



<sup>TM</sup>  
**Core Lab**  
**RESERVOIR OPTIMIZATION**

**Reservoir Fluid Study**

**for**

**3D Oil**

**West Seahorse-3**

**AFL 20080022**

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16<sup>th</sup> September 2008

3D Oil Limited  
Level 5,  
164 Flinders Lane,  
Melbourne  
VIC 3000

Attention: Jon Keall

Dear Jon,

**Subject: Reservoir Fluid Study: Well: West Seahorse-3; Our file: AFL 20080022**

Three sub-surface oil samples were forwarded to our Perth laboratory on 22<sup>nd</sup> May 2008 for initial validation, compositional analysis and a PVT analysis program. Presented in the following report are the results of the requested analyses.

Core Laboratories Australia Pty Ltd are very pleased to have been of service to 3D Oil Limited in this work. Should any questions arise concerning the data presented in this report, or if we may be of assistance in any other matter, please do not hesitate to contact us.

Yours Faithfully,  
For CORE LABORATORIES AUSTRALIA PTY LTD

Murray Macleod  
Laboratory Supervisor

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**Section A - Summary of Analysis Methods**

## **Summary of Analysis Methods**

### **Sample Validation**

The opening pressures of the three sub-surface oil samples were recorded at ambient temperature. They were then stabilised at 5000 psig and heated to 100°C for 24 hours. The samples were agitated thoroughly to ensure they were completely single phase and homogenous. A check for free water was made and the sample volume determined.

### **Compositional Analysis**

The fluid composition of each oil sample was determined using a combination of flash separation and gas chromatography techniques. Each fluid was flashed at a controlled temperature (50°C) and separated into oil and gas phases.

The gas was analysed using extended gas chromatography with compositions determined by a GPA 2286 method using a multi-column gas chromatograph system. A temperature programme was utilised to obtain optimum detection and separation of dodecanes plus components.

The flashed oil was analysed by temperature programmed high resolution capillary gas chromatography. The two analyses were then mathematically recombined to the flash gas-oil ratio.

### **Constant Composition Expansion**

A portion of the reservoir fluid sample was charged to a high pressure visual cell maintained at the reservoir temperature of 66.0°C. A constant composition expansion was carried out during which the bubble point pressure of 1227 psig was determined and pressure-volume data for the single phase and two phase fluid were measured. The density of the single phase fluid was determined by weighing measured volumes pumped from the cell at 5000 psig. Density data for other pressures were calculated using the volumetric data.

### **Differential Vaporisation**

This was performed in the high pressure visual cell at reservoir temperature following the constant composition expansion. At several pressure stages, below the observed saturation pressure, the sample was stabilised. The gas evolved was then pumped out of the cell and the volume, compressibility and composition were determined. The final stage was carried out at atmospheric pressure when the residual liquid was pumped out of the cell and its density and composition were determined.

### **Viscosity**

This was measured in an electro-magnetic viscometer at reservoir temperature. Viscosity determinations were carried out over a wide range of pressures from above the reservoir pressure to atmospheric pressure.

### **Separator Test**

A two-stage separator test was carried out using a pressurised test separator cell. A portion of the reservoir fluid sample, at a pressure above saturation pressure, was pumped into the separator cell and stabilised at the pressure and temperature required for the first stage separation. The gas evolved was pumped out of the cell and the volume and composition were determined. The final stage was carried out at atmospheric pressure and the density and composition of the residual liquid was determined.

### **Compositional Analysis Databases**

For all compositions reported in this study, the properties used, eg Molecular Weight and Density of the individual components are tabulated in Section D of the Appendix.

**Summary of PVT Analysis Data**

**Constant Composition Expansion**

Saturation pressure (bubble-point)	1227 psig
Average single phase compressibility (From 1968 psig to 1227 psig)	$13.74 \times 10^{-6} \text{ psi}^{-1}$
Density at saturation pressure	0.7034 g cm <sup>-3</sup>

**Differential Vaporisation**

Solution gas-oil ratio at saturation pressure	391 scf/bbl of residual oil at 15.6°C
Relative oil volume at saturation pressure	1.245 vol/vol of residual oil at 15.6°C

**Reservoir Fluid Viscosity**

Viscosity at reservoir pressure	0.549 centipoise at 1968 psig
Viscosity at saturation pressure	0.518 centipoise at 1227 psig

**Separator Test**

Solution gas-oil ratio at saturation pressure	325 scf/bbl of residual oil at 15.6°C
Relative oil volume at saturation pressure	1.195 vol/vol of residual oil at 15.6°C

**Section B - Summary of Samples Received and Validation Data**

**Reported Well and Sampling Information - MDTs**

**Reservoir and Well Information**

Field.....	
Well.....	West Seahorse-3
Reservoir Fluid.....	Oil
Formation.....	
Reservoir Pressure .....	1968.0 psig
Reservoir Temperature.....	66.0 °C
Installation.....	
Test.....	
Perforations.....	

**Sampling Information**

Date sampled.....	
Time sampled .....	
Type of samples.....	MDT
Sampling company.....	Schlumberger
Sampling point.....	
Sampling Depth.....	1567.0 mMDRT
Choke.....	
Status of well.....	
Bottomhole pressure.....	1968.0 psig
Bottomhole temperature.....	66.0°C
Wellhead flowing pressure.....	
Wellhead flowing temperature.....	
Separator pressure .....	
Separator temperature .....	
Pressure base.....	14.696 psia
Temperature base .....	60°F
Water flowrate.....	
Gas gravity (Air = 1).....	
H2S.....	
CO2.....	
BS&W.....	
Oil gravity at 60°F .....	

Comments:  
Other details not supplied



**Summary of MDT Samples Received and Validation Data**

MDT Samples									
Sample Number	Cylinder Number	Sample Depth (m MDRT)	Type	Sampling :- Pressure (psig)	Temp. (°C)	Laboratory opening :- Pressure (psig)	Temp. (°C)	Water Volume (cm <sup>3</sup> )	Sample Volume (cm <sup>3</sup> )
T.01	PT-3001	1567.0	Oil	1968	65.0	1671	18.2	15	385
T.02	PT-3153	1567.0	Oil	1968	65.0	2126	16.5	13	370
T.03	PT-3184	1567.0	Oil	1968	65.0	1562	15.3	15	390

**Notes:**

Sample Volumes at 5000 psig and 94°C

Sampling pressure and temperature information from Expro sampling sheets

Sample T.01, Expro cylinder PT-3001 is transferred from Schlumberger chamber No. 3452

Sample T.02, Expro cylinder PT-3153 is transferred from Schlumberger chamber No. 3353

Sample T.03, Expro cylinder PT-3184 is transferred from Schlumberger chamber No. 3358

**Section C - Compositional Analysis Data**

**Compositional Analysis of Sample T.01, Cylinder No. PT-3001 to C36+**

	Component	Mole %	Weight %
H <sub>2</sub>	Hydrogen	0.00	0.00
H <sub>2</sub> S	Hydrogen Sulphide	0.00	0.00
CO <sub>2</sub>	Carbon Dioxide	0.75	0.30
N <sub>2</sub>	Nitrogen	0.26	0.06
C <sub>1</sub>	Methane	26.62	3.83
C <sub>2</sub>	Ethane	1.95	0.53
C <sub>3</sub>	Propane	2.84	1.12
iC <sub>4</sub>	i-Butane	2.00	1.04
nC <sub>4</sub>	n-Butane	2.16	1.12
C <sub>5</sub>	Neo-Pentane	0.08	0.05
iC <sub>5</sub>	i-Pentane	2.15	1.39
nC <sub>5</sub>	n-Pentane	1.93	1.25
C <sub>6</sub>	Hexanes	4.96	3.83
	M-C-Pentane	1.11	0.84
	Benzene	0.01	0.01
	Cyclohexane	0.94	0.71
C <sub>7</sub>	Heptanes	5.70	5.12
	M-C-Hexane	4.11	3.62
	Toluene	0.02	0.02
C <sub>8</sub>	Octanes	6.97	7.13
	E-Benzene	0.13	0.12
	M/P-Xylene	0.33	0.31
	O-Xylene	0.08	0.07
C <sub>9</sub>	Nonanes	4.68	5.39
	1,2,4-TMB	0.17	0.19
C <sub>10</sub>	Decanes	3.78	4.83
C <sub>11</sub>	Undecanes	2.81	3.70
C <sub>12</sub>	Dodecanes	2.27	3.28
C <sub>13</sub>	Tridecanes	2.41	3.78
C <sub>14</sub>	Tetradecanes	2.01	3.42
C <sub>15</sub>	Pentadecanes	2.25	4.17
C <sub>16</sub>	Hexadecanes	1.93	3.84
C <sub>17</sub>	Heptadecanes	1.91	4.05
C <sub>18</sub>	Octadecanes	1.90	4.27
C <sub>19</sub>	Nonadecanes	1.45	3.42
C <sub>20</sub>	Eicosanes	1.22	3.01
C <sub>21</sub>	Heneicosanes	1.00	2.62
C <sub>22</sub>	Docosanes	0.84	2.31
C <sub>23</sub>	Tricosanes	0.71	2.04
C <sub>24</sub>	Tetracosanes	0.59	1.74
C <sub>25</sub>	Pentacosanes	0.49	1.51
C <sub>26</sub>	Hexacosanes	0.38	1.22
C <sub>27</sub>	Heptacosanes	0.32	1.06
C <sub>28</sub>	Octacosanes	0.24	0.85
C <sub>29</sub>	Nonacosanes	0.21	0.77
C <sub>30</sub>	triacontanes	0.17	0.63
C <sub>31</sub>	Hentriacontanes	0.14	0.56
C <sub>32</sub>	Dotriacontanes	0.11	0.42
C <sub>33</sub>	Tritriacontanes	0.09	0.39
C <sub>34</sub>	Tetratriacontanes	0.07	0.31
C <sub>35</sub>	Pentatriacontanes	0.06	0.25
C <sub>36+</sub>	Hexatriacontanes Plus	0.69	3.50
	Totals :	100.00	100.00
	Note: 0.00 means < 0.005.		

**Compositional Analysis of sample T.01, cylinder No. PT-3001 to C36+**

**Calculated Residue Properties**

<b>C<sub>7+</sub></b>	Mole%	54.30
	Molecular Weight (g mol <sup>-1</sup> )	175
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8046
<b>C<sub>11+</sub></b>	Mole%	26.27
	Molecular Weight (g mol <sup>-1</sup> )	242
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8512
<b>C<sub>20+</sub></b>	Mole%	7.33
	Molecular Weight (g mol <sup>-1</sup> )	352
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8878
<b>C<sub>36+</sub></b>	Mole %	0.69
	Molecular Weight (g mol <sup>-1</sup> )	561
	Density at 15.6°C (g cm <sup>-3</sup> )	0.9288

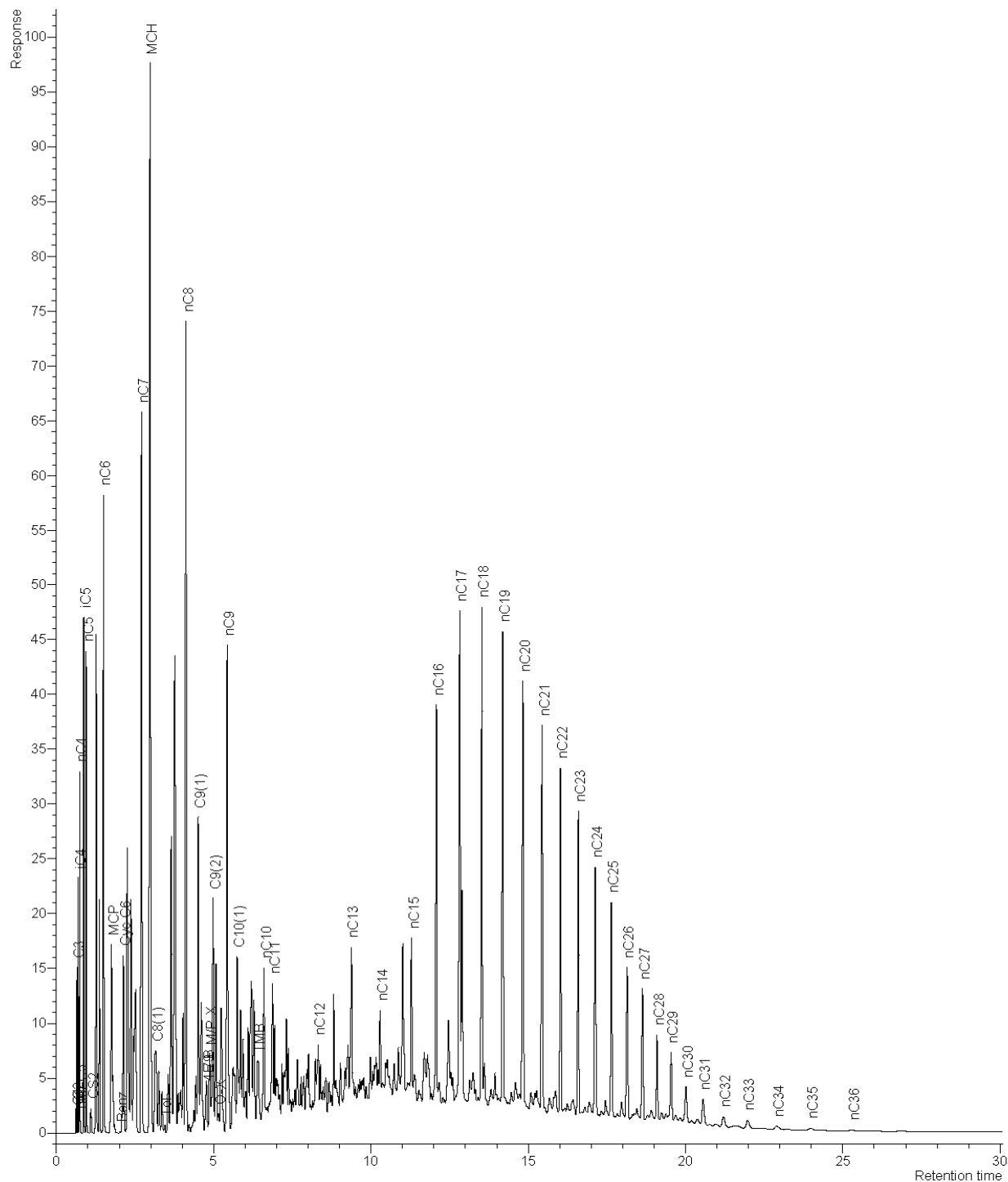
**Calculated Whole Sample Properties**

Average mole weight (g mol <sup>-1</sup> )	111
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**Chromatogram of sample T.01, cylinder No. PT-3001 to C36+**

West Seahorse-3 (1,1)  
Acquired Friday, 30 May 2008 3:41:17 PM

wb25052008\_as\_1.2008,1,1,1



**Compositional Analysis of Sample T.02, Cylinder No. PT-3153 to C36+**

	Component	Mole %	Weight %
H <sub>2</sub>	Hydrogen	0.00	0.00
H <sub>2</sub> S	Hydrogen Sulphide	0.00	0.00
CO <sub>2</sub>	Carbon Dioxide	0.72	0.28
N <sub>2</sub>	Nitrogen	0.22	0.05
C <sub>1</sub>	Methane	26.08	3.71
C <sub>2</sub>	Ethane	1.92	0.51
C <sub>3</sub>	Propane	2.79	1.09
iC <sub>4</sub>	i-Butane	1.95	1.01
nC <sub>4</sub>	n-Butane	2.10	1.08
C <sub>5</sub>	Neo-Pentane	0.08	0.05
iC <sub>5</sub>	i-Pentane	2.18	1.40
nC <sub>5</sub>	n-Pentane	1.97	1.26
C <sub>6</sub>	Hexanes	5.06	3.87
	M-C-Pentane	1.13	0.84
	Benzene	0.01	0.01
	Cyclohexane	0.98	0.73
C <sub>7</sub>	Heptanes	5.79	5.15
	M-C-Hexane	4.19	3.65
	Toluene	0.02	0.02
C <sub>8</sub>	Octanes	7.05	7.15
	E-Benzene	0.12	0.11
	M/P-Xylene	0.33	0.31
	O-Xylene	0.07	0.07
C <sub>9</sub>	Nonanes	4.69	5.33
	1,2,4-TMB	0.18	0.19
C <sub>10</sub>	Decanes	3.83	4.84
C <sub>11</sub>	Undecanes	2.84	3.70
C <sub>12</sub>	Dodecanes	2.24	3.20
C <sub>13</sub>	Tridecanes	2.46	3.81
C <sub>14</sub>	Tetradecanes	2.02	3.40
C <sub>15</sub>	Pentadecanes	2.25	4.12
C <sub>16</sub>	Hexadecanes	1.98	3.90
C <sub>17</sub>	Heptadecanes	1.90	4.00
C <sub>18</sub>	Octadecanes	1.90	4.24
C <sub>19</sub>	Nonadecanes	1.45	3.39
C <sub>20</sub>	Eicosanes	1.23	3.01
C <sub>21</sub>	Heneicosanes	1.00	2.59
C <sub>22</sub>	Docosanes	0.85	2.29
C <sub>23</sub>	Tricosanes	0.72	2.02
C <sub>24</sub>	Tetracosanes	0.59	1.74
C <sub>25</sub>	Pentacosanes	0.49	1.49
C <sub>26</sub>	Hexacosanes	0.38	1.21
C <sub>27</sub>	Heptacosanes	0.32	1.06
C <sub>28</sub>	Octacosanes	0.25	0.85
C <sub>29</sub>	Nonacosanes	0.22	0.77
C <sub>30</sub>	triacontanes	0.17	0.62
C <sub>31</sub>	Hentriacontanes	0.15	0.55
C <sub>32</sub>	Dotriacontanes	0.11	0.42
C <sub>33</sub>	Trtriacontanes	0.09	0.38
C <sub>34</sub>	Tetratriacontanes	0.07	0.31
C <sub>35</sub>	Pentatriacontanes	0.06	0.25
C <sub>36+</sub>	Hexatriacontanes Plus	0.80	3.97
	Totals :	100.00	100.00
	Note: 0.00 means < 0.005.		

**Compositional Analysis of Sample T.02, Cylinder No. PT-3153 to C36+**

**Calculated Residue Properties**

<b>C<sub>7+</sub></b>	Mole%	54.93
	Molecular Weight (g mol <sup>-1</sup> )	176
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8051
<b>C<sub>11+</sub></b>	Mole%	26.54
	Molecular Weight (g mol <sup>-1</sup> )	243
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8518
<b>C<sub>20+</sub></b>	Mole%	7.50
	Molecular Weight (g mol <sup>-1</sup> )	354
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8886
<b>C<sub>36+</sub></b>	Mole %	0.80
	Molecular Weight (g mol <sup>-1</sup> )	561
	Density at 15.6°C (g cm <sup>-3</sup> )	0.9289

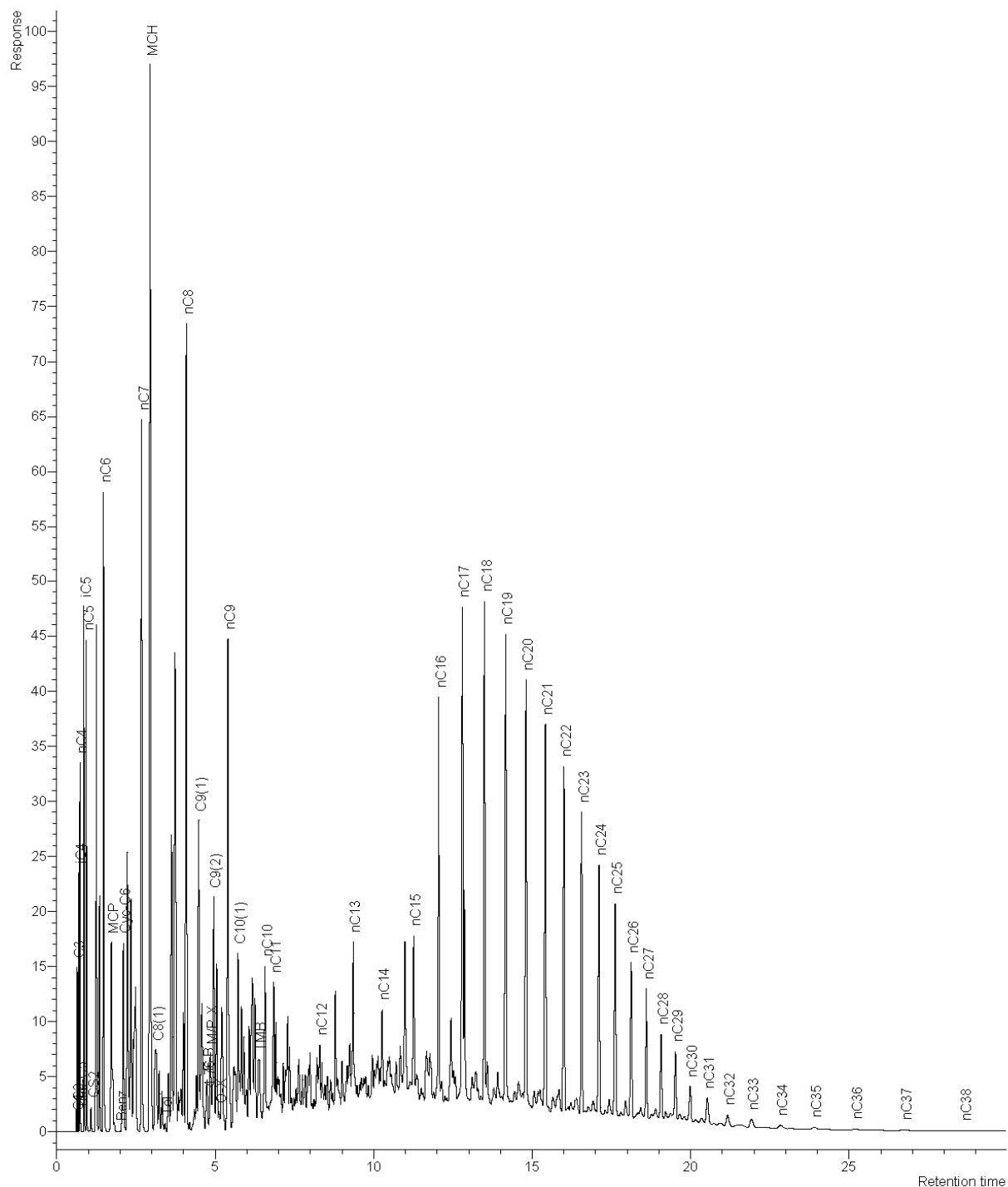
**Calculated Whole Sample Properties**

Average mole weight (g mol <sup>-1</sup> )	113
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**Chromatogram of Sample T.02, Cylinder No. PT-3153 to C36+**

West Seahorse-3 unspkd (1,1)  
Acquired Tuesday, 3 June 2008 2:05:36 PM

wb01062008,as\_1.2010,1,1,1





**Compositional Analysis of Sample T.03, Cylinder PT-3184 to C36+**

	Component	Mole %	Weight %
H <sub>2</sub>	Hydrogen	0.00	0.00
H <sub>2</sub> S	Hydrogen Sulphide	0.00	0.00
CO <sub>2</sub>	Carbon Dioxide	0.76	0.30
N <sub>2</sub>	Nitrogen	0.24	0.06
C <sub>1</sub>	Methane	26.49	3.81
C <sub>2</sub>	Ethane	1.94	0.52
C <sub>3</sub>	Propane	2.82	1.11
iC <sub>4</sub>	i-Butane	1.96	1.02
nC <sub>4</sub>	n-Butane	2.15	1.12
C <sub>5</sub>	Neo-Pentane	0.05	0.03
iC <sub>5</sub>	i-Pentane	2.13	1.38
nC <sub>5</sub>	n-Pentane	1.92	1.24
C <sub>6</sub>	Hexanes	4.96	3.83
	M-C-Pentane	1.11	0.84
	Benzene	0.02	0.02
	Cyclohexane	0.95	0.72
C <sub>7</sub>	Heptanes	5.75	5.16
	M-C-Hexane	4.17	3.67
	Toluene	0.03	0.02
C <sub>8</sub>	Octanes	7.04	7.18
	E-Benzene	0.13	0.12
	M/P-Xylene	0.33	0.31
	O-Xylene	0.07	0.07
C <sub>9</sub>	Nonanes	4.72	5.42
	1,2,4-TMB	0.17	0.19
C <sub>10</sub>	Decanes	3.81	4.86
C <sub>11</sub>	Undecanes	2.81	3.71
C <sub>12</sub>	Dodecanes	2.28	3.29
C <sub>13</sub>	Tridecanes	2.41	3.77
C <sub>14</sub>	Tetradecanes	2.04	3.47
C <sub>15</sub>	Pentadecanes	2.21	4.09
C <sub>16</sub>	Hexadecanes	1.95	3.88
C <sub>17</sub>	Heptadecanes	1.89	4.01
C <sub>18</sub>	Octadecanes	1.89	4.25
C <sub>19</sub>	Nonadecanes	1.46	3.43
C <sub>20</sub>	Eicosanes	1.21	2.99
C <sub>21</sub>	Heneicosanes	1.01	2.63
C <sub>22</sub>	Docosanes	0.84	2.30
C <sub>23</sub>	Tricosanes	0.71	2.03
C <sub>24</sub>	Tetracosanes	0.59	1.74
C <sub>25</sub>	Pentacosanes	0.49	1.51
C <sub>26</sub>	Hexacosanes	0.38	1.22
C <sub>27</sub>	Heptacosanes	0.32	1.06
C <sub>28</sub>	Octacosanes	0.24	0.85
C <sub>29</sub>	Nonacosanes	0.21	0.76
C <sub>30</sub>	triacontanes	0.17	0.63
C <sub>31</sub>	Hentriacontanes	0.14	0.56
C <sub>32</sub>	Dotriacontanes	0.11	0.42
C <sub>33</sub>	Tritriacontanes	0.09	0.37
C <sub>34</sub>	Tetratriacontanes	0.07	0.30
C <sub>35</sub>	Pentatriacontanes	0.06	0.24
C <sub>36+</sub>	Hexatriacontanes Plus	0.70	3.49
	Totals :	100.00	100.00
	Note: 0.00 means < 0.005.		

**Compositional Analysis of Sample T.03, Cylinder PT-3184 to C36+**

**Calculated Residue Properties**

<b>C<sub>7+</sub></b>	Mole%	54.58
	Molecular Weight (g mol <sup>-1</sup> )	175
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8043
<b>C<sub>11+</sub></b>	Mole%	26.28
	Molecular Weight (g mol <sup>-1</sup> )	242
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8511
<b>C<sub>20+</sub></b>	Mole%	7.34
	Molecular Weight (g mol <sup>-1</sup> )	352
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8877
<b>C<sub>36+</sub></b>	Mole %	0.70
	Molecular Weight (g mol <sup>-1</sup> )	560
	Density at 15.6°C (g cm <sup>-3</sup> )	0.9287

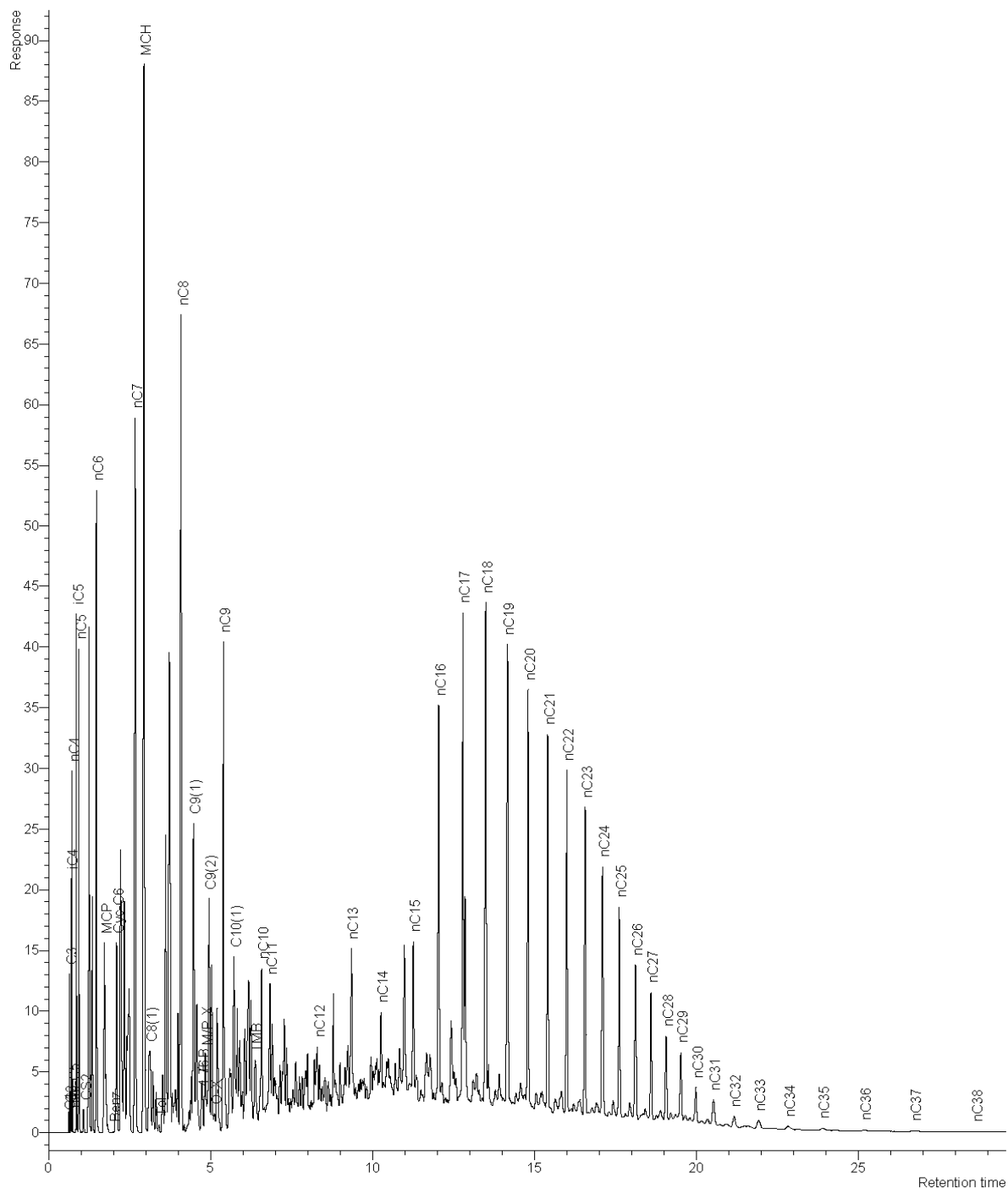
**Calculated Whole Sample Properties**

Average mole weight (g mol <sup>-1</sup> )	112
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**Chromatogram of Sample T.03, Cylinder PT-3184 to C36+**

West Seahorse -3 S/F (1,1)  
Acquired Tuesday, 3 June 2008 7:06:29 PM

wb01062008\_as\_1.2012,1,1,1



**Section D - Constant Composition Expansion - PT-3184 (Sample No.: T.03)**

**Constant Composition Expansion at 66.0°C**

**Single-phase Fluid Properties**

Saturation pressure (bubble-point pressure)	1227 psig
Average single phase compressibility (From 1968 psig to 1227 psig)	$13.74 \times 10^{-6} \text{ psi}^{-1}$
Density at saturation pressure	$0.7034 \text{ g cm}^{-3}$

**Mean Single-phase Compressibilities**

Initial Pressure (psig)	Pressure Range Final Pressure (psig)	Mean Compressibility (psi <sup>-1</sup> ) (1)
5000	4000	$7.51 \times 10^{-6}$
4000	3000	$8.57 \times 10^{-6}$
3000	1800	$10.60 \times 10^{-6}$
1800	1227	$14.23 \times 10^{-6}$

(1) Mean compressibility =  $(V_2 - V_1) / [(V_1 + V_2)/2] \times 1/(P_1 - P_2)$

**Constant Composition Expansion at 66.0°C**

Pressure (psig)		Relative Volume (1)	Density (g cm-3)	Instantaneous Compressibility (psi-1 x 10-6) (2)	Y-function (3)
5000		0.9637	0.7299	7.10	
4500		0.9672	0.7272	7.49	
4000		0.9710	0.7244	7.96	
3500		0.9750	0.7214	8.54	
3000		0.9793	0.7182	9.28	
2500		0.9841	0.7148	10.25	
2200		0.9873	0.7125	11.02	
2100		0.9884	0.7117	11.32	
2000		0.9895	0.7109	11.65	
<b>1968</b>	<b>Reservoir pressure</b>	<b>0.9899</b>	<b>0.7106</b>	<b>11.76</b>	
1900		0.9907	0.7100	12.01	
1800		0.9919	0.7092	12.41	
1700		0.9931	0.7083	12.86	
1600		0.9944	0.7073	13.38	
1500		0.9958	0.7064	14.00	
1400		0.9972	0.7054	14.77	
1300		0.9988	0.7043	15.93	
<b>1227</b>	<b>Saturation pressure</b>	<b>1.0000</b>	<b>0.7034</b>		
1219		1.0029			
1220		1.0026			
1219		1.0029			
1218		1.0033			
1212		1.0056			
1197		1.0113			
1164		1.0246			
1096		1.0553			2.133
1019		1.0963			2.089
923		1.1593			2.035
824		1.2429			1.978
711		1.3715			1.914
595		1.5610			1.848
480		1.8472			1.782
374		2.2743			1.722
284		2.8895			1.671
203		3.8951			1.625

(1) Relative Volume =  $V / V_{sat}$  ie. volume at indicated pressure per volume at saturation pressure.

(2) Instantaneous compressibility =  $(V_2 - V_1) / V_1 \times 1 / (P_1 - P_2)$

(3) Y-function =  $(P_{sat} - P) / ((P_{abs})(V/V_{sat} - 1))$ .

**Section E - Differential Vaporisation Data - PT-3184 (Sample No.: T.03)**

**Differential Vaporisation at 66.0°C**

Pressure (psig)	Solution Gas-Oil Ratio Rs(1)	Relative Oil Volume Bod(2)	Relative Total Volume Btd(3)	Density (g cm-3)	Deviation Factor (Z)	Gas Formation Volume Factor (4)	Incremental Gas Gravity (Air = 1.000)
<b>1227</b>	<b>391</b>	<b>1.245</b>	<b>1.245</b>	<b>0.7034</b>	<b>Saturation Pressure</b>		
1000	336	1.222	1.377	0.7103	0.920	0.01565	0.649
800	283	1.201	1.580	0.7163	0.930	0.01971	0.656
600	235	1.182	1.917	0.7222	0.942	0.02646	0.666
400	185	1.162	2.624	0.7280	0.955	0.03977	0.694
200	132	1.140	4.747	0.7342	0.970	0.07799	0.761
100	104	1.127	8.665	0.7382	0.978	0.14715	0.874
0	0	1.053		0.7526	0.987		1.760
At 15.6°C =		1.000					

**Residual Oil Properties**

Density of residual oil                      0.7921      g cm<sup>-3</sup> at 15.6°C

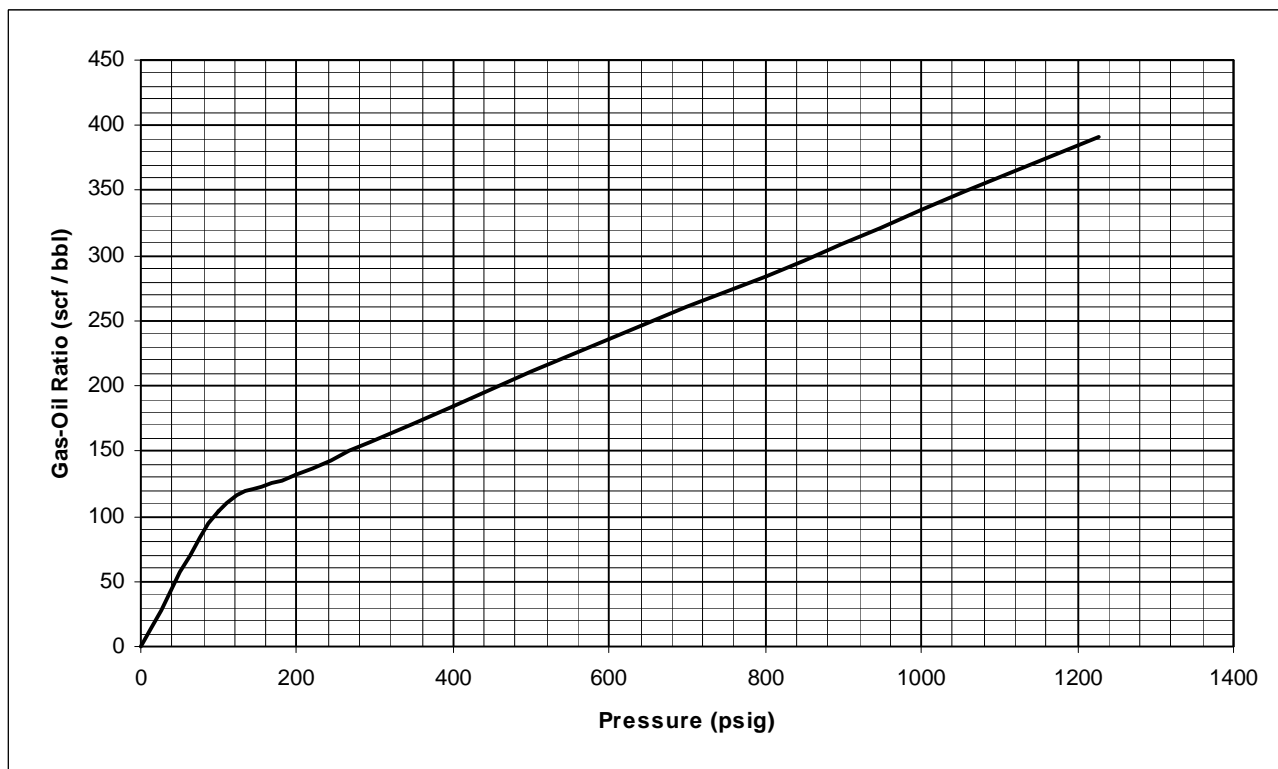
°API    47.0

- (1) GOR in cubic feet of gas at 14.70 psia and 15.6°C per barrel of residual oil at 15.6°C.  
(2) Volume of oil at indicated pressure and temperature per volume of residual oil at 15.6°C.  
(3) Volume of oil plus liberated gas at indicated pressure and temperature per volume of residual oil at 15.6°C.  
(4) Volume of gas at indicated pressure and temperature per volume at 14.70 psia and 15.6°C.

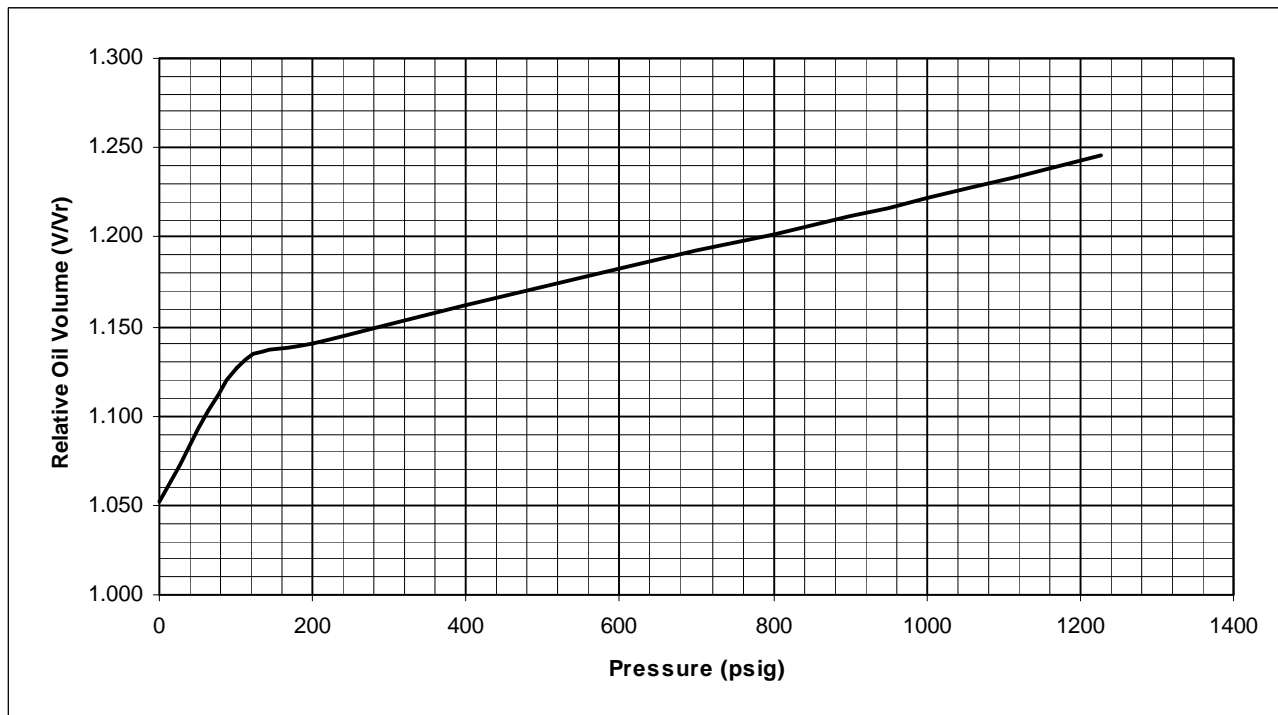


Graphs of Differential Vaporisation

**Solution Gas-Oil Ratio v Pressure**



**Relative Oil Volume v Pressure**



**Compositional Analysis of Differential Vaporisation Gases to C11+**

Sample I.D.								
Test Stage		1	2	3	4	5	6	7
Stage Pressure (psig)		1000	800	600	400	200	100	0
Component (Mole%)								
H <sub>2</sub>	Hydrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H <sub>2</sub> S	Hydrogen Sulphide	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO <sub>2</sub>	Carbon Dioxide	1.47	1.59	1.76	2.02	2.51	2.97	1.52
N <sub>2</sub>	Nitrogen	1.77	1.24	0.84	0.47	0.21	0.12	0.05
C <sub>1</sub>	Methane	90.53	90.25	89.44	87.28	81.29	72.11	24.52
C <sub>2</sub>	Ethane	2.24	2.50	2.92	3.69	5.54	7.98	8.51
C <sub>3</sub>	Propane	1.52	1.72	1.98	2.63	4.34	6.95	17.46
iC <sub>4</sub>	i-Butane	0.62	0.67	0.83	1.02	1.82	2.76	10.88
nC <sub>4</sub>	n-Butane	0.52	0.57	0.67	0.86	1.48	2.37	10.62
C <sub>5</sub>	Neo-Pentane	0.02	0.02	0.03	0.02	0.04	0.06	0.26
iC <sub>5</sub>	i-Pentane	0.31	0.34	0.38	0.51	0.75	1.24	6.45
nC <sub>5</sub>	n-Pentane	0.23	0.25	0.28	0.37	0.54	0.90	4.81
C <sub>6</sub>	Hexanes	0.33	0.35	0.40	0.50	0.68	1.16	6.31
	M-C-Pentane	0.04	0.05	0.05	0.06	0.09	0.15	0.85
	Benzene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cyclohexane	0.06	0.07	0.07	0.09	0.12	0.20	1.01
C <sub>7</sub>	Heptanes	0.14	0.15	0.15	0.20	0.26	0.44	2.43
	M-C-Hexane	0.09	0.10	0.09	0.12	0.15	0.26	1.46
	Toluene	0.00	0.00	0.00	0.00	0.00	0.01	0.03
C <sub>8</sub>	Octanes	0.07	0.08	0.07	0.10	0.13	0.22	1.25
	E-Benzene	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	M/P-Xylene	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	O-Xylene	0.00	0.00	0.00	0.00	0.00	0.00	0.01
C <sub>9</sub>	Nonanes	0.03	0.04	0.03	0.04	0.04	0.08	0.47
	1,2,4-TMB	0.00	0.00	0.00	0.00	0.00	0.00	0.01
C <sub>10</sub>	Decanes	0.01	0.01	0.01	0.02	0.01	0.02	0.22
C <sub>11+</sub>	Undecanes plus	0.00	0.00	0.00	0.00	0.00	0.00	0.88
Totals :		100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Gas Properties								
Gas Gravity (Air = 1.000)		0.649	0.656	0.666	0.694	0.761	0.874	1.760

Note: 0.00 means less than 0.005.

**Compositional Analysis of Differential Vaporisation Residue to C36+**

Component		Mole %	Weight %
H <sub>2</sub>	Hydrogen	0.00	0.00
H <sub>2</sub> S	Hydrogen Sulphide	0.00	0.00
CO <sub>2</sub>	Carbon Dioxide	0.00	0.00
N <sub>2</sub>	Nitrogen	0.00	0.00
C <sub>1</sub>	Methane	0.00	0.00
C <sub>2</sub>	Ethane	0.05	0.01
C <sub>3</sub>	Propane	0.41	0.11
iC <sub>4</sub>	i-Butane	0.84	0.30
nC <sub>4</sub>	n-Butane	1.29	0.46
C <sub>5</sub>	Neo-Pentane	0.07	0.03
iC <sub>5</sub>	i-Pentane	2.08	0.92
nC <sub>5</sub>	n-Pentane	2.13	0.94
C <sub>6</sub>	Hexanes	6.63	3.50
	M-C-Pentane	1.65	0.85
	Benzene	0.00	0.00
	Cyclohexane	1.26	0.65
C <sub>7</sub>	Heptanes	8.85	5.43
	M-C-Hexane	6.37	3.83
	Toluene	0.02	0.01
C <sub>8</sub>	Octanes	11.18	7.82
	E-Benzene	0.20	0.13
	M/P-Xylene	0.54	0.35
	O-Xylene	0.12	0.08
C <sub>9</sub>	Nonanes	7.46	5.86
	1,2,4-TMB	0.30	0.22
C <sub>10</sub>	Decanes	6.10	5.31
C <sub>11</sub>	Undecanes	4.56	4.10
C <sub>12</sub>	Dodecanes	3.62	3.57
C <sub>13</sub>	Tridecanes	3.90	4.18
C <sub>14</sub>	Tetradecanes	3.23	3.76
C <sub>15</sub>	Pentadecanes	3.58	4.51
C <sub>16</sub>	Hexadecanes	3.14	4.27
C <sub>17</sub>	Heptadecanes	3.06	4.44
C <sub>18</sub>	Octadecanes	3.06	4.70
C <sub>19</sub>	Nonadecanes	2.33	3.75
C <sub>20</sub>	Eicosanes	1.96	3.30
C <sub>21</sub>	Heneicosanes	1.62	2.88
C <sub>22</sub>	Docosanes	1.35	2.53
C <sub>23</sub>	Tricosanes	1.15	2.24
C <sub>24</sub>	Tetracosanes	0.95	1.92
C <sub>25</sub>	Pentacosanes	0.79	1.66
C <sub>26</sub>	Hexacosanes	0.61	1.34
C <sub>27</sub>	Heptacosanes	0.51	1.17
C <sub>28</sub>	Octacosanes	0.40	0.94
C <sub>29</sub>	Nonacosanes	0.34	0.84
C <sub>30</sub>	triacontanes	0.27	0.70
C <sub>31</sub>	Hentriacontanes	0.24	0.62
C <sub>32</sub>	Dotriacontanes	0.17	0.46
C <sub>33</sub>	Trtriacontanes	0.15	0.42
C <sub>34</sub>	Tetratriacontanes	0.12	0.34
C <sub>35</sub>	Pentatriacontanes	0.09	0.28
C <sub>36+</sub>	Hexatriacontanes plus	1.25	4.27
Totals :		100.00	100.00
Note: 0.00 means less than 0.005.			

**Compositional Analysis of Differential Vaporisation Residue to C36+**

**Calculated Residue Properties**

<b>C<sub>7+</sub></b>	Mole%	86.50
	Molecular Weight (g mol <sup>-1</sup> )	177
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8056
<b>C<sub>11+</sub></b>	Mole%	42.45
	Molecular Weight (g mol <sup>-1</sup> )	243
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8517
<b>C<sub>20+</sub></b>	Mole%	11.97
	Molecular Weight (g mol <sup>-1</sup> )	354
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8884
<b>C<sub>36+</sub></b>	Mole %	1.25
	Molecular Weight (g mol <sup>-1</sup> )	560
	Density at 15.6°C (g cm <sup>-3</sup> )	0.9287

**Calculated Whole Sample Properties**

Average mole weight (g mol <sup>-1</sup> )	163
Density at 15.6°C (g cm <sup>-3</sup> ) [Measured]	0.7921
API	47.0

**Differential Vaporisation Data Converted to Production Separator Conditions**

Pressure (psig)	Oil Density (g cm-3)	Solution Gas/Oil (scf / bbl) Rs(1)	Formation Volume Factor Bo(1)	Gas Formation Volume Factor Bg(2)
5000	0.7299		1.152	
4500	0.7272		1.156	
4000	0.7244		1.160	
3500	0.7214		1.165	
3000	0.7182		1.170	
2500	0.7148		1.176	
2200	0.7125		1.180	
2100	0.7117		1.181	
2000	0.7109		1.182	
<b>1968</b>	<b>Reservoir pressure</b>	<b>0.7106</b>	<b>1.183</b>	
1900		0.7100	1.184	
1800		0.7092	1.185	
1700		0.7083	1.187	
1600		0.7073	1.188	
1500		0.7064	1.190	
1400		0.7054	1.192	
1300		0.7043	1.194	
1227		0.7034	1.195	
<b>1227</b>	<b>Saturation pressure</b>	<b>0.7034</b>	<b>325</b>	<b>1.195</b>
1000		0.7103	1.173	0.01565
800		0.7163	1.153	0.01971
600		0.7222	1.134	0.02646
400		0.7280	1.115	0.03977
200		0.7342	1.094	0.07799

Notes:

(1) Differential data corrected to surface separator conditions of :-

Stage 1            150 psig and 15.0°C  
Stage 2            0 psig and 15.0°C

$$R_s = R_{sfb} - (R_{sdb} - R_{sd}) \times (B_{ofb} / B_{odb})$$

$$B_o = B_{od} \times (B_{ofb} / B_{odb})$$

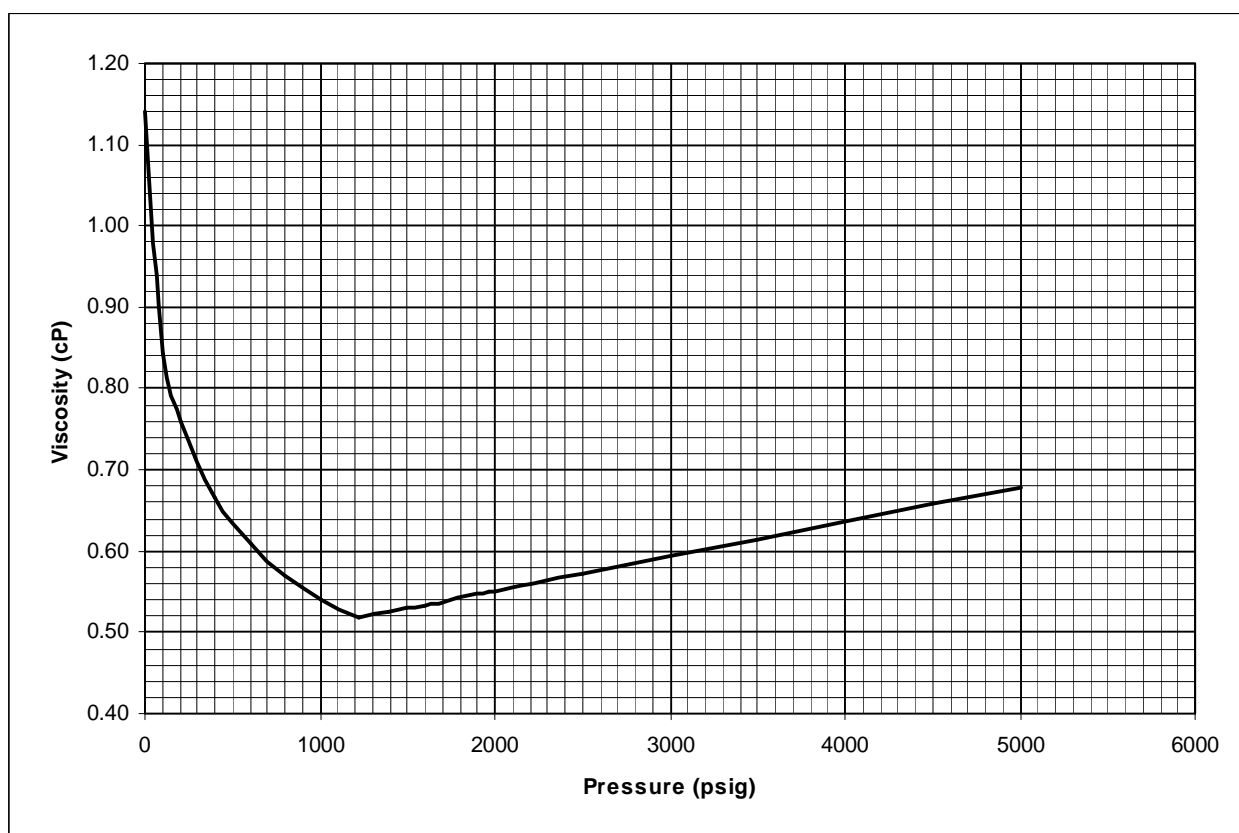
(2) Volume of gas at indicated pressure and temperature per volume at 14.70 psia and 15.6°C.

**Section F - Viscosity Data - PT-3184 (Sample No.: T.03)**

**Reservoir Fluid Viscosity Data at 66°C**

Pressure (psig)		Oil Viscosity (cP)	Calculated Gas Viscosity (cP) (1)	Oil/Gas Viscosity Ratio
5000		0.679		
4500		0.657		
4000		0.636		
3500		0.615		
3000		0.593		
2500		0.572		
2000		0.551		
<b>1968</b>	<b>Reservoir pressure</b>	<b>0.549</b>		
1600		0.534		
1500		0.529		
1400		0.525		
<b>1227</b>	<b>Saturation pressure</b>	<b>0.518</b>		
1000		0.541	0.0139	38.9
800		0.569	0.0135	42.3
600		0.608	0.0131	46.6
400		0.666	0.0126	52.8
200		0.760	0.0120	63.2
100		0.842	0.0114	73.8
0		1.140		

**Reservoir Fluid Viscosity v Pressure at 66°C**



(1) Calculated using the method of Lee, Gonzales and Eakin, JPT, Aug 1966.

**Section G - Separator Test Data - PT-3184 (Sample NO.: T.03)**



### Separator Test Data

Pressure (psig)	Temperature (°C)	Gas-Oil Ratio (1)	Gas-Oil Ratio Rsfb (2)	Oil Density (g cm-3)	Formation Volume Factor Bofb (3)	Separation Volume Factor (4)	Gas Gravity of flashed gas (Air = 1.000)
<b>1227</b>	<b>66.0</b>	<b>-</b>	<b>325</b>	<b>0.7034</b>	<b>1.195</b>	<b>Saturation Pressure</b>	
150	15.0	239	248	0.7785		1.036	0.646
0	15.0	77	77	0.7925 (°API = 48.0)		0.999	1.101

### Note

Evolved gas collected and analysed to Undecanes plus.  
Stocktank oil collected and analysed to Hexatriacontanes plus.

- (1) GOR in cubic feet of gas at 14.70 psia and 15.6°C per barrel of oil at indicated pressure and temperature.  
(2) GOR in cubic feet of gas at 14.70 psia and 15.6°C per barrel of stocktank oil at 15.6°C.  
(3) Volume of saturated oil at 1227 psig and 66.0°C per volume of stocktank oil at 15.6°C.  
(4) Volume of oil at indicated pressure and temperature per volume of stocktank oil at 15.6°C.

**Compositional Analysis of Separator Test Gases to C11+**

Sample I.D.			
Test Stage		1	2
Stage Pressure (psig)		150	0
Component (Mole%)			
H <sub>2</sub>	Hydrogen	0.00	0.00
H <sub>2</sub> S	Hydrogen Sulphide	0.00	0.00
CO <sub>2</sub>	Carbon Dioxide	1.84	2.54
N <sub>2</sub>	Nitrogen	0.98	0.15
C <sub>1</sub>	Methane	89.68	52.92
C <sub>2</sub>	Ethane	3.53	11.13
C <sub>3</sub>	Propane	2.08	14.39
iC <sub>4</sub>	i-Butane	0.70	6.41
nC <sub>4</sub>	n-Butane	0.51	5.27
C <sub>5</sub>	Neo-Pentane	0.02	0.13
iC <sub>5</sub>	i-Pentane	0.23	2.47
nC <sub>5</sub>	n-Pentane	0.15	1.63
C <sub>6</sub>	Hexanes	0.15	1.64
	M-C-Pentane	0.02	0.19
	Benzene	0.00	0.00
	Cyclohexane	0.02	0.22
C <sub>7</sub>	Heptanes	0.03	0.45
	M-C-Hexane	0.03	0.26
	Toluene	0.00	0.00
C <sub>8</sub>	Octanes	0.02	0.15
	E-Benzene	0.00	0.00
	M/P-Xylene	0.00	0.00
	O-Xylene	0.00	0.00
C <sub>9</sub>	Nonanes	0.01	0.04
	1,2,4-TMB	0.00	0.00
C <sub>10</sub>	Decanes	0.00	0.01
C <sub>11+</sub>	Undecanes plus	0.00	0.00
Totals :		100.00	100.00
Gas Properties			
Gas Gravity (Air = 1.000)		0.646	1.101

**Compositional Analysis of Stocktank Oil to C36+**

Component		Mole %	Weight %
H <sub>2</sub>	Hydrogen	0.00	0.00
H <sub>2</sub> S	Hydrogen Sulphide	0.00	0.00
CO <sub>2</sub>	Carbon Dioxide	0.04	0.01
N <sub>2</sub>	Nitrogen	0.00	0.00
C <sub>1</sub>	Methane	0.00	0.00
C <sub>2</sub>	Ethane	0.26	0.05
C <sub>3</sub>	Propane	1.67	0.47
iC <sub>4</sub>	i-Butane	1.78	0.66
nC <sub>4</sub>	n-Butane	2.32	0.86
C <sub>5</sub>	Neo-Pentane	0.02	0.01
iC <sub>5</sub>	i-Pentane	2.74	1.26
nC <sub>5</sub>	n-Pentane	2.60	1.20
C <sub>6</sub>	Hexanes	7.05	3.88
	M-C-Pentane	1.62	0.87
	Benzene	0.02	0.01
	Cyclohexane	1.27	0.68
C <sub>7</sub>	Heptanes	8.52	5.45
	M-C-Hexane	6.11	3.83
	Toluene	0.02	0.01
C <sub>8</sub>	Octanes	10.52	7.69
	E-Benzene	0.19	0.13
	M/P-Xylene	0.52	0.35
	O-Xylene	0.10	0.07
C <sub>9</sub>	Nonanes	6.94	5.68
	1,2,4-TMB	0.26	0.20
C <sub>10</sub>	Decanes	5.79	5.26
C <sub>11</sub>	Undecanes	4.26	4.00
C <sub>12</sub>	Dodecanes	3.38	3.47
C <sub>13</sub>	Tridecanes	3.65	4.08
C <sub>14</sub>	Tetradecanes	3.03	3.67
C <sub>15</sub>	Pentadecanes	3.39	4.46
C <sub>16</sub>	Hexadecanes	2.93	4.15
C <sub>17</sub>	Heptadecanes	2.84	4.30
C <sub>18</sub>	Octadecanes	2.86	4.59
C <sub>19</sub>	Nonadecanes	2.19	3.68
C <sub>20</sub>	Eicosanes	1.83	3.22
C <sub>21</sub>	Heneicosanes	1.51	2.81
C <sub>22</sub>	Docosanes	1.27	2.47
C <sub>23</sub>	Tricosanes	1.08	2.20
C <sub>24</sub>	Tetracosanes	0.88	1.86
C <sub>25</sub>	Pentacosanes	0.74	1.64
C <sub>26</sub>	Hexacosanes	0.57	1.31
C <sub>27</sub>	Heptacosanes	0.48	1.14
C <sub>28</sub>	Octacosanes	0.37	0.91
C <sub>29</sub>	Nonacosanes	0.32	0.82
C <sub>30</sub>	triacontanes	0.26	0.68
C <sub>31</sub>	Hentriacontanes	0.22	0.60
C <sub>32</sub>	Dotriacontanes	0.16	0.45
C <sub>33</sub>	Tritriacontanes	0.14	0.41
C <sub>34</sub>	Tetratriacontanes	0.11	0.33
C <sub>35</sub>	Pentatriacontanes	0.09	0.27
C <sub>36+</sub>	Hexatriacontanes plus	1.08	3.85
Totals :		100.00	100.00
Note: 0.00 means < 0.005.			

**Compositional Analysis of Stocktank Oil to C36+**

Calculated residue properties		
C <sub>7+</sub>	Mole%	81.52
	Molecular Weight (g mol <sup>-1</sup> )	176
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8048
C <sub>11+</sub>	Mole%	39.64
	Molecular Weight (g mol <sup>-1</sup> )	243
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8513
C <sub>20+</sub>	Mole%	11.11
	Molecular Weight (g mol <sup>-1</sup> )	352
	Density at 15.6°C (g cm <sup>-3</sup> )	0.8879
C <sub>36+</sub>	Mole %	1.08
	Molecular Weight (g mol <sup>-1</sup> )	560
	Density at 15.6°C (g cm <sup>-3</sup> )	0.9287
Whole sample properties		
	Average mole weight (g mol <sup>-1</sup> )	156.6
	Density at 15.6°C (g cm <sup>-3</sup> ) [Measured]	0.7925
	API	48.0

**Section H - Appendix**

**Data Used in Gas Compositional Calculations**

Component		Mole Weight (g mol-1)	Density (g cm-3 at 60°F)	Component		Mole Weight (g mol-1)	Density (g cm-3 at 60°F)
Hydrogen	*	2.016	N/A	33DMC5	*	100.20	0.6954
Oxygen/(Argon)	**	31.999	1.1410	Cyclohexane	*	84.16	0.7827
Nitrogen (Corrected)	**	28.013	0.8086	2MC6/23DMC5	*	100.20	0.6917
Methane	**	16.043	0.2997	11DMCYC5/3MC6	*	99.20	0.7253
Carbon Dioxide	**	44.010	0.8172	t13DMCYC5	*	98.19	0.7528
Ethane	**	30.070	0.3558	c13DMCYC5/3EC5	*	99.20	0.7262
Hydrogen Sulphide	**	34.080	0.8006	t12DMCYC5	*	98.19	0.7554
Propane	**	44.097	0.5065	Heptanes (nC7)	*	100.20	0.6875
i-Butane	**	58.123	0.5623	22DMC6	*	114.23	0.6994
n-Butane	**	58.123	0.5834	MCYC6	*	98.19	0.7740
Neo-Pentane	*	72.15	0.5968	ECYC5	*	98.19	0.7704
i-Pentane	**	72.150	0.6238	223TMC5/24&25DMC6	*	114.23	0.7060
n-Pentane	**	72.150	0.6305	ctc124TMCYC5	*	112.21	0.7511
22DMC4	*	86.18	0.6529	ctc123TMCYC5	*	112.21	0.7574
23DMC4/CYC5	*	78.16	0.7129	Toluene	*	92.14	0.8734
2MC5	*	86.18	0.6572	Octanes (nC8)	*	114.23	0.7063
3MC5	*	86.18	0.6682	E-Benzene	*	106.17	0.8735
Hexanes (nC6)	*	86.18	0.6631	M/P-Xylene	*	106.17	0.8671
22DMC5	*	100.20	0.6814	O-Xylene	*	106.17	0.8840
M-C-Pentane	*	84.16	0.7533	Nonanes (nC9)	*	128.26	0.7212
24DMC5	*	100.20	0.6757	Decanes	***	134	0.778
223TMC4	*	100.20	0.6947	Undecanes	***	147	0.789
Benzene	*	78.11	0.8820	Dodecanes	***	161	0.800

Data Source Refs :

\* ASTM Data Series Publication DS 4B (1991) - Physical Constants of Hydrocarbon and Non-Hydrocarbon Compounds.

\*\* GPA Table of Physical Constants of Paraffin Hydrocarbons and Other Components of Natural Gas, GPA 2145-96.

\*\*\* Journal of Petroleum Technology, Nov 1978, Pages 1649-1655.  
Predicting Phase Behaviour of Condensate/Crude Oil Systems Using Methane Interaction Coefficients  
- D.L. Katz & A. Firoozabadi.

Note :

The gas mole % compositions were calculated from the measured weight % compositions using the most detailed analysis results, involving as many of the above components as were identified. The reported component mole % compositions were then sub-grouped into the generic carbon number components.

**Data Used in Liquid Compositional Calculations**

Component		Mole Weight (g mol-1)	Density (g cm-3 at 60°F)	Component		Mole Weight (g mol-1)	Density (g cm-3 at 60°F)
Hydrogen	*	2.016	N/A	Undecanes	***	147	0.789
Hyd. sulphide	**	34.080	0.8006	Dodecanes	***	161	0.800
Carbon Dioxide	**	44.010	0.8172	Tridecanes	***	175	0.811
Nitrogen	**	28.013	0.8086	Tetradecanes	***	190	0.822
Methane	**	16.043	0.2997	Pentadecanes	***	206	0.832
Ethane	**	30.070	0.3558	Hexadecanes	***	222	0.839
Propane	**	44.097	0.5065	Heptadecanes	***	237	0.847
i-Butane	**	58.123	0.5623	Octadecanes	***	251	0.852
n-Butane	**	58.123	0.5834	Nonadecanes	***	263	0.857
i-Pentane	**	72.150	0.6238	Eicosanes	***	275	0.862
n-Pentane	**	72.150	0.6305	Heneicosanes	***	291	0.867
Hexanes	**	86.177	0.6634	Docosanes	***	305	0.872
Me-cyclo-pentane	*	84.16	0.7533	Tricosanes	***	318	0.877
Benzene	*	78.11	0.8820	Tetracosanes	***	331	0.881
Cyclo-hexane	*	84.16	0.7827	Pentacosanes	***	345	0.885
Heptanes	**	100.204	0.6874	Hexacosanes	***	359	0.889
Me-cyclo-hexane	*	98.19	0.7740	Heptacosanes	***	374	0.893
Toluene	*	92.14	0.8734	Octacosanes	***	388	0.896
Octanes	**	114.231	0.7061	Nonacosanes	***	402	0.899
Ethyl-benzene	*	106.17	0.8735	Triacosanes	***	416	0.902
Meta/Para-xylene	*	106.17	0.8671	Hentriacosanes	***	430	0.906
Ortho-xylene	*	106.17	0.8840	Dotriacosanes	***	444	0.909
Nonanes	**	128.258	0.7212	Tritriacosanes	***	458	0.912
1-2-4-T-M-benzene	*	120.19	0.8797	Tetratriacosanes	***	472	0.914
Decanes	**	142.285	0.7334	Pentatriacosanes	***	486	0.917

Data Source Refs :

\* ASTM Data Series Publication DS 4B (1991) - Physical Constants of Hydrocarbon and Non-Hydrocarbon Compounds.

\*\* GPA Table of Physical Constants of Paraffin Hydrocarbons and Other Components of Natural Gas GPA 2145-96.

\*\*\* Journal of Petroleum Technology, Nov 1978, Pages 1649-1655.  
Predicting Phase Behaviour of Condensate/Crude Oil Systems Using Methane Interaction Coefficients  
- D.L. Katz & A. Firoozabadi.

Note :

The residue mole weight and density values ( eg heptanes plus, undecanes plus, eicosanes plus) are calculated so that the calculated average mole weights and densities correspond with the measured values. This can lead to anomalous residue mole weights and densities where the Katz and Firoozabadi values may not be suitable for the isomer groups detected.

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