
Hexanes	C_6	0.0072	0.0073	6.999	39.293
Heptanes	C_7	0.0070	0.0072	7.708	43.277
Octanes	C_8	0.0053	0.0054	6.404	35.957
Nonanes	C_9	0.0002	0.0002	0.281	1.576
Decanes	C_{10}	0.0000	0.0000	0.015	0.082
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		**1.0000**	**1.0000**	**141.247**	**793.034**
Propanes Plus	C_{3+}	0.1897	0.1929	141.247	793.034
Butanes Plus	C_{4+}	0.0853	0.0867	73.071	410.256
Pentanes Plus	C_{5+}	0.0394	0.0401	38.465	215.960

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	26.43 kg/kmol	26.43 lb/lb-mol	Ppc	661.4 psia	4.56 MPa
Specific Gravity	0.9125 (Air = 1)	0.9125 (Air = 1)	Tpc	456.0 R	253.3 K
MW of C7+	101.08 kg/kmol	101.08 lb/lbmol	Ppc*	657.2 psia	4.53 MPa
Density of C7+	0.7324 g/cc	732.4 kg/m3	Tpc*	453.1 R	251.7 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,526.4 Btu/scf	56.98 MJ/m3	Dry	1,391.9 Btu/scf	51.95 MJ/m3
Wet	1,499.9 Btu/scf	55.99 MJ/m3	Wet	1,367.6 Btu/scf	51.05 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

TABLE C9
DIFFERENTIAL LIBERATION GAS COMPOSITION @ 15 psia (0.10 MPa)

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N_2	0.0001	0.0001		
Carbon Dioxide	CO_2	0.0110	0.0000		
Hydrogen Sulphide	H_2S	0.0000	0.0000		
Methane	C_1	0.2558	0.2586		
Ethane	C_2	0.1887	0.1908		
Propane	C_3	0.2101	0.2125	137.222	770.432
i-Butane	i-C_4	0.0337	0.0341	26.169	146.924
n-Butane	n-C_4	0.1126	0.1139	84.243	472.982
i-Pentane	i-C_5	0.0401	0.0405	34.824	195.522
n-Pentane	n-C_5	0.0470	0.0475	40.407	226.863
Hexanes	C_6	0.0378	0.0382	36.877	207.044
Heptanes	C_7	0.0375	0.0379	41.048	230.464
Octanes	C_8	0.0249	0.0251	30.198	169.549
Nonanes	C_9	0.0007	0.0007	0.882	4.952
Decanes	C_{10}	0.0000	0.0000	0.029	0.164
Undecane	C_{11}	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C_{12+}	0.0000	0.0000	0.000	0.000
Total		1.0000	1.0000	431.898	2424.896
Propanes Plus	C_{3+}	0.5443	0.5504	431.898	2424.896
Butanes Plus	C_{4+}	0.3342	0.3379	294.676	1654.463
Pentanes Plus	C_{5+}	0.1879	0.1900	184.265	1034.557

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	43.92 kg/kmol	43.92 lb/lb-mol	Ppc	608.9 psia	4.20 MPa
Specific Gravity	1.5163 (Air = 1)	1.5163 (Air = 1)	Tpc	618.8 R	343.8 K
MW of C7+	100.61 kg/kmol	100.61 lb/lbmol	Ppc*	607.0 psia	4.19 MPa
Density of C7+	0.7315 g/cc	731.5 kg/m3	Tpc*	616.8 R	342.6 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	2,491.9 Btu/scf	93.02 MJ/m3	Dry	2,292.3 Btu/scf	85.57 MJ/m3
Wet	2,448.5 Btu/scf	91.40 MJ/m3	Wet	2,252.5 Btu/scf	84.08 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)