Western Atlas International
A Litton Dresser Company

CORE LABORATORIES

February 19, 1990

BIRD CREEK RESOURCES, INC.
1412 S. Boston
Suite 550
Tulsa, Oklahoma 74119

Attention: Mr. Bill Burks

Subject: Reservoir Fluid Study
Carrasco "14" #1
East Loving Delaware Field
Eddy County, New Mexico
File: RFLM 89108

Gentlemen:

Duplicate separator oil and gas samples were collected from the subject well and were submitted to our Midland laboratory on October 20, 1989 for use in a reservoir fluid study. Presented in the following report are the results of this study as requested by Bird Creek Resources, Inc.

As a quality check, the room temperature saturation pressure of each separator oil sample was initially determined. At 70°F., separator oil samples, numbers one and two, were found to have bubble point pressures of 392 psig and 371 psig, respectively. These values were considered to be in good agreement with the sampling conditions and sample number one was selected for use in the reservoir fluid study.

The composition of the separator gas was determined by gas chromatography while the composition of the separator liquid was determined by spike/flash chromatographic technique. The composition of the separator products are reported on page four.

We were initially requested to recombine the separator products to a ratio of 1000 standard cubic feet of gas at 15.025 psia and 60°F. per barrel of stock tank oil at 60°F. The physical recombination was performed and the resulting fluid was placed into a high pressure windowed cell and thermally expanded to the reservoir temperature of 106°F. This fluid was found to have a bubble point pressure of 3270 psig at 106°F. This bubble point did not correlate with the reported reservoir pressure of 2892 psig, therefore, it was decided to recombine the separator

products to a ratio of 820 SCF/STB. The resulting fluid was used for the remainder of the study. The composition of the well stream material was calculated using the gas/oil ratio of 820 SCF/STB.

A small quantity of the reservoir fluid was charged to a high pressure windowed cell and thermally expanded to the reservoir temperature of 106°F. During a constant composition expansion at this temperature, the fluid was found to have a bubble point pressure of 2858 psig. The results of the pressure-volume measurements at reservoir temperature may be found on page seven.

When subjected to differential pressure depletion at the reservoir temperature, The fluid evolved a total of 1108 cubic feet of gas at 15.025 psia and 60°F. per barrel of residual oil at 60°F. The resulting relative oil volume factor was 1.543 barrels of saturated fluid per barrel of residual oil. The oil density and the properties of the evolved gases were measured at each point during the differential pressure depletion and these data are included in the summary of the differential depletion data on page eight.

The viscosity of the reservoir fluid was measured over a wide range of pressures at 106°F. in a rolling ball viscosimeter. The viscosity of the fluid was found to vary from a minimum of 0.54 centipoise at the saturation pressure to a maximum of 2.59 centipoise at atmospheric pressure. The results of the viscosity measurements are tabulated on page fifteen.

One multi-stage separator test was performed at room temperature to measure gas-oil ratio, stock tank oil gravity, and formation volume factor. The results of the separator test can be found on page eleven.

For your convenience, differential data has been adjusted to separator conditions. The results can be found on page twelve.

Thank you for the opportunity to be of service to Bird Creek Resources, Inc. If you have any question or if we may be of further assistance in any way, please feel free to call upon us.

Very truly yours,
CORE LABORATORIES, a division of
WESTERN ATLAS INTERNATIONAL, INC.

Richard Hulme

Richard Hulme
Supervisor
Reservoir Fluid Lab

File RFLM 89108

BIRD CREEK RESOURCES, INC.
Carrasco "14" #1
East Loving Delaware Field

Date Sampled: October 20, 1989
Eddy County, New Mexico

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File RFLM 89108
Carrasco "14" #1

FORMATION CHARACTERISTICS

Formation Name	Delaware
Date First Well Completed	July 15, 1989
Original Reservoir Pressure	2892 psig @ 6130 ft.
Original Produced Gas/Liquid Ratio	1071 SCF/Bbl
Production Rate	480 Bbls/Day
Separator Pressure and Temperature	160 psig 61°F.
Liquid Gravity at 60°F.	42.5°API
Datum	3117 ft. Subsea

WELL CHARACTERISTICS

Elevation	3013 ft. KB
Total Depth	6420 ft.
Producing Interval	6086-6190 ft.
Tubing Size and Depth	2.875 In. to 5987 ft.
Open Flow Potential	N/A MMSCF/Day
Last Reservoir Pressure	2892 psig @ 6130 ft.
Date	June 17, 1989
Reservoir Temperature	106°F. @ 6130 ft.
Status of Well	Producing
Pressure Gauge	Amerada bomb

SAMPLING CONDITIONS

Flowing Tubing Pressure	N/A psig
Flowing Bottom Hole Pressure	N/A psig
Primary Separator Pressure	437 psig
Primary Separator Temperature	85°F.
Secondary Separator Pressure	20 psig
Secondary Separator Temperature	74°F.
Field Stock Tank Liquid Gravity	42.5°API @ 60°F.
Primary Separator Gas Production Rate	N/A MSCF/Day
Pressure Base	15.025 psia
Temperature Base	60°F.
Compressibility Factor (Fpv)	1.03975
Gas Gravity (Laboratory)	0.697
Gas Gravity Factor (Fg)	1.19779
Stock Tank Liquid Production Rate @ 60°F.	N/A Bbls/Day
Primary Separator Gas/Stock Tank Liquid Ratio	820 SCF/Bbl

Sampled by Core Laboratories

REMARKS:

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SUMMARY OF RESERVOIR FLUID PVT DATA

Volumetric Data

Bubble point pressure (Pb) at 106°F. = 2858 psig

Thermal expansion of reservoir fluid at
5000 psig = $\frac{\text{V at } 106°\text{F.}}{\text{V at } 72°\text{F.}} = 1.02259$

Compressibility of reservoir fluid at 106°F.
from 4000 psig to 3500 psig = 12.91×10^{-6} V/V/psi
from 3500 psig to 2858 psig = 13.40×10^{-6} V/V/psi

Differential Vaporization Data

Solution gas/oil ratio at 2858 psig and 106°F. = 1108 standard cubic feet of gas at 15.025 psia and 60°F. per barrel of residual oil at 60°F.

Relative oil volume at 2858 psig and 106°F. = 1.543 barrels of oil per barrel of residual oil at 60°F.

Density of reservoir fluid at 2858 psig and 106°F. = 0.6641 gm/cc

Viscosity Data

Viscosity of reservoir fluid at 2858 psig and 106°F. = 0.54 centipoise

Separator Test Data

Separator Conditions	Bo(1)	GOR Rs(2)	Tank Oil Gravity API at 60°F.
437 psig and 74°F. to 20 psig and 74°F. to 0 psig and 74°F.	1.508	1039	43.5

(1) Formation volume factor, barrels of oil at 2858 psig and 106°F. per barrel of stock tank oil at 60°F.
(2) Total solution gas/oil ratio at 2858 psig and 106°F., total standard cubic feet of gas at 15.025 psia and 60°F. per barrel of stock tank oil at 60°F.

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SUMMARY OF QUALITY CONTROL DATA OF SEPARATOR LIQUID SAMPLES

Cylinder Number	Sampling Conditions Pressure, PSIG	Temperature, °F.	Laboratory Bubble point Pressure, PSIG	Temperature, °F.
1*	437	85	392	70
2	437	85	371	70

* Selected for use in study.

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HYDROCARBON ANALYSES OF SEPARATOR PRODUCTS AND CALCULATED WELL STREAM

Component	Separator Liquid, Mol Percent	Separator Gas Mol Percent	Separator Gas GPM (gal/mcf)	Well Stream Mol Percent
Hydrogen Sulfide	0.00	0.00		0.00
Carbon Dioxide	0.12	0.46		0.29
Nitrogen	0.10	3.41		1.73
Methane	8.04	78.41		42.62
Ethane	7.05	11.79	3.216	9.38
Propane	10.21	4.39	1.234	7.35
iso-Butane	2.13	0.37	0.123	1.27
n-Butane	7.18	0.84	0.270	4.06
iso-Pentane	2.35	0.12	0.045	1.25
n-Pentane	3.00	0.12	0.044	1.58
Hexanes	11.45	0.06	0.024	5.85
Heptanes	7.85	0.02	0.009	4.00
Octanes	9.02	0.01	0.005	4.59
Nonanes	5.48	0.00	0.000	2.79
Decanes	4.07	0.00	0.000	2.07
Undecanes	3.21	0.00	0.000	1.63
Dodecanes	2.33	0.00	0.000	1.19
Tridecanes	2.23	0.00	0.000	1.13
Tetradecanes	1.93	0.00	0.000	0.98
Pentadecanes	1.84	0.00	0.000	0.94
Hexadecanes	1.41	0.00	0.000	0.72
Heptadecanes	1.10	0.00	0.000	0.56
Octadecanes	1.26	0.00	0.000	0.64
Nonadecanes	1.20	0.00	0.000	0.61
Eicosanes plus	5.44	0.00	0.000	2.77
	100.00	100.00	4.970	100.00

Properties of Heptanes plus			
API Gravity @ 60°F.	37.2		
Density, Gm/Cc @ 60°F.	0.8382	0.7395	0.838
Molecular Weight	214	105	214

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Calculated separator gas gravity (air=1.000) = 0.697
Calculated gross heating value for separator gas = 1190 BTU per cubic foot of dry gas @ 15.025 psia and 60°F.

Primary separtor gas collected @ 437 psig and 85°F.
Primary separator liquid collected @ 437 psig and 85°F.

Primary separator gas/separator liquid ratio =717 SCF/Bbl @ 85°F.
Primary separator liquid/stock tank liquid ratio = 1.1434 Bbls @ 85°F./Bbl @ 60°F.

PROPERTIES OF SEPARATOR LIQUID HEAVIER FRACTIONS

Component		Mol Percent	Density	API	Mol Weight
C_6	Hexanes plus	59.82	0.8227	40.3	189.
	Heptanes plus	48.37	0.8382	37.2	214.
	Undecanes plus	21.95	0.8795	29.2	338.
	Pentadecanes plus	12.25	0.9028	25.1	475.
	Eicosanes plus	5.44	0.9266	21.1	527.

Sample Molecular Weight = 131.4

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VOLUMETRIC DATA OF RESERVOIR FLUID SAMPLE

Saturation pressure (bubble point pressure) = 2858 PSIG 106°F.

Specific volume at saturation pressure = 0.02412 ft ^{3}/lb @ 106°F.

Thermal expansion @ 5000 PSIG = 1.02259 V @ 106°F./V @ 72°F.

Compressibility @ 106°F.:

From 5000 PSIG to 4500 PSIG = 10.21 x 10^{-6} V/V/PSI

From 4500 PSIG to 4000 PSIG = 11.78 x 10^{-6} V/V/PSI

From 4000 PSIG to 3500 PSIG = 12.91 x 10^{-6} V/V/PSI

From 3500 PSIG to 2858 PSIG = 13.40 x 10^{-6} V/V/PSI

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PRESSURE-VOLUME RELATIONS OF RESERVOIR FLUID AT 106°F.
(Constant Composition Expansion)

Pressure PSIG	Relative Volume(1)	Y Function(2)	Density Gm/cc
5000	0.9742		0.6817
4500	0.9792		0.6782
4000	0.9850		0.6742
3500	0.9914		0.6699
3000	0.9954		0.6672
3100	0.9967		0.6663
3000	0.9981		0.6654
2900	0.9994		0.6645
2858 Pb	1.0000		0.6641
2826	1.0029		
2801	1.0051		
2777	1.0072		
2753	1.0092		
2661	1.0185		
2490	1.0394	3.725	
2289	1.0712	3.471	
2090	1.1134	3.218	
1868	1.1780	2.954	
1658	1.2631	2.726	
1469	1.3691	2.536	
1292	1.5034	2.380	
1137	1.6663	2.242	
1019	1.8284	2.147	
925	1.9901	2.077	
752	2.4114	1.945	
586	3.0572	1.838	
390	4.1816	1.720	

(1) Relative Volume: V/Vsat is barrels at indicated pressure/ barrel at saturation pressure.

(2) $$\text{Y Function} = \frac{(Psat-P)}{(Pabs)(V/Vsat-1)}$$

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DIFFERENTIAL VAPORIZATION AT 106°F

Pressure, psig	Solution Gas/Oil Ratio, Rsd(1)	Relative Oil Volume, Bod(2)	Relative Total Volume(3)	Oil Density, Gm/Cc	Deviation Factor, Z	Gas Formation Volume Factor(4)	Incremental Gas Gravity
2858 Pb	1108	1.543	1.543	0.6641			
2600	1021	1.499	1.574	0.6740	0.773	0.00483	0.715
2350	939	1.458	1.619	0.6833	0.773	0.00535	0.712
2100	859	1.421	1.687	0.6921	0.777	0.00601	0.708
1850	778	1.384	1.790	0.7017	0.788	0.00691	0.706
1600	694	1.348	1.947	0.7107	0.802	0.00812	0.705
1350	612	1.314	2.180	0.7201	0.818	0.00980	0.707
1100	533	1.280	2.539	0.7298	0.838	0.01229	0.711
850	450	1.246	3.149	0.7398	0.859	0.01624	0.719
600	368	1.212	4.321	0.7508	0.887	0.02359	0.735
350	281	1.171	7.256	0.7620	0.922	0.04131	0.785
145	186	1.126	17.273	0.7744	0.962	0.09833	0.947
0	0	1.023		0.7941			1.438

at 60°F = 1.000

Gravity of Residual Oil = 42.5°API @ 60°F.

(1) Cubic feet of gas at 15.025 psia and 60°F. per barrel of residual oil at 60°F.
(2) Barrels of oil at indicated pressure and temperature per barrel of residual oil at 60°F.
(3) Barrels of oil plus liberated gas at indicated pressure and temperature per barrel of residual oil at 60°F.
(4) Cubic feet of gas at indicated pressure and temperature per cubic foot at 15.025 psia and 60°F.

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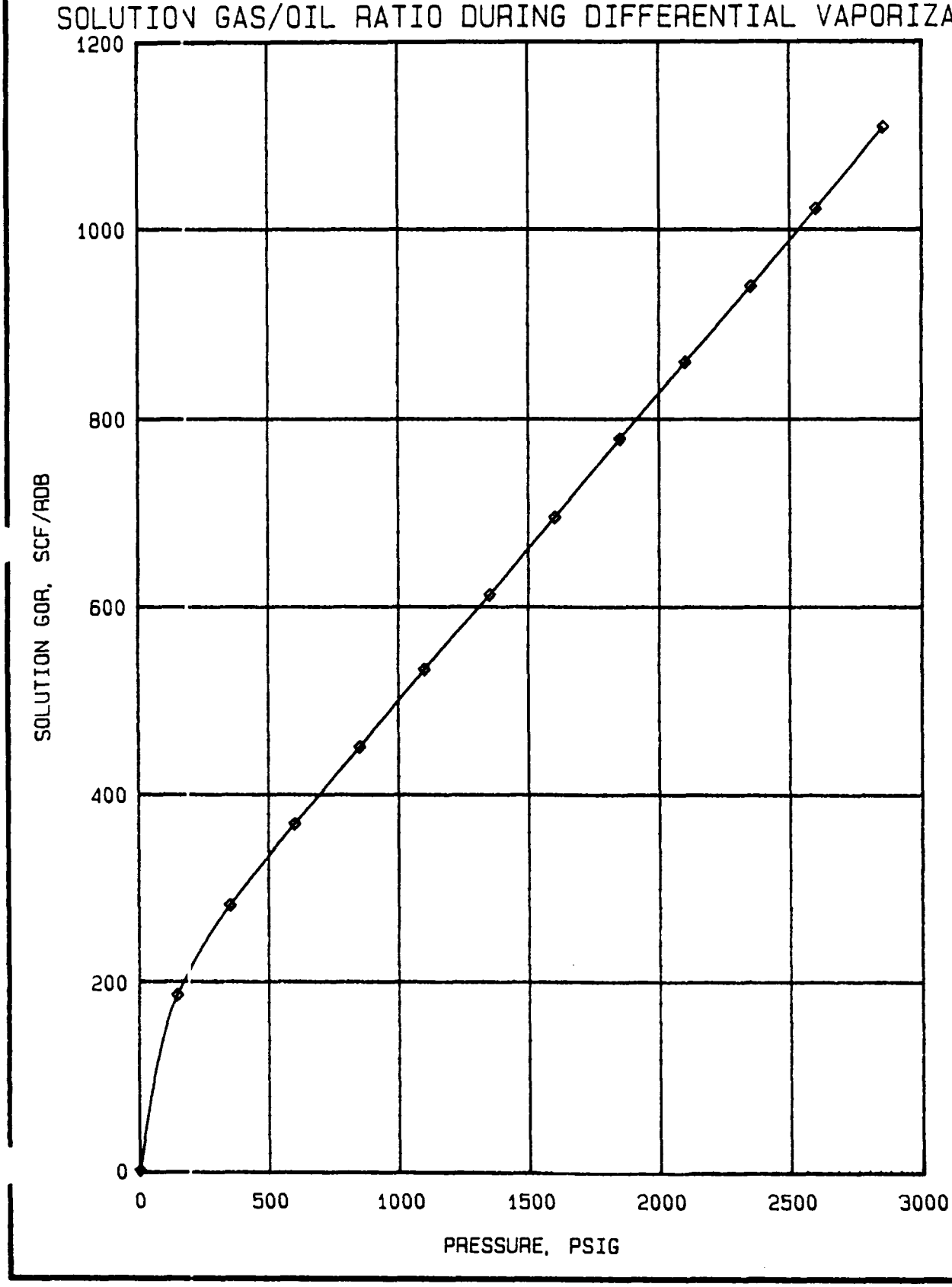
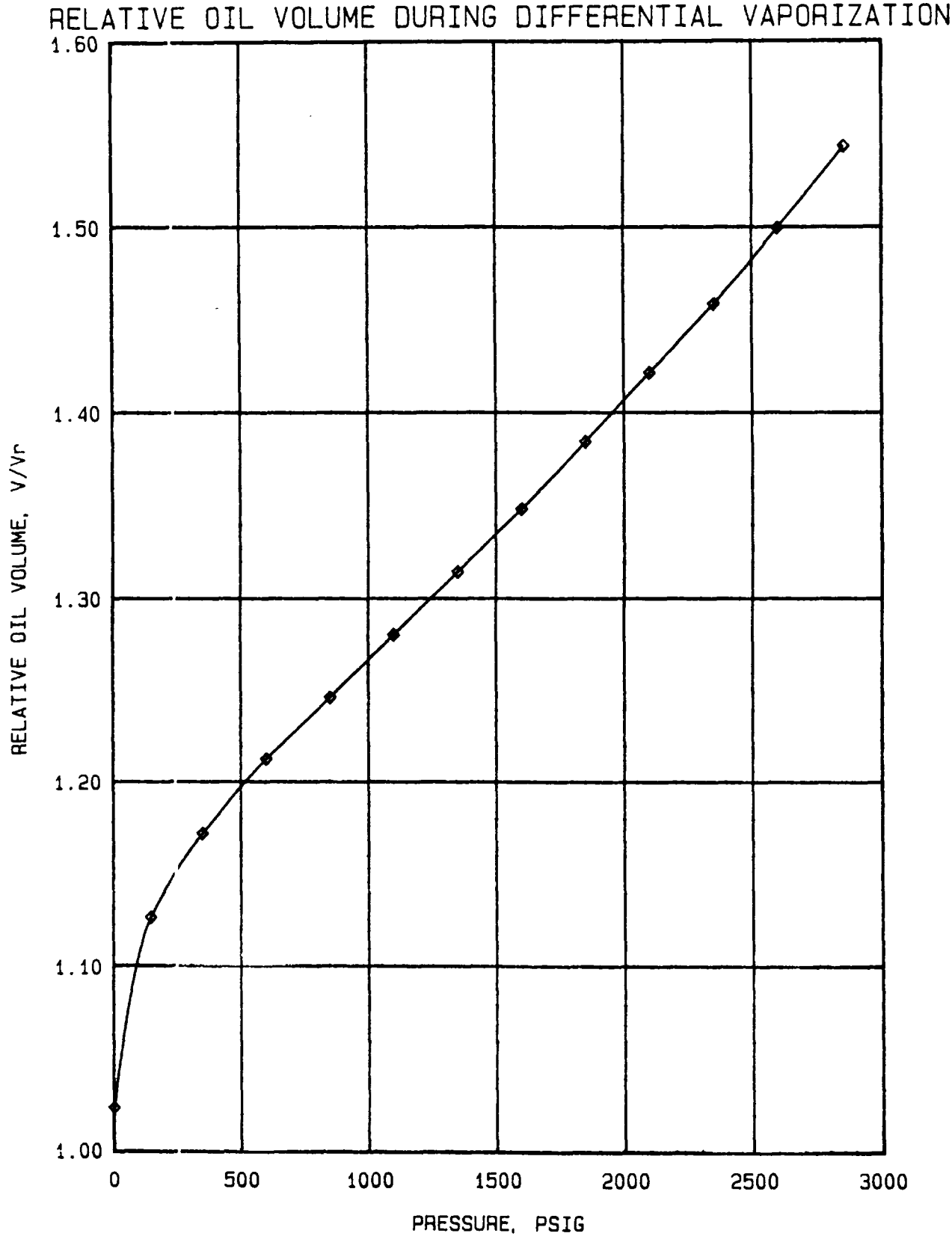

SOLUTION GAS/OIL RATIO DURING DIFFERENTIAL VAPORIZATION
SOLUTION GOR, SCF/RDB
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
PRESSURE, PSIG


RELATIVE OIL VOLUME DURING DIFFERENTIAL VAPORIZATION
1.60
1.50
1.40
1.30
1.20
1.10
1.00
RELATIVE OIL VOLUME, V/Vr
0
500
1000
1500
2000
2500
3000
PRESSURE, PSIG

SEPARATOR TEST OF RESERVOIR FLUID SAMPLE

Separator Pressure, PSI Gauge	Separator Temperature, °F	Gas/Oil Ratio (1)	Gas/Oil Ratio (2)	Stock Tank Gravity, °API @ 60°F	Formation Volume Factor, Bofb(3)	Separator Volume Factor (4)	Specific Gravity of Flashed Gas
437 to 20	74	636	746			1.174	0.698
to 0	74	190	205			1.074	0.965
	74	87	88	43.5	1.508	1.007	1.467
		Rsfb =	1039				

(1) Gas/Oil Ratio in cubic feet of gas @ 60°F. and 15.025 PSI absolute per barrel of oil @ indicated pressure and temperature.
(2) Gas/Oil Ratio in cubic feet of gas @ 60°F. and 15.025 PSI absolute per barrel of stock tank oil @ 60°F.
(3) Formation Volume Factor is barrels of saturated oil @ 2858 PSI gauge and 106°F. per barrel of stock tank oil @ 60°F.
(4) Separator Volume Factor is barrels of oil @ indicated pressure and temperature per barrel of stock tank oil @ 60°F.

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DIFFERENTIAL VAPORIZATION DATA ADJUSTED TO SEPARATOR CONDITIONS*

Pressure, psig	Solution Gas/Oil Ratio, Rs(1)	Formation Volume Factor, Bo(2)	Gas Formation Volume Factor, Bg(3)	Oil Density, gm/cc	Oil/Gas Viscosity Ratio
5000	1039	1.469		0.6817	
4500	1039	1.477		0.6782	
4000	1039	1.485		0.6742	
3500	1039	1.495		0.6699	
3200	1039	1.501		0.6672	
3100	1039	1.503		0.6663	
3000	1039	1.505		0.6654	
2858 Pb	1039	1.508		0.6641	
2600	954	1.465	0.00483	0.6740	26.0
2350	874	1.425	0.00535	0.6833	28.6
2100	796	1.389	0.00601	0.6921	32.2
1850	716	1.353	0.00691	0.7017	36.7
1600	634	1.317	0.00812	0.7107	41.4
1350	554	1.284	0.00980	0.7201	47.3
1100	477	1.251	0.01229	0.7298	53.3
850	396	1.218	0.01624	0.7398	62.0
600	316	1.184	0.02359	0.7508	72.7
350	231	1.144	0.04131	0.7620	87.7
145	138	1.100	0.09833	0.7744	110.6
0	0	1.000		0.7941	301.2

@ 60°F. = 1.000

Gravity of Stock Tank Oil = 43.5°API @ 60°F.

*Separator Conditions: Separator at 437 psig and 74°F., Secondary Separator at 20 psig and 74°F., stock tank at 74°F.

(1) Cubic feet of gas at 15.025 psia and 60°F. per barrel of stock tank oil at 60°F.
(2) Barrels of oil at indicated pressure and 106°F. per barrel of stock tank oil at 60°F.
(3) Cubic feet of gas at indicated pressure and 106°F. per cubic foot at 15.025 psia and 60°F.

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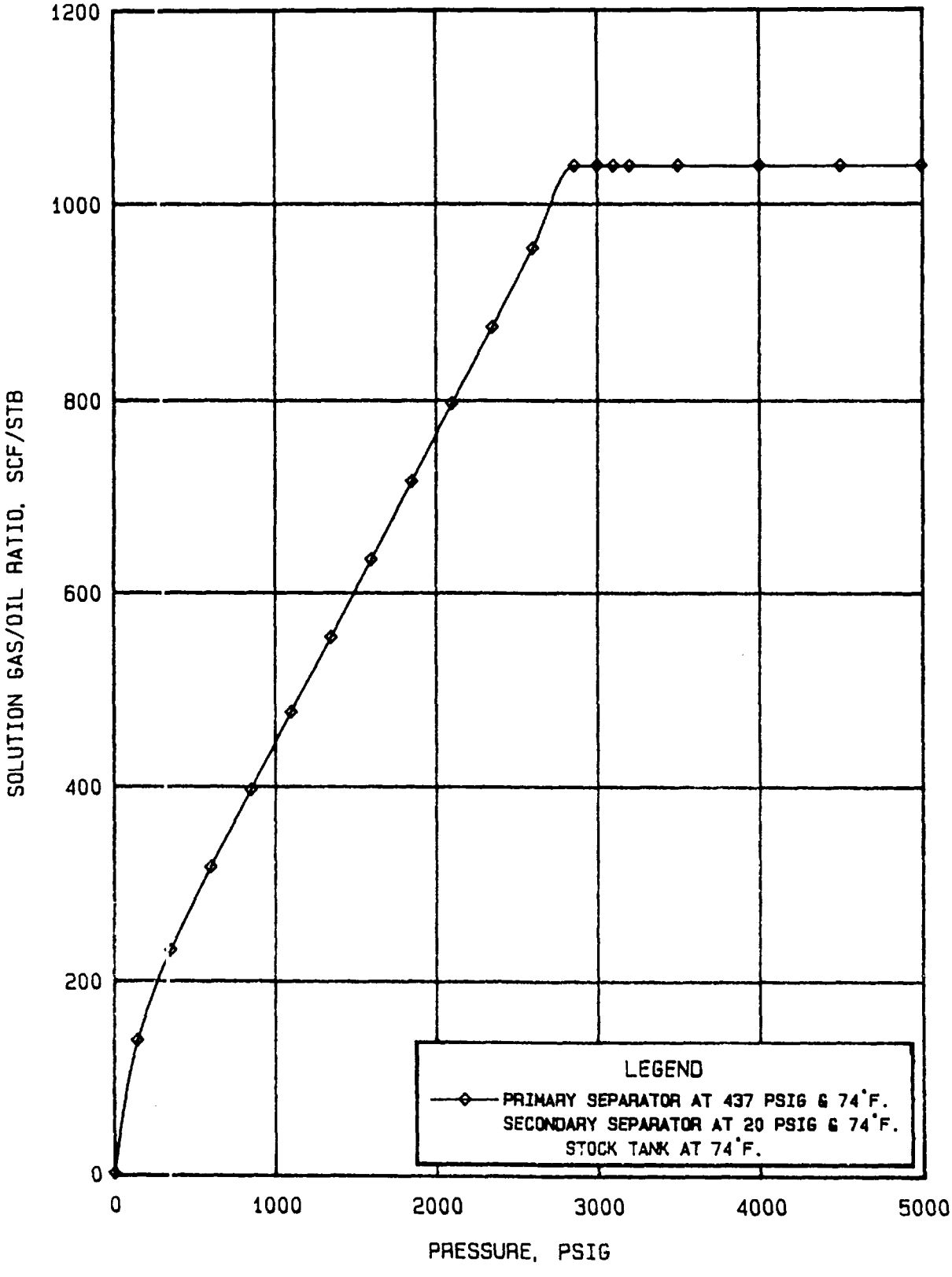
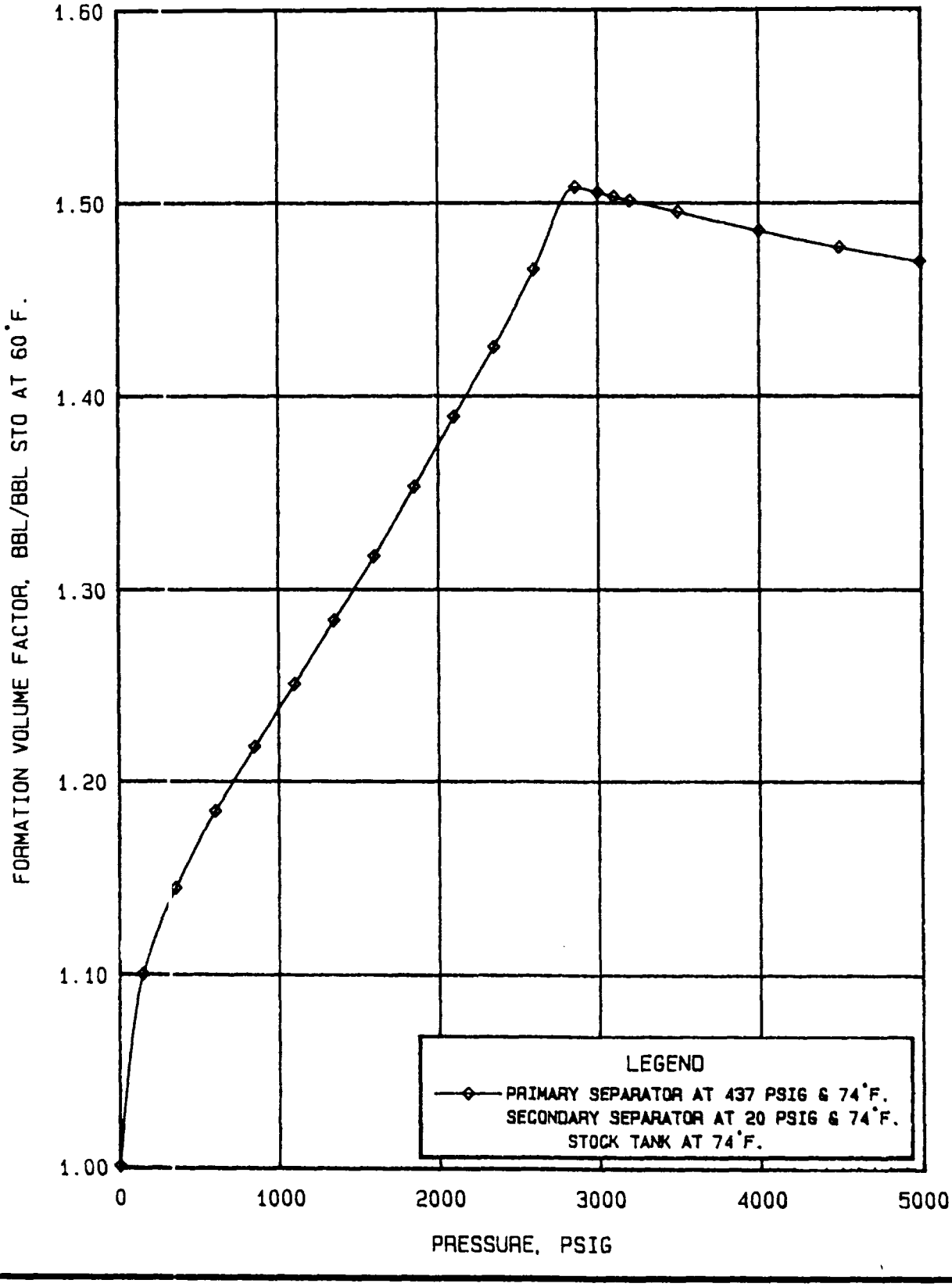
SOLUTION GAS/OIL RATIO
ADJUSTED TO SEPARATOR CONDITIONS



FORMATION VOLUME FACTOR
ADJUSTED TO SEPARATOR CONDITIONS



VISCOSITY DATA AT 106°F

Pressure, psig	Oil Viscosity Centipoise	Calculated Gas Viscosity, Centipoise	Oil/Gas Viscosity Ratio
5000	0.60		
4500	0.59		
4000	0.58		
3500	0.56		
3200	0.55		
3100	0.55		
3000	0.55		
2900	0.55		
2858 Pb	0.54		
2600	0.56	0.0215	26.0
2350	0.57	0.0199	28.6
2100	0.59	0.0183	32.2
1850	0.62	0.0169	36.7
1600	0.65	0.0157	41.4
1350	0.69	0.0146	47.3
1100	0.73	0.0137	53.3
850	0.80	0.0129	62.0
600	0.88	0.0121	72.7
350	1.00	0.0114	87.7
145	1.15	0.0104	110.6
0	2.59	0.0086	301.2

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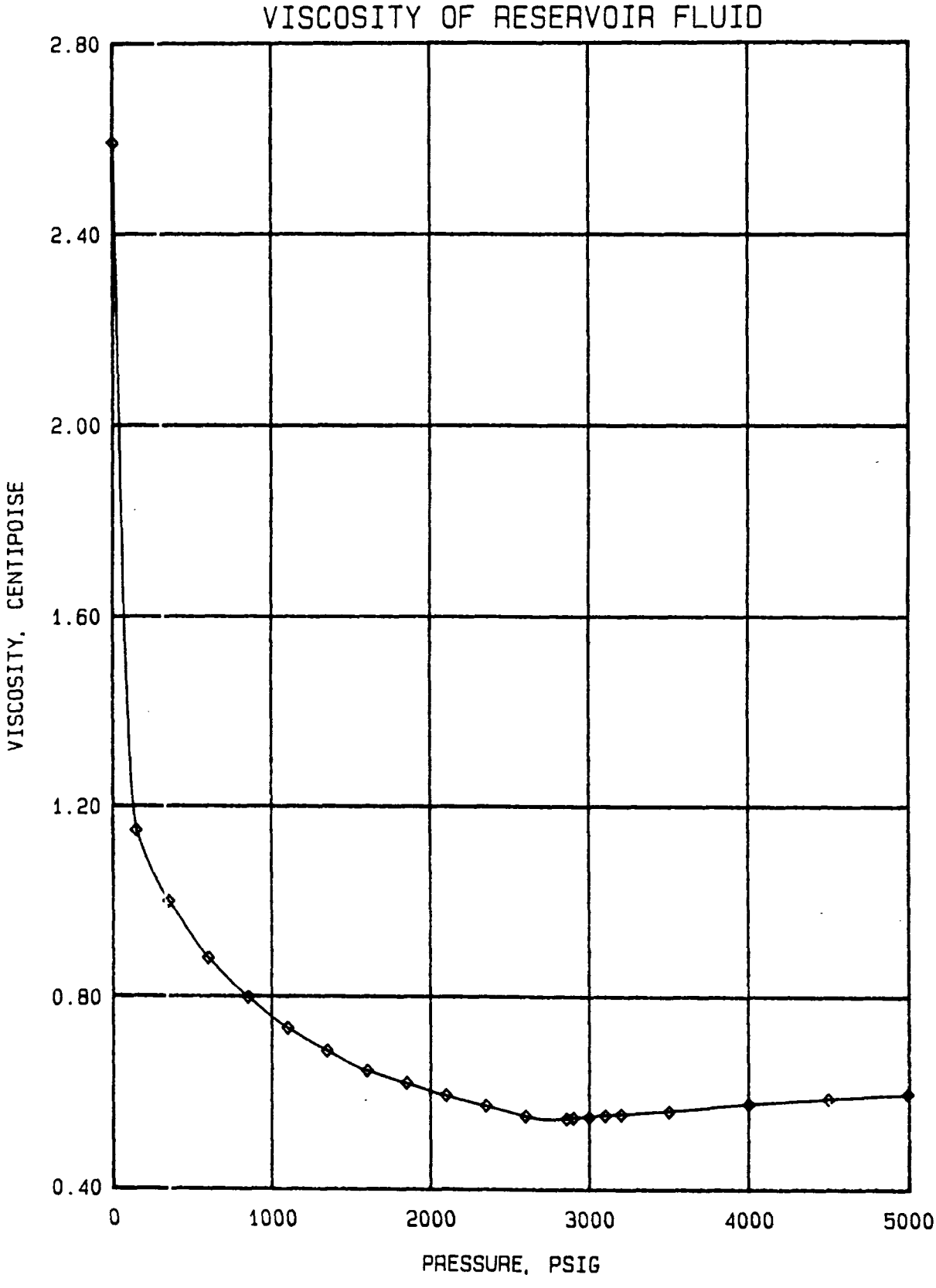
VISCOSITY OF RESERVOIR FLUID
2.80
2.40
2.00
1.60
1.20
0.80
0.40
VISCOSITY, CENTIPOISE
0
1000
2000
3000
4000
5000
PRESSURE, PSIG

NOMENCLATURE AND EQUATIONS TO ADJUST DIFFERENTIAL VAPORIZATION DATA TO SURFACE CONDITIONS

Pb = Bubble point pressure

Bo = Oil formation volume factor

Bofb = Formation volume factor from field conditions (or optimum) separator flash test.

Bob = Relative oil volume from differential vaporization test.

Bodb = Value of Bod at the bubble point pressure.

R.V. = Relative volume from pressure-volume relations test.

For Bo above the bubble point pressure:

$$Bo = R.V. \times Bofb$$

For Bo below the bubble point pressure:

$$Bo = (Bod)(Bofb/Bodb)$$

Rs = Gas in solution, standard cubic feet per barrel of stock tank oil.

Rsfb = Sum of separator gas and the stock tank gas from field conditions (or optimum) separator flash test, standard cubic feet per barrel of stock tank oil.

Rsd = The gas in solution from the differential vaporization test.

Rsdb = The value of Rsd at the bubble point pressure.

$$Rs - Rsfb - [(Rsdb - Rsd)(Bofb/Bodbl)]$$

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Western Atlas International
A Litton Dresser Company

CORE LABORATORIES

October 26, 1990

Oryx Energy Company
Technology Center
P.O. Box 830936
Richardson, TX 75083-0936

Attention: Mr. Robert A. Skopec

Subject: Reservoir Fluid Study
Pardue Farm No. 1 Well
Loving Field
Eddy County, New Mexico
RFL 900381

Gentlemen:

Samples of primary separator gas and liquid were collected from the subject well by a representative of Core Laboratories on September 17, 1990. These samples were shipped to our laboratory in Carrollton, Texas for use in a reservoir fluid study. The results of this study are presented in the following report.

Thank you for the opportunity to perform this study for Orxy Energy Company. Should any questions arise or if we may be of further service in any way, please do not hesitate to contact us.

Sincerely,

James R. Fortner

James R. Fortner
Area Manager
Reservoir Fluid Analysis

JRF:KWK:jlp
6 cc: Addressee

LABORATORY PROCEDURES

Oryx Energy Comapny
Reservoir Fluid Study
Pardue Farm No. 1 Well
Loving Field
Eddy County, New Mexico
RFL 900381

As quality control checks, the laboratory temperature opening pressure of each separator gas and the laboratory temperature bubblepoint of each separator liquid sample were determined. These preliminary data are presented on page three.

In a high pressure, windowed cell, separator gas and liquid were physically recombined to a GOR of 1150 scf/separator barrel. The mixture was then pressurized into single-phase at 5000 psig and 115°F. The sample was expanded to 2375 psig, and the resulting gas cap was removed. This bubblepoint adjusted fluid was then used for the remainder of the testing program. The composition of the reservoir fluid was measured through eicosanes plus by a flash chromatographic procedure. The results of this extended compositional analysis, in terms of both mole percent and weight percent, are presented on page four.

A small quantity of the reservoir fluid was charged to a high pressure windowed cell and thermally expanded to the reservoir temperature of 115°F. During a constant composition expansion at this temperature, the fluid was found to have a bubblepoint pressure at 2375 psig. The results of the pressure-volume relation measurements at reservoir temperature may be found on pages five and six.

When subjected to differential pressure depletion at the reservoir temperature, the fluids evolved a total of 983 cubic feet of gas at 15.025 psia and 60°F per barrel of residual oil at 60°F. The resulting relative oil volume factor was 1.525 barrels of saturated fluid per barrel of residual oil at 60°F. The oil density and the properties of the evolved gases were measured at each point during the differential pressure depletion, and these data are included in the summary of the differential depletion data on page seven.

The viscosity of the reservoir fluid was measured over a wide range of pressures at 115°F in a rolling ball viscosimeter. The viscosity of the fluid was found to vary from a minimum of 0.427 centipoise at the saturation pressure to a maximum of 1.893 centipoises at atmospheric pressure. The results of the viscosity measurements are tabulated on page ten.

Two single-stage separator tests were performed to determine the formation volume factor, gas/oil ratio and stock tank oil gravity. One separator test was performed at field operating conditions and the other at the calculated optimum primary separator pressure and ambient temperature. The data are presented on page 12. The primary separator gas from each test was collected and analyzed through heptanes plus by routine gas chromatography and is presented on page 13. These data were used to adjust the differential vaporization data to surface conditions, and the resulting values are presented on pages 14 and 15.

Company Oryx Energy Company File RFL 900381
Well Pardue Farm No. 1 County Eddy
Field Loving State New Mexico

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The interpretations or opinions contained in this report are based on inferences from electrical or other measurements, and we cannot, and do not guarantee the accuracy or correctness of any interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, cost, damages or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees. These interpretations are also subject to our General Terms and Conditions as set out in our current price schedule.

File RFL 900381

Well Pardue Farm No. 1

WELL INFORMATION

FORMATION CHARACTERISTICS

Formation	Delaware (Brushy Canyon)
Datum	6090 (-3114) ft ss
Date First Well Completed	
Original Reservoir Pressure	psig @ ft
Original Produced Gas/Liquid Ratio	1000 scf/bbl
Production Rate	B/D
Separator Conditions	psig and °F
Stock Tank Liquid Gravity	41 °API @ 60°F

WELL CHARACTERISTICS

Elevation	2976 ft
Total Depth	6200 ft
Producing Interval	6052-6128 ft
Tubing Size and Depth	2-7/8 in. to 6004 ft
Productivity Index	B/D/psi @ B/D
Reservoir Conditions:	
Pressure	2390 psig @ 6072 ft
Date	August 28, 1990
Temperature	115 °F @ 6200 ft
Status of Well	Flowing
Water Cut	None percent

SAMPLING CONDITIONS

Flowing Tubing Pressure	1375 psig
Flowing Bottomhole Pressure	psig @ ft
Primary Separator Conditions	410 psig and 45 °F
Secondary Separator Conditions	psig and °F
Stock Tank Temperature	80 °F
Field Stock Tank Liquid Gravity	41 °API @ 60°F
Primary Separator Gas Production Rate	560 Mscf/D
Standard Conditions	15.025 psia and 60°F
Stock Tank Liquid Production Data	262 B/D @ 80 °F
Primary Separator Gas/Stock Tank Liquid	2137 scf/bbl
Sampled By	Core Laboratories (KWK)
Date Sampled	September 17, 1990

SUMMARY OF RESERVOIR FLUID DATA

Volumetric Data

Bubblepoint pressure (P_b) = 2375 psig at 115°F

Thermal expansion at 5000 psig = $\frac{V \text{ at } 115°F}{V \text{ at } 69°F}$ = 1.02389

Differential Vaporization (DV) Data

Solution gas/oil ratio (R_{sdb}) at bubblepoint = 983 standard cubic feet of gas per barrel of residual oil at 60°F

Relative oil volume (B_{odb}) at bubblepoint = 1.525 barrels of oil per barrel of residual oil at 60°F

Density of reservoir fluid at bubblepoint = 0.6604 gm/cc

Viscosity Data

Viscosity of reservoir fluid at bubblepoint = 0.427 centipoise

Separator Test Data

Separator Conditions	B_{ofb}(1)	R_{sfb}(2)	Tank Oil Gravity, °API at 60°F
410 psig at 45°F	1.525	986	43.9
110 psig at 67°F	1.500	958	44.3

Standard corditions = 15.025 psia and 60°F

(1) Formation volume factor, barrels of oil at bubblepoint per barrel of stock tank oil at 60°F.
(2) Solution gas/oil ratio at bubblepoint, total standard cubic feet of gas per barrel of stock tank oil at 60°F.

SUMMARY OF SAMPLES

Separator Gas

Cylinder Number	Separator Conditions Pressure, psig	Separator Conditions Temperature, °F	Laboratory Opening Conditions Pressure, psig	Laboratory Opening Conditions Temperature, °F
193487D(1)	410	45	385	70
193523D	410	45	385	70

Separator Liquid

Cylinder Number	Separator Conditions Pressure, psig	Separator Conditions Temperature, °F	Laboratory Bubblepoint Pressure, psig	Laboratory Bubblepoint Temperature, °F
2079(1)	410	45	414	69
2068	410	45	364	70

(1) Selected for analysis.

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Well Pardue Farm No. 1

RESERVOIR FLUID COMPOSITION

Component	Mole Percent	Weight Percent	Molecular Weight(1)	Density, gm/cc at 60°F(1)
Hydrogen Sulfide	0.00	0.00	34.080	0.80064
Carbon Dioxide	0.01	0.01	44.010	0.81720
Nitrogen	1.68	0.59	28.013	0.80860
Methane	41.30	8.34	16.043	0.29970
Ethane	9.75	3.69	30.070	0.35584
Propane	8.44	4.69	44.097	0.50648
iso-Butane	1.36	1.00	58.123	0.56231
n-Butane	4.05	2.96	58.123	0.58343
iso-Pentane	1.42	1.29	72.150	0.62408
n-Pentane	1.83	1.66	72.150	0.63049
Hexanes	2.55	2.70	84	0.685
Heptanes	4.05	4.90	96	0.722
Octanes	4.41	5.94	107	0.745
Nonanes	3.07	4.68	121	0.764
Decanes	2.44	4.12	134	0.778
Undecanes	1.88	3.48	147	0.789
Dodecanes	1.42	2.88	161	0.800
Tridecanes	1.41	3.11	175	0.811
Tetradecanes	1.15	2.75	190	0.822
Pentadecanes	1.02	2.65	206	0.832
Hexadecanes	0.80	2.24	222	0.839
Heptadecanes	0.71	2.12	237	0.847
Octadecanes	0.69	2.18	251	0.852
Nonadecanes	0.63	2.09	263	0.857
Eicosanes plus	3.93	29.93	605(2)	0.912(2)
	100.00	100.00		

Properties of Fractions(2)

Heptanes plus	27.61	73.07	210	0.835
Undecanes plus	13.64	53.43	311	0.871
Pentadecanes plus	7.78	41.21	421	0.892
Eicosanes plus	3.93	29.93	605	0.912
Molecular weight			79.40	

(1) Assigned properties taken from literature.
(2) Calculated.

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Well Pardue Farm No. 1

PRESSURE-VOLUME RELATIONS AT 115°F
(Constant Composition Expansion)

Pressure, psig	Relative Volume(1)	Y Function(2)	Density, gm/cc
5000	0.9699		0.6809
4500	0.9747		0.6775
4000	0.9800		0.6739
3500	0.9857		0.6700
3000	0.9918		0.6659
2700	0.9957		0.6633
2600	0.9970		0.6624
2500	0.9983		0.6615
2400	0.9997		0.6606
2375 P_b	1.0000		0.6604
2369	1.0008	3.159	
2363	1.0016	3.153	
2354	1.0028	3.145	
2321	1.0074	3.114	
2285	1.0127	3.080	
2217	1.0235	3.018	
2101	1.0445	2.912	
1918	1.0856	2.762	
1716	1.1475	2.581	
1520	1.2302	2.419	
1343	1.3329	2.283	
1186	1.4584	2.160	
1060	1.5934	2.061	
809	2.0151	1.872	
609	2.6379	1.728	
436	3.6836	1.602	

(1) Volume at indicated pressure per volume at bubblepoint.
(2) Y Function = $(P_b - P)/[(P_{abs})(RV - 1)]$.

COMPRESSIBILITY AT 115°F

From 5000 psig to 4500 psig = 9.97 x 10^{-6} V/V/psi

From 4500 psig to 4000 psig = 10.73 x 10^{-6} V/V/psi

From 4000 psig to 3500 psig = 11.54 x 10^{-6} V/V/psi

From 3500 psig to 3000 psig = 12.27 x 10^{-6} V/V/psi

From 3000 psig to 2500 psig = 13.11 x 10^{-6} V/V/psi

From 2500 psig to 2375 psig = 13.64 x 10^{-6} V/V/psi

DIFFERENTIAL VAPORIZATION AT 115°F

Pressure, psig	Solution Gas/Oil Ratio, R_{sd}(1)	Relative Oil Volume, B_{od}(2)	Relative Total Volume, B_{td}(3)	Oil Density, gm/cc	Deviation Factor Z	Gas Formation Volume Factor(4)	Incremental Gas Gravity
2375 P_b	983	1.525	1.525	0.6604			
2100	878	1.478	1.595	0.6696	0.799	0.00628	0.765
1850	791	1.438	1.687	0.6783	0.818	0.00729	0.722
1600	708	1.401	1.820	0.6871	0.834	0.00858	0.701
1350	626	1.364	2.027	0.6964	0.857	0.01043	0.693
1100	544	1.327	2.350	0.7060	0.878	0.01308	0.697
850	462	1.291	2.897	0.7158	0.901	0.01731	0.713
600	379	1.254	3.945	0.7258	0.926	0.02502	0.748
350	292	1.215	6.554	0.7362	0.953	0.04338	0.808
171	217	1.178	13.072	0.7465	0.976	0.08718	0.928
97	174	1.153	22.207	0.7531	0.985	0.14612	1.111
0	0	1.030		0.7824			1.468
	@ 60°F =	1.000	@ 60°F =	0.8059			

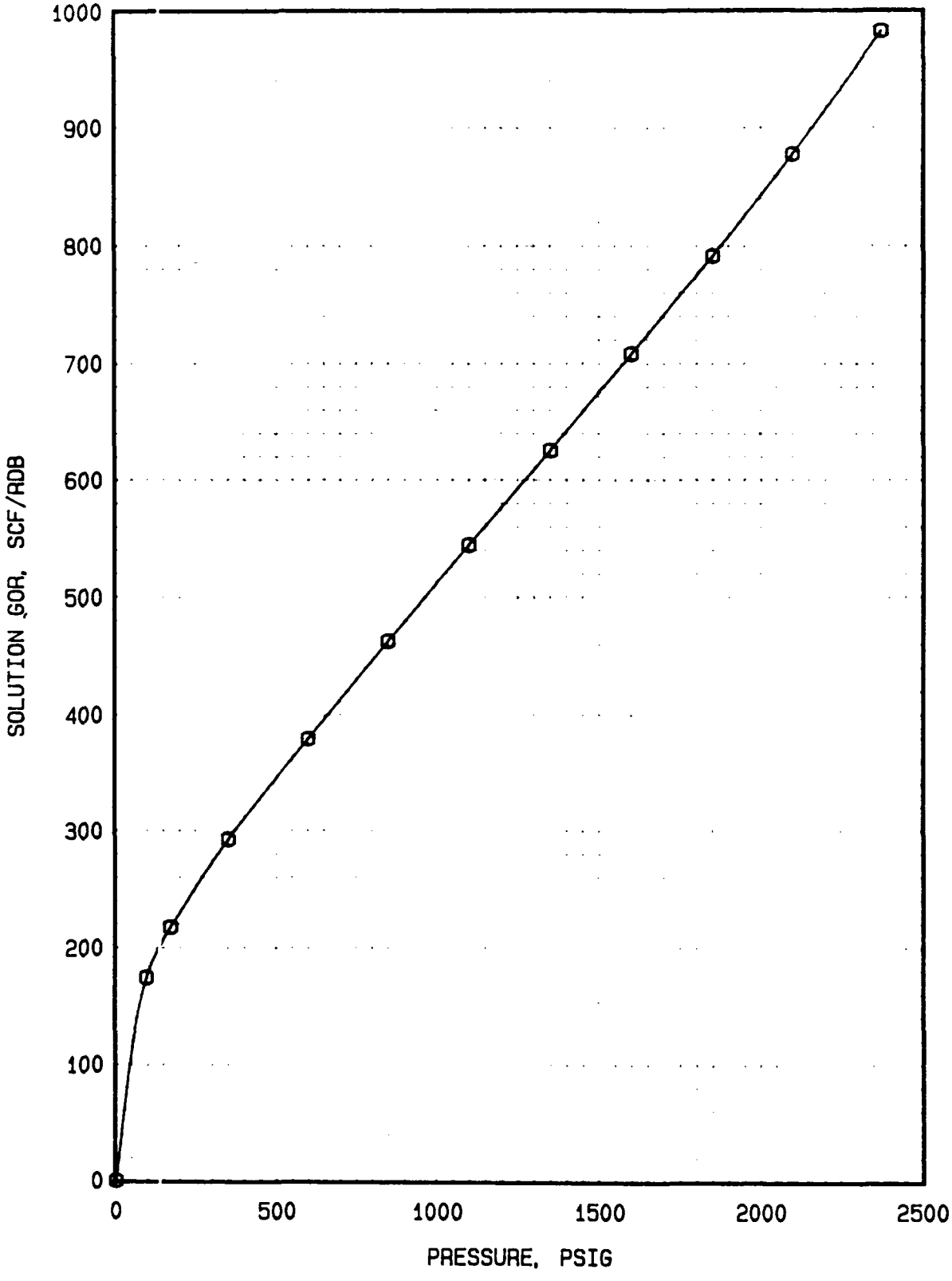
Gravity of residual oil = 43.9°API @ 60°F

Molecular weight of residual oil = 183 gm/mole

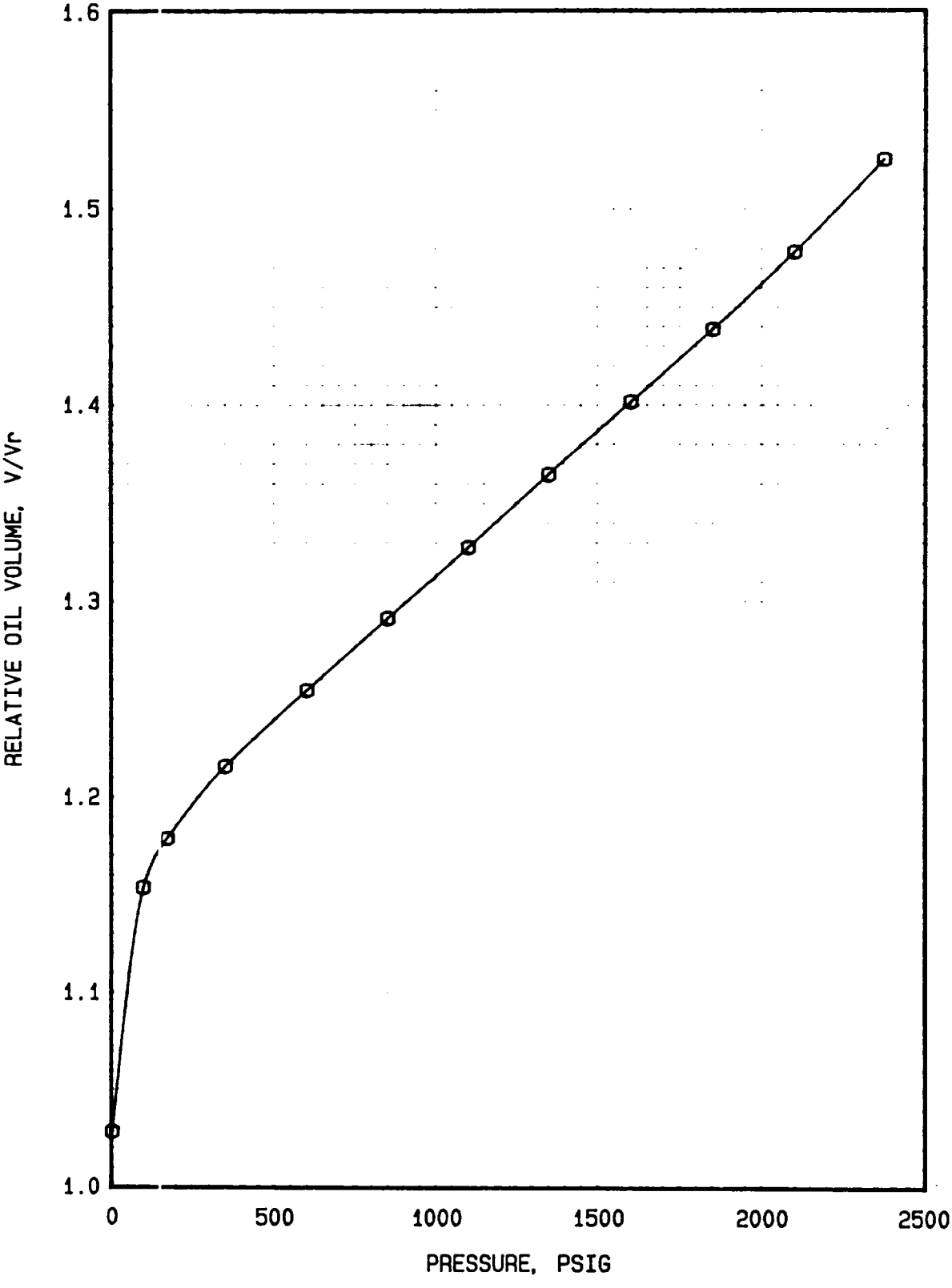
Standard conditions = 15.025 psia and 60°F

(1) Cubic feet of gas per barrel of residual oil at 60°F.
(2) Barrels of oil at indicated pressure per barrel of residual oil at 60°F.
(3) Barrels of oil plus liberated gas at indicated pressure per barrel of residual oil at 60°F.
(4) Cubic feet of gas at indicated pressure per standard cubic foot.

SOLUTION GAS/OIL RATIO
DURING DIFFERENTIAL VAPORIZATION

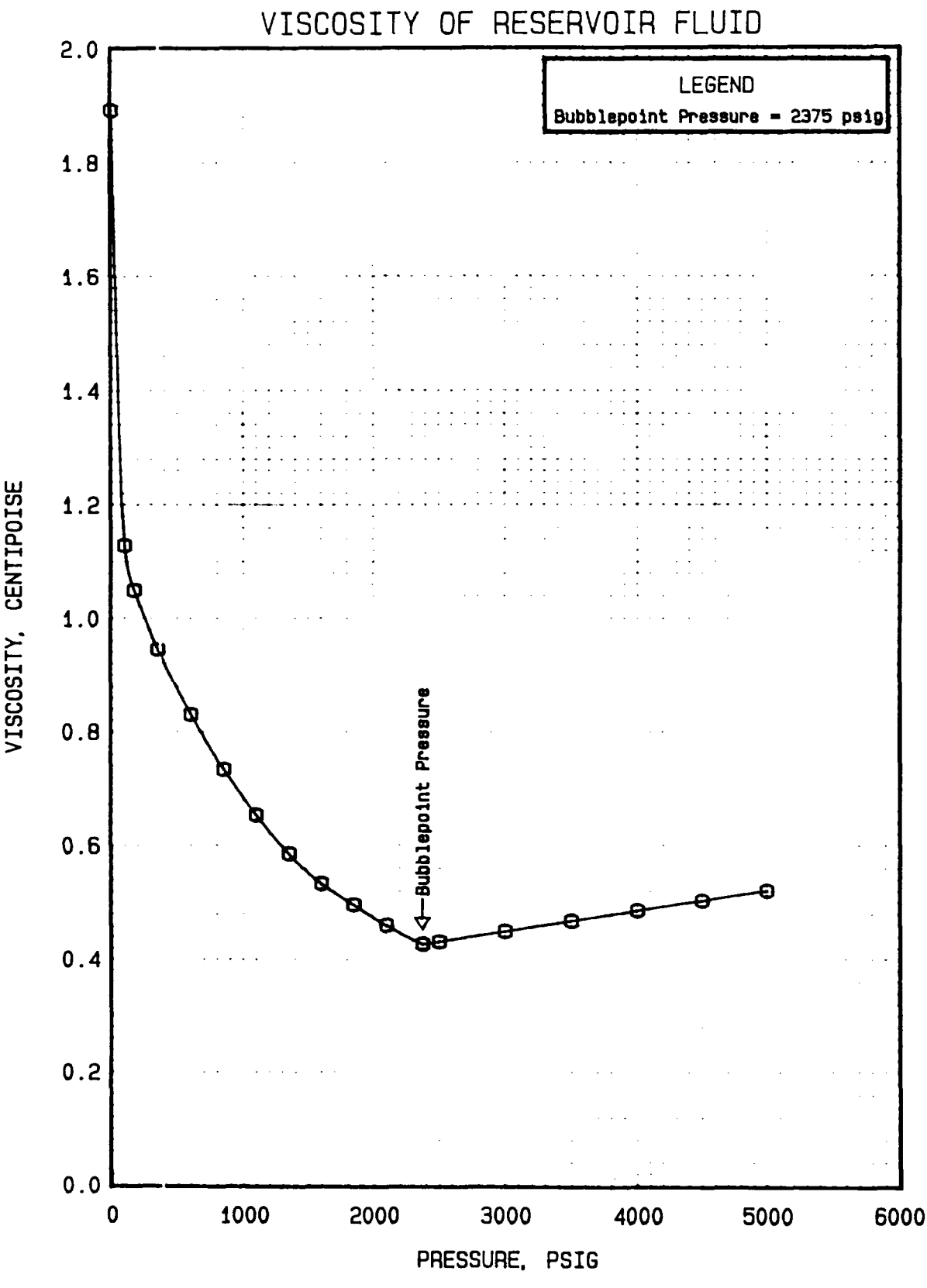


RELATIVE OIL VOLUME
DURING DIFFERENTIAL VAPORIZATION



VISCOSITY AT 115°F

Pressure, psig	Oil Viscosity, centipoise	Gas Viscosity, centipoise	Oil/Gas Viscosity Ratio
5000	0.522		
4500	0.505		
4000	0.484		
3500	0.467		
3000	0.448		
2500	0.431		
2375 P_b	0.427		
2100	0.460	0.0185	24.84
1850	0.496	0.0167	29.70
1600	0.534	0.0155	34.51
1350	0.586	0.0145	40.42
1100	0.654	0.0136	47.90
850	0.735	0.0129	56.98
600	0.831	0.0122	68.11
350	0.945	0.0114	82.89
171	1.050	0.0107	98.13
97	1.129	0.0099	114.04
0	1.893		


VISCOSITY OF RESERVOIR FLUID
LEGEND
Bubblepoint Pressure = 2375 psig
VISCOSITY, CENTIPOISE
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Bubblepoint Pressure
0
1000
2000
3000
4000
5000
6000
PRESSURE, PSIG

SEPARATOR TESTS

Separator Conditions, psig at °F		Gas/Liquid Ratio (1)	Gas/Liquid Ratio (2)	Stock Tank Liquid Gravity, °API at 60°F	Formation Volume Factor B_{ofb}(3)	Separator Volume Factor(4)	Gas Gravity
410 to 0	45	518	621			1.200	0.669*
	68	363	365	43.9	1.525	1.004	1.216
		R_{sfb} =	986				
110 to 0	67	764	827			1.083	0.766*
	69	131	131	44.3	1.500	1.005	1.428
		R_{sfb} =	958				

* Collected and analyzed in the laboratory.

Standard conditions = 15.025 psia and 60°F

(1) Standard cubic feet of gas per barrel of liquid at indicated pressure and temperature.
(2) Standard cubic feet of gas per barrel of stock tank liquid at 60°F.
(3) Barrels of licuid at bubblepoint per barrel of stock tank liquid at 60°F.
(4) Barrels of licuid at indicated pressured and temperature per barrel of stock tank liquid at 60°F.

COMPOSITION OF SEPARATOR TEST GAS SAMPLES

Component	410 psig, 45°F Mole Percent	410 psig, 45°F GPM	110 psig, 67°F Mole Percent	110 psig, 67°F GPM
Hydrogen Sulfide	0.00		0.00	
Carbon Dioxide	0.01		0.05	
Nitrogen	3.96		3.06	
Methane	81.77		71.74	
Ethane	9.64	2.630	13.84	3.701
Propane	3.50	0.984	7.93	2.185
iso-Butane	0.27	0.090	0.76	0.249
n-Butane	0.60	0.193	1.78	0.561
iso-Pentane	0.10	0.037	0.30	0.110
n-Pentane	0.09	0.033	0.30	0.109
Hexanes	0.05	0.020	0.13	0.050
Heptanes plus	0.01	0.005	0.11	0.049
	100.00	3.992	100.00	7.014
Gas gravity (air=1.000):	0.669		0.766	
Gross heating value (Btu per cubic foot of dry gas at 15.025 psia and 60°F):	1149		1291	

DIFFERENTIAL VAPORIZATION AT 115°F ADJUSTED TO SEPARATOR CONDITIONS

Pressure, psig	Gas/Oil Ratio, R_s(1)	Formation Volume Factor, B_o(2)	Oil Density, gm/cc	Gas Formation Volume Factor(3)	Oil/Gas Viscosity Ratio
5000	986	1.479	0.6809		
4500	986	1.486	0.6775		
4000	986	1.495	0.6739		
3500	986	1.503	0.6700		
3000	986	1.512	0.6659		
2500	986	1.522	0.6615		
2375 P_b	986	1.525	0.6604		
2100	881	1.478	0.6696	0.00628	24.84
1850	794	1.438	0.6783	0.00729	29.70
1600	711	1.401	0.6871	0.00858	34.51
1350	629	1.364	0.6964	0.01043	40.42
1100	547	1.327	0.7060	0.01308	47.90
850	465	1.291	0.7158	0.01731	56.98
600	382	1.254	0.7258	0.02502	68.11
350	295	1.215	0.7362	0.04338	82.89
171	220	1.178	0.7465	0.08718	99.13
97	177	1.153	0.7531	0.14612	114.04

Separator Conditions: Primary Separator 410 psig at 45°F
Stock Tank 0 psig at 68°F

Standard conditions = 15.025 psia and 60°F

(1) Standard cubic feet of gas per barrel of stock tank liquid at 60°F.
(2) Barrels of oil per barrel of stock tank liquid at 60°F.
(3) Cubic feet of gas at indicated pressure per standard cubic foot.

File RFL 900381

Well Pardue Farm No. 1

DIFFERENTIAL VAPORIZATION AT 115°F ADJUSTED TO SEPARATOR CONDITIONS

Pressure, psig	Gas/Oil Ratio, R_s(1)	Formation Volume Factor, B_o(2)	Oil Density, gm/cc	Gas Formation Volume Factor(3)	Oil/Gas Viscosity Ratio
5000	958	1.455	0.6809		
4500	958	1.462	0.6775		
4000	958	1.470	0.6739		
3500	958	1.479	0.6700		
3000	958	1.488	0.6659		
2500	958	1.497	0.6615		
2375 P_b	958	1.500	0.6604		
2100	855	1.454	0.6696	0.00628	24.84
1850	769	1.414	0.6783	0.00729	29.70
1600	688	1.378	0.6871	0.00858	34.51
1350	607	1.342	0.6964	0.01043	40.42
1100	526	1.305	0.7060	0.01308	47.90
850	446	1.270	0.7158	0.01731	56.98
600	364	1.233	0.7258	0.02502	68.11
350	278	1.195	0.7362	0.04338	82.89
171	205	1.159	0.7465	0.08718	98.13
97	162	1.134	0.7531	0.14612	114.04

Separator Conditions: Primary Separator 110 psig at 67°F
Stock Tank 0 psig at 69°F

Standard conditions = 15.025 psia and 60°F

(1) Standard cubic feet of gas per barrel of stock tank liquid at 60°F.
(2) Barrels of oil per barrel of stock tank liquid at 60°F.
(3) Cubic feet of gas at indicated pressure per standard cubic foot.

NOMENCLATURE AND EQUATIONS

Symbols

B_o	Barrels at reservoir conditions per barrel of stock tank oil.
B_{od}	Relative oil volume from differential vaporization test.
B_{odb}	B_{od} at bubblepoint pressure.
B_{ofb}	Formation volume factor from separator test.
B_t	Total (two-phase) formation volume factor.
B_{td}	Total formation volume factor from differential vaporization test.
P_{res}	Reservoir pressure.
P_b	Bubblepoint pressure.
R_s	Standard cubic feet of gas per barrel of stock tank oil.
R_{sd}	Solution gas/oil ratio from differential vaporization test.
R_{sdb}	R_{sd} at bubblepoint pressure.
R_{sfb}	Sum of separator and stock tank gas/oil ratios from separator test.
RV	Relative volume from pressure-volume test.

Equations

For B_o at and above the bubblepoint pressure: $B_o = (RV)(B_{ofb})$

For B_o below the bubblepoint pressure: $B_o = (B_{od})(B_{ofb}/B_{odb})$

For R_s: $R_s = R_{sfb} - [(R_{sdb} - R_{sd})(B_{ofb}/B_{odb})]$

For B_t: $B_t = (B_{td})(B_{ofb}/B_{odb})$