

Reservoir Fluid Study
for
Arco Exploration & Production Technology
Brad Berg #1

Reservoir Fluid Study
*
*

Reservoir Fluid Study
*
*

RELEASED TO PUBLIC FILE
DATE 20 NOV 1996

RFL 920279
19-Nov-92

A product of
Core Laboratories
a division of Western Atlas International, Inc.

The analysis, opinions or interpretations contained in this report are based upon observations and material supplied by the client for whose exclusive and confidential use this report has been made. The interpretations or opinions expressed represent the best judgement of Core Laboratories. Core Laboratories assumes no responsibility and makes no warranty or representations, express or implied, as to the productivity, proper operations, or profitability however of any oil, gas, coal or other mineral, property, well or sand in connection with which such report is used or relied upon for any reason whatsoever.



CORE LABORATORIES

November 19, 1992

Arco Exploration and Production Technology
2300 West Plano Parkway
Rm PRC -E1115
Plano, TX 75075

ATTENTION: Mr. Russ Bone

Subject: Reservoir Fluid Study
Well: Brad Berg #1
File: RFL 920279

Dear Mr. Bone,

Multiple samples of separator gas and oil were collected from the subject well by representatives of Arco Exploration and Production Technology. These samples were shipped to our laboratory in Carrollton, Texas for use in a reservoir fluid study. The results of this study are presented on the following pages.

It has been a pleasure to perform this reservoir fluid study for Arco Exploration and Production Technology. Should any questions arise or if we may be of further service in any way, please do not hesitate to contact us.

Sincerely,

Karl W. Karnes
Supervising Engineer
Reservoir Fluid Analysis

KWK

16 cc: Addressee

15 bound & 1 unbound

Laboratory Procedures

Arco Exploration & Production Technology Reservoir Fluid Study Brad Berg #1

RFL 920279

On October 16, 1992, multiple samples of separator gas and oil were received in our Carrollton, Texas laboratory. Bubblepoint determinations of each liquid sample were measured at lab ambient temperature as a quality check. Gas opening pressures were also measured. A summary of samples received in the laboratory may be found on page four.

Each of the six separator gas samples was analyzed by extended gas chromatography to determine gas composition to the last detectable peak. These data are presented on pages five through ten. The compositions of the two separator oil samples were measured through a heptanes plus residual fraction by low temperature fractional distillation. The heptanes plus fractions were further analyzed by gas chromatography through hexatriacontanes plus. The composition and density of the fluids can be found on pages 11 through 16.

A routine quality control check of separator products' compositions is a "K-value" plot of relative component content versus component boiling point. Specifically, the K-value is the mole percent of a particular hydrocarbon component of the gas divided by the mole percent of this component of the separator oil. When the logs of the K-values of methane through hexanes plus nitrogen, carbon dioxide and hydrogen sulfide are plotted against the boiling points of the individual components, the results should yield a smooth line. Additionally, theoretical equilibrium ratios (K-values) can be determined for specific separator conditions and plotted with the measured data. When these plots were made for the above compositional data, the plots did not agree well with the theoretical data. An example of the K-value plots is presented following the separator products' compositions and is designated figure QC-1.

The separator gas was combined with the separator oil to yield a saturation pressure of 3000 psig at 119°F. This recombined reservoir fluid was used for all further analyses. The composition of the reservoir fluid was determined through a heptanes plus residual fraction by low temperature fractional distillation. The heptanes plus fractions were further analyzed by gas chromatography through hexatriacontanes plus. These data are presented on pages 17 through 19.

A portion of the reservoir fluid was charged to a high pressure, windowed cell heated to the reported reservoir temperature of 119°F. During the constant composition expansion at this temperature, a bubblepoint was observed at 3019 psig. The results of the pressure-volume relations are presented on pages 20 and 21.

During the differential vaporization at the reservoir temperature, the fluid evolved a total of 612 cubic feet of gas at 14.65 psia and 60°F per barrel of residual oil at 60°F. The resulting relative oil volume factor was 1.272 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 the data included in the summary of the differential vaporization data on page 22.

Arco Exploration & Production Technology
Brad Berg #1
RFL 920279

The viscosity of the reservoir fluid was measured over a wide range of pressures at 119°F in a rolling ball viscosimeter. The viscosity of the fluid was found to vary from a minimum of 1.014 centipoises at the saturation pressure to a maximum of 3.623 centipoises at atmospheric pressure. The results of the viscosity measurements are presented on page 23.

Small portions of the reservoir fluid were subjected to two two-stage and one three-stage separator tests to determine gas/oil ratio, stock tank oil gravity and formation volume factor. These data can be found on page 24. The gases and stock tank oil evolved from the "base case" separator test were collected and analyzed. These compositions are presented on pages 25 through 28. The separator test data were used to adjust the differential vaporization data to surface conditions and are summarized on pages 30 and 32.

A large portion of reservoir fluid was charged to a PVT cell at 119°F. From this sample three gas depleted oils were prepared at specified saturation pressures. A separator test was performed on the individual "DV" oils at the same conditions as the "base case" multi-stage separator test investigated above. The results of these analyses are presented on page 29.

Equations and nomenclature are included in the appendix of the report which extend and define the analytical expressions and data relationships presented in the study.

TABLE OF CONTENTS

	<i>pg</i>
<i>Laboratory Procedures</i>	<i>i</i>
<i>Summary of PVT Data</i>	<i>1</i>
<i>General Well Information</i>	<i>2,3</i>
<i>Preliminary Quality Checks</i>	<i>4</i>
<i>Separator Gas Composition</i>	<i>5-10</i>
<i>Separator Oil Composition</i>	<i>11-16</i>
<i>Reservoir Fluid Composition</i>	<i>17-19</i>
<i>Pressure-Volume Relations</i>	<i>20,21</i>
<i>Differential Vaporization</i>	<i>22</i>
<i>Viscosity of Reservoir Fluid</i>	<i>23</i>
<i>Separator Flash Analysis</i>	<i>24,29</i>
<i>Separator Test Gas Compositions</i>	<i>25-27</i>
<i>Stock Tank Oil Composition</i>	<i>28</i>
<i>Differential Vaporization adjusted to Separator Conditions</i>	<i>30-32</i>
<i>Equations and Nomenclature</i>	<i>Appendix</i>

LIST OF FIGURES

fig

Quality Control Check

<i>K-value Plot</i>	<i>QC-1</i>
---------------------	-------	-------------

Pressure-Volume Relations

<i>Relative Volume</i>	<i>A-1</i>
------------------------	-------	------------

<i>Y-Function</i>	<i>A-2</i>
-------------------	-------	------------

Differential Vaporization

<i>Relative Oil Volume</i>	<i>B-1</i>
----------------------------	-------	------------

<i>Solution Gas/Oil Ratio</i>	<i>B-2</i>
-------------------------------	-------	------------

<i>Oil Density</i>	<i>B-3</i>
--------------------	-------	------------

<i>Incremental Gas Gravity</i>	<i>B-4</i>
--------------------------------	-------	------------

<i>Deviation Factor, Z</i>	<i>B-5</i>
----------------------------	-------	------------

Viscosity Analysis

<i>Viscosity below Saturation Pressure</i>	<i>C-1</i>
--	-------	------------

<i>Single-Phase Oil Viscosity</i>	<i>C-2</i>
-----------------------------------	-------	------------

Differential Vaporization Adjusted to Separator Conditions

<i>Solution Gas/Oil Ratio</i>	<i>D-1</i>
-------------------------------	-------	------------

<i>Formation Volume Factor</i>	<i>D-2</i>
--------------------------------	-------	------------

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

SUMMARY OF PVT DATA

Reservoir Conditions

Current Reservoir Pressure	3000	psig
Reservoir Temperature	119	°F

Pressure-Volume Relations

Saturation Pressure	3019	psig
Avg Single-Phase Compressibility	8.08	E-6 v/v/psi (5000 to 3019 psig)
Thermal Exp @ 5000 psig	1.02791	V at 119 °F / V at 70 °F

Differential Vaporization Data

(at 3019 psig and 119 °F)

Solution Gas/Oil Ratio	612	scf / bbl of residual oil at 60 °F
Relative Oil Volume	1.272	bbl / bbl of residual oil at 60 °F
Density of Reservoir Fluid	0.7448	gm/cc

Reservoir Fluid Viscosity

1.01 cp at 3019 psig and 119 °F

Separator Test Data

Separator Conditions		Formation Volume Factor (A)	Total Solution Gas/Oil Ratio (B)	Tank Oil Gravity (°API at 60 °F)
psig	°F			
100	90	1.276	625	34.1
100	140	1.284	632	34.0
500	90	1.260	593	34.6

(A) Barrels of oil at 3019 psig and 119 °F per barrel of stock tank oil at 60 °F.

(B) Total standard cubic feet of gas per barrel of stock tank oil at 60 °F.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

General Well Information

Company.....	Arco Exploration & Production Technology
Well Name.....	Brad Berg #1
API Well Number.....	*
File Number.....	RFL 920279
Date Sample Collected.....	*
Sample Type.....	Separator
Geographical Location.....	*
Field.....	*

Well Description

Formation.....	*	
Pool (or Zone).....	*	
Date Completed.....	*	
Elevation.....	*	ft
Producing Interval.....	*	ft
Total Depth.....	*	ft
Tubing Size.....	*	in
Tubing Depth.....	*	ft
Casing Size.....	*	in
Casing Depth.....	*	ft

Pressure Survey Data

Data from Original Discovery Well

Date	*	
Reservoir Pressure	*	psig

Data at Sample Collection

Date.....	*	
Reservoir Pressure.....	3000	psig
Reservoir Temperature.....	119	°F
Pressure Tool.....	*	
Flowing Bottom-Hole Pressure.....	*	psig
Flowing Tubing Pressure.....	*	psig

* Data not forwarded to Core Laboratories.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Production Data

Data from Original Discovery Well

Location.....	*	
Date.....	*	
Oil Gravity @ STP.....	*	°API
Separator Pressure.....	*	psig
Separator Temperature.....	*	°F
Production Rates		
Gas.....	*	Mscf/D
Liquid.....	*	STbbl/D
Gas/Liquid Ratio.....	*	scf/bbl

Separator Conditions

Primary Separator Pressure.....	*	psig
Primary Separator Temperature.....	*	°F
Secondary Separator Pressure.....	*	psig
Secondary Separator Temperature.....	*	°F
Primary Separator Gas Production Rate.....	*	Mscf/D

Gas Factors -

Field Values:

Pressure Base.....	*	psia
Temperature Base.....	*	°F
Compressibility Factor (Fpv).....	*	
Gas Gravity Factor (Fg).....	*	

Laboratory Values:

Pressure Base.....	14.65	psia
Temperature Base.....	60	°F
Compressibility Factor (Fpv).....		
Gas Gravity Factor (Fg).....		

Primary Separator Liquid Rate.....	*	bbl/D	at	°F
Stock Tank Liquid Rate.....	*	bbl/D	at	°F
Separator Gas / Separator Liquid Ratio.....	*	scf/bbl		
Separator Gas / Stock Tank Liquid Ratio.....	*	scf/bbl		
Stock Tank Liquid / Separator Gas Ratio.....	*	bbl/Mscf		
Separator Liquid / Stock Tank Liquid Ratio.....	*	bbl/bbl	at	°F

* Data not forwarded to Core Laboratories.

Arco Exploration & Production Technology**Brad Berg #1**

RFL 920279

**PRELIMINARY QUALITY CHECKS PERFORMED ON SAMPLES
RECEIVED IN LABORATORY**

Separator Gas					
Cylinder Number	Sampling Conditions		Laboratory Opening Conditions		
	psig	°F	psig	°F	Liquid Recovered (cc)
257903D	127	106	125	71	2
349859C	127	106	135	71	2
349869D*	127	106	127	71	2
8EK080	127	106	125	71	2
G20033	127	106	125	71	1
CLH478	127	106	125	71	0

Separator Oil					
Cylinder Number	Sampling Conditions		Laboratory Bubblepoint		Water Recovered (cc)
	psig	°F	psig	°F	
193471D*	127	106	98	71	3
W3A8814	127	106	61	69	2

* Sample selected for recombination.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Separator Gas

(From Chromatographic Technique)

Component	Mol %	GPM	MW	Liq Dens (gm/cc)
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.41		44.010	.8172
Nitrogen	0.24		28.013	.8086
Methane	82.30		16.043	.2997
Ethane	5.67	1.508	30.070	.3558
Propane	5.17	1.417	44.097	.5065
iso-Butane	1.43	.465	58.123	.5623
n-Butane	1.93	.605	58.123	.5834
iso-Pentane	0.88	.320	72.150	.6241
n-Pentane	0.51	.184	72.150	.6305
Hexanes	0.58	.224	84.000	.6850
Heptanes	0.47	.197	96.000	.7220
Octanes	0.29	.131	107.00	.7450
Nonanes	0.09	.045	121.00	.7640
Decanes plus	0.03	.017	141.00	.7840
Totals	100.00	5.113		

Sampling Conditions

125 psig

106 °F

Sample Characteristics

Cylinder No. 257903D

Critical Pressure (psia) 644.2

Critical Temperature (°R) 376.3

Average Molecular Weight 21.79

Calculated Gas Gravity (air = 1.000) 0.752

Gas Gravity

Factor, Fg 1.1528

Super Compressibility Factor, Fpv

at sampling conditions 1.0091

Gas Z-Factor

at sampling conditions * 0.982

at 14.65 psia and 60 °F

Gross Heating Value

(BTU/scf dry gas) 1299

Air Content, mol %

Air Oxygen 0.20

Air Nitrogen 0.72

Total Air Content 0.92

Properties of Plus Fractions

Component	Mol %	MW	Liq Dens (gm/cc)	API Gravity
Heptanes plus	0.88	103.7	0.736	44.6
Decanes plus	0.03	141.0	0.784	38.3

* From: Standing, M.B., "Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems", SPE (Dallas), 1977, 8th Edition, Appendix II.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Separator Gas

(From Chromatographic Technique)

Component	Mol %	GPM	MW	Liq Dens (gm/cc)
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.43		44.010	.8172
Nitrogen	0.13		28.013	.8086
Methane	81.03		16.043	.2997
Ethane	5.86	1.559	30.070	.3558
Propane	5.50	1.507	44.097	.5065
iso-Butane	1.55	.504	58.123	.5623
n-Butane	2.24	.702	58.123	.5834
iso-Pentane	1.07	.389	72.150	.6241
n-Pentane	0.62	.223	72.150	.6305
Hexanes	0.68	.262	84.000	.6850
Heptanes	0.48	.201	96.000	.7220
Octanes	0.25	.113	107.00	.7450
Nonanes	0.10	.050	121.00	.7640
Decanes	0.06	.033	134.00	.7780
Undecanes plus	0.00			
Totals	100.00	5.543		

Sampling Conditions

125 psig

106 °F

Sample Characteristics

Cylinder No. 349859C

Critical Pressure (psia) 641.1

Critical Temperature (°R) 378.3

Average Molecular Weight 22.34

Calculated Gas Gravity (air = 1.000) 0.771

Gas Gravity

Factor, Fg 1.1387

Super Compressibility Factor, Fpv

at sampling conditions 1.0093

Gas Z-Factor

at sampling conditions * 0.982

at 14.65 psia and 60 °F

Gross Heating Value

(BTU/scf dry gas) 1330

Air Content, mol %

Air Oxygen 0.11

Air Nitrogen 0.40

Total Air Content 0.52

Properties of Plus Fractions

Component	Mol %	MW	Liq Dens (gm/cc)	API Gravity
Heptanes plus	0.89	104.5	0.737	44.5
Decanes plus	0.06	134.0	0.778	39.1

* From: Standing, M.B., "Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems", SPE (Dallas), 1977, 8th Edition, Appendix II.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Separator Gas

(From Chromatographic Technique)

Component	Mol %	GPM	MW	Liq Dens (gm/cc)
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.43		44.010	.8172
Nitrogen	0.14		28.013	.8086
Methane	81.53		16.043	.2997
Ethane	5.81	1.545	30.070	.3558
Propane	5.33	1.461	44.097	.5065
iso-Butane	1.47	.478	58.123	.5623
n-Butane	2.07	.649	58.123	.5834
iso-Pentane	0.97	.353	72.150	.6241
n-Pentane	0.56	.202	72.150	.6305
Hexanes	0.66	.255	84.000	.6850
Heptanes	0.54	.226	96.000	.7220
Octanes	0.37	.167	107.00	.7450
Nonanes	0.10	.050	121.00	.7640
Decanes	0.02	.011	134.00	.7780
Undecanes plus	Trace			
Totals	100.00	5.397		

Sampling Conditions

127 psig

106 °F

Sample Characteristics

Cylinder No. 349869D

Critical Pressure (psia) 641.6

Critical Temperature (°R) 376.7

Average Molecular Weight 22.18

Calculated Gas Gravity (air = 1.000) 0.766

Gas Gravity

Factor, Fg 1.1426

Super Compressibility Factor, Fpv

at sampling conditions 1.0093

Gas Z-Factor

at sampling conditions * 0.982

at 14.65 psia and 60 °F

Gross Heating Value

(BTU/scf dry gas) 1321

Air Content, mol %

Air Oxygen 0.20

Air Nitrogen 0.72

Total Air Content 0.92

Properties of Plus Fractions

Component	Mol %	MW	Liq Dens (gm/cc)	API Gravity
Heptanes plus	1.03	103.1	0.735	44.8
Decanes plus	0.02	134.0	0.779	39.0

* From: Standing, M.B., "Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems", SPE (Dallas), 1977, 8th Edition, Appendix II.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Separator Gas

(From Chromatographic Technique)

Component	Mol %	GPM	MW	Liq Dens (gm/cc)
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.43		44.010	.8172
Nitrogen	0.13		28.013	.8086
Methane	81.39		16.043	.2997
Ethane	5.68	1.511	30.070	.3558
Propane	5.28	1.447	44.097	.5065
iso-Butane	1.47	.478	58.123	.5623
n-Butane	2.04	.640	58.123	.5834
iso-Pentane	1.02	.371	72.150	.6241
n-Pentane	0.60	.216	72.150	.6305
Hexanes	0.73	.282	84.000	.6850
Heptanes	0.59	.247	96.000	.7220
Octanes	0.38	.172	107.00	.7450
Nonanes	0.12	.060	121.00	.7640
Decanes	0.09	.049	134.00	.7780
Undecanes plus	0.05	.030	154.00	.7950
Totals	100.00	5.503		

Sampling Conditions

127 psig

106 °F

Sample Characteristics

Cylinder No. 8EK080

Critical Pressure (psia) 639.3

Critical Temperature (°R) 374.9

Average Molecular Weight 22.46

Calculated Gas Gravity (air = 1.000) 0.775

Gas Gravity

Factor, Fg 1.1356

Super Compressibility Factor, Fpv

at sampling conditions 1.0092

Gas Z-Factor

at sampling conditions * 0.982

at 14.65 psia and 60 °F

Gross Heating Value

(BTU/scf dry gas) 1336

Air Content, mol %

Air Oxygen 0.00

Air Nitrogen 0.00

Total Air Content 0.00

Properties of Plus Fractions

Component	Mol %	MW	Liq Dens (gm/cc)	API Gravity
Heptanes plus	1.23	107.0	0.740	44.1
Decanes plus	0.14	141.1	0.784	38.3
Undecanes plus	0.05	154.0	0.795	36.9

* From: Standing, M.B., "Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems", SPE (Dallas), 1977, 8th Edition, Appendix II.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Separator Gas

(From Chromatographic Technique)

Component	Mol %	GPM	MW	Liq Dens (gm/cc)
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.40		44.010	.8172
Nitrogen	0.25		28.013	.8086
Methane	82.65		16.043	.2997
Ethane	5.73	1.524	30.070	.3558
Propane	5.21	1.428	44.097	.5065
iso-Butane	1.39	.452	58.123	.5623
n-Butane	1.87	.586	58.123	.5834
iso-Pentane	0.85	.309	72.150	.6241
n-Pentane	0.49	.176	72.150	.6305
Hexanes	0.51	.197	84.000	.6850
Heptanes	0.36	.151	96.000	.7220
Octanes	0.21	.095	107.00	.7450
Nonanes	0.07	.035	121.00	.7640
Decanes plus	0.01	.006	141.00	.7840
Totals	100.00	4.959		

Sampling Conditions

125 psig

106 °F

Sample Characteristics

Cylinder No. G20033

Critical Pressure (psia) 646.6

Critical Temperature (°R) 377.3

Average Molecular Weight 21.49

Calculated Gas Gravity (air = 1.000) 0.742

Gas Gravity

Factor, Fg 1.1610

Super Compressibility Factor, Fpv

at sampling conditions 1.0091

Gas Z-Factor

at sampling conditions * 0.982

at 14.65 psia and 60 °F

Gross Heating Value

(BTU/scf dry gas) 1283

Air Content, mol %

Air Oxygen 0.10

Air Nitrogen 0.37

Total Air Content 0.47

Properties of Plus Fractions

Component	Mol %	MW	Liq Dens (gm/cc)	API Gravity
Heptanes plus	0.65	102.9	0.735	44.8
Decanes plus	0.01	141.0	0.784	38.3

* From: Standing, M.B., "Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems", SPE (Dallas), 1977, 8th Edition, Appendix II.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Separator Gas

(From Chromatographic Technique)

Component	Mol %	GPM	MW	Liq Dens (gm/cc)
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.48		44.010	.8172
Nitrogen	0.12		28.013	.8086
Methane	78.87		16.043	.2997
Ethane	5.49	1.460	30.070	.3558
Propane	5.48	1.502	44.097	.5065
iso-Butane	1.62	.527	58.123	.5623
n-Butane	2.41	.756	58.123	.5834
iso-Pentane	1.28	.466	72.150	.6241
n-Pentane	0.80	.288	72.150	.6305
Hexanes	1.27	.490	84.000	.6850
Heptanes	1.47	.615	96.000	.7220
Octanes	0.53	.240	107.00	.7450
Nonanes	0.11	.055	121.00	.7640
Decanes plus	0.07	.040	141.00	.7840
Totals	100.00	6.439		

Sampling Conditions

125 psig

106 °F

Sample Characteristics

Cylinder No. CLH478

Critical Pressure (psia) 625.8

Critical Temperature (°R) 370.8

Average Molecular Weight 24.09

Calculated Gas Gravity (air = 1.000) 0.832

Gas Gravity

Factor, Fg 1.0966

Super Compressibility Factor, Fpv

at sampling conditions 1.0089

Gas Z-Factor

at sampling conditions * 0.982

at 14.65 psia and 60 °F

Gross Heating Value

(BTU/scf dry gas) 1421

Air Content, mol %

Air Oxygen 0.01

Air Nitrogen 0.04

Total Air Content 0.06

Properties of Plus Fractions

Component	Mol %	MW	Liq Dens (gm/cc)	API Gravity
Heptanes plus	2.18	101.4	0.732	45.1
Decanes plus	0.07	141.0	0.784	38.3

* From: Standing, M.B., "Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems", SPE (Dallas), 1977, 8th Edition, Appendix II.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Separator Oil*

Component	Mol %	Wt %	MW	Liq Dens (gm/cc)
Hydrogen	0.00			
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.05	0.010	44.010	0.8172
Nitrogen	0.00			
Methane	2.34	0.180	16.043	0.2997
Ethane	0.69	0.100	30.070	0.3558
Propane	1.61	0.340	44.097	0.5065
i-Butane	0.83	0.230	58.123	0.5623
n-Butane	1.51	0.420	58.123	0.5834
i-Pentane	1.27	0.440	72.15	0.6241
n-Pentane	1.47	0.510	72.15	0.6305
Hexanes	3.05	1.230	84.00	0.6850
Heptanes plus	87.18	96.540	231.00	0.8750
	100.00	100.00		

Sampling Conditions

127 psig
106 °F

Sample Characteristics

Cylinder No. 193471D

Average Molecular Weight 208.6
Sample Density (at 60 °F) 0.8596

Note: Heptanes plus MW and Density are measured values.

* Corrected for hexanes minus fraction identified in residue analysis.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Heptanes Plus Fraction

(From Chromatographic Technique)

Component	Mol %	Wt %	Density (gm/cc)	MW	Vol %
Hydrogen Sulfide	.00	.00			
Carbon Dioxide	.00	.00			
Nitrogen	.00	.00			
Methane	.00	.00			
Ethane	.00	.00			
Propane	.00	.00			
iso-Butane	.00	.00			
n-Butane	.00	.00			
iso-Pentane	.00	.00			
n-Pentane	.00	.00			
Hexanes	.00	.00			
Heptanes	6.70	2.76	.722	96.0	3.35
Octanes	10.58	4.85	.745	107.0	5.70
Nonanes	7.84	4.07	.764	121.0	4.67
Decanes	7.40	4.25	.778	134.0	4.78
Undecanes	5.93	3.74	.789	147.0	4.15
Dodecanes	5.01	3.46	.800	161.0	3.79
Tridecanes	5.58	4.19	.811	175.0	4.53
Tetradecanes	4.98	4.06	.822	190.0	4.33
Pentadecanes	4.90	4.33	.832	206.0	4.55
Hexadecanes	3.86	3.67	.839	222.0	3.83
Heptadecanes	3.38	3.44	.847	237.0	3.56
Octadecanes	3.40	3.66	.852	251.0	3.77
Nonadecanes	2.75	3.10	.857	263.0	3.17
Eicosanes	2.25	2.65	.862	275.0	2.69
Heneicosanes	1.98	2.47	.867	291.0	2.50
Docosanes	1.80	2.35	.872	305.0	2.36
Tricosanes	1.57	2.14	.877	318.0	2.14
Tetracosanes	1.39	1.97	.881	331.0	1.96
Pentacosanes	1.24	1.84	.885	345.0	1.82
Hexacosanes	1.08	1.66	.889	359.0	1.64
Heptacosanes	1.07	1.72	.893	374.0	1.69
Octacosanes	1.00	1.66	.896	388.0	1.62
Nonacosanes	.91	1.57	.899	402.0	1.53
Triacontanes	.87	1.56	.902	416.0	1.52
Hentriacontanes	.74	1.36	.906	430.0	1.31
Dotriacontanes	.64	1.21	.909	444.0	1.16
Tritriacontanes	.57	1.12	.912	458.0	1.08
Tettratriacontanes	.45	.91	.914	472.0	0.88
Pentatriacontanes	.35	.73	.917	486.0	0.70
Hexatriacontanes plus	9.78	23.50	1.070	560.3	19.23
Totals	100.00	100.00			100.00

Sample Characteristics

Cylinder No. 193471D

Total Liquid Molecular Weight 233.2
 Total Liquid Density (gm/cc) 0.8760
 Total Liquid API Gravity 30.0

Properties of Heavy Fractions

Plus Fractions	Mol %	Wt %	Density (gm/cc)	°API	MW
Heptanes plus	100.00	100.00	0.876	30.0	233.2
Decanes plus	74.88	88.32	0.897	26.3	275.1
Undecanes plus	67.48	84.07	0.904	25.1	290.5
Pentadecanes plus	45.98	68.62	0.929	20.8	348.1
Eicosanes plus	27.69	50.42	0.964	15.3	424.7
Pentacosanes plus	18.70	38.84	0.995	10.6	484.3
Triacotanes plus	13.40	30.39	1.029	6.1	528.9
Pentatriacontanes plus	10.13	24.23	1.065	1.4	557.7

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Low Temperature Distillation Residue

(From Chromatographic Technique)

Component	Mol %	Wt %	Density (gm/cc)	MW	Vol %
Hydrogen Sulfide	.00	.00			
Carbon Dioxide	.00	.00			
Nitrogen	.00	.00			
Methane	.00	.00			
Ethane	.00	.00			
Propane	.00	.00			
iso-Butane	.00	.00			
n-Butane	.04	.01	.583	58.1	0.02
iso-Pentane	.10	.03	.624	72.2	0.04
n-Pentane	.10	.03	.630	72.2	0.04
Hexanes	1.21	.44	.685	84.0	0.56
Heptanes	6.62	2.75	.722	96.0	3.33
Octanes	10.40	4.83	.745	107.0	5.67
Nonanes	7.73	4.05	.764	121.0	4.64
Decanes	7.29	4.23	.778	134.0	4.76
Undecanes	5.85	3.72	.789	147.0	4.12
Dodecanes	4.94	3.44	.800	161.0	3.76
Tridecanes	5.50	4.17	.811	175.0	4.50
Tetradecanes	4.91	4.04	.822	190.0	4.29
Pentadecanes	4.83	4.31	.832	206.0	4.53
Hexadecanes	3.80	3.65	.839	222.0	3.80
Heptadecanes	3.33	3.42	.847	237.0	3.53
Octadecanes	3.35	3.64	.852	251.0	3.73
Nonadecanes	2.71	3.08	.857	263.0	3.14
Eicosanes	2.22	2.64	.862	275.0	2.68
Heneicosanes	1.95	2.46	.867	291.0	2.48
Docosanes	1.77	2.34	.872	305.0	2.34
Tricosanes	1.55	2.13	.877	318.0	2.13
Tetracosanes	1.37	1.96	.881	331.0	1.94
Pentacosanes	1.23	1.83	.885	345.0	1.81
Hexacosanes	1.06	1.65	.889	359.0	1.63
Heptacosanes	1.06	1.71	.893	374.0	1.67
Octacosanes	.98	1.65	.896	388.0	1.61
Nonacosanes	.90	1.56	.899	402.0	1.52
Triacotanes	.86	1.55	.902	416.0	1.50
Hentriacotanes	.73	1.35	.906	430.0	1.30
Dotriacotanes	.62	1.20	.909	444.0	1.15
Tritriacotanes	.56	1.11	.912	458.0	1.07
Tettriacotanes	.45	.91	.914	472.0	0.87
Pentatriacotanes	.35	.73	.917	486.0	0.70
Hexatriacotanes pl	9.63	23.38	1.070	560.3	19.12
Totals	100.00	100.00			100.00

Sample Characteristics

Cylinder No. 193471D

Total Liquid Molecular Weight 231.0
 Total Liquid Density (gm/cc) 0.8746
 Total Liquid API Gravity 30.3

Properties of Heavy Fractions

Plus Fractions	Mol %	Wt %	Density (gm/cc)	°API	MW
Hexanes plus	99.76	99.93	0.875	30.2	231.4
Heptanes plus	98.55	99.49	0.876	30.0	233.2
Decanes plus	73.80	87.86	0.897	26.3	275.0
Undecanes plus	66.51	83.63	0.904	25.1	290.5
Pentadecanes plus	45.31	68.26	0.929	20.8	348.1
Eicosanes plus	27.29	50.16	0.964	15.3	424.7
Pentacosanes plus	18.43	38.63	0.995	10.7	484.3
Triacotanes plus	13.20	30.23	1.028	6.1	528.9
Pentatriacotanes plus	9.98	24.11	1.064	1.4	557.7

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Separator Liquid*

Component	Mol %	Wt %	MW	Liq Dens (gm/cc)
Hydrogen	0.00			
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.03	0.010	44.010	0.8172
Nitrogen	0.01	0.000	28.013	0.8086
Methane	2.65	0.200	16.043	0.2997
Ethane	0.74	0.100	30.070	0.3558
Propane	1.72	0.350	44.097	0.5065
i-Butane	0.90	0.240	58.123	0.5623
n-Butane	1.70	0.460	58.123	0.5834
i-Pentane	1.40	0.470	72.15	0.6241
n-Pentane	1.37	0.460	72.15	0.6305
Hexanes	3.71	1.460	84.00	0.6850
Heptanes plus	85.77	96.250	240.00	0.8740
	100.00	100.00		

Sampling Conditions

127 psig
106 °F

Sample Characteristics

Cylinder No. W3A8814

Average Molecular Weight 213.9
Sample Density (at 60 °F) 0.8575

Note: Heptanes plus MW and Density are measured values.

* Corrected for hexanes minus fraction identified in residue analysis.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Heptanes Plus Fraction

(From Chromatographic Technique)

Component	Mol %	Wt %	Density (gm/cc)	MW	Vol %
Hydrogen Sulfide	.00	.00			
Carbon Dioxide	.00	.00			
Nitrogen	.00	.00			
Methane	.00	.00			
Ethane	.00	.00			
Propane	.00	.00			
iso-Butane	.00	.00			
n-Butane	.00	.00			
iso-Pentane	.00	.00			
n-Pentane	.00	.00			
Hexanes	.00	.00			
Heptanes	5.71	2.28	.722	96.0	2.76
Octanes	9.08	4.04	.745	107.0	4.74
Nonanes	7.09	3.57	.764	121.0	4.08
Decanes	6.87	3.83	.778	134.0	4.30
Undecanes	5.64	3.45	.789	147.0	3.82
Dodecanes	4.88	3.27	.800	161.0	3.58
Tridecanes	5.55	4.04	.811	175.0	4.35
Tetradecanes	5.11	4.04	.822	190.0	4.29
Pentadecanes	5.17	4.42	.832	206.0	4.65
Hexadecanes	4.04	3.73	.839	222.0	3.89
Heptadecanes	3.61	3.56	.847	237.0	3.67
Octadecanes	3.71	3.87	.852	251.0	3.97
Nonadecanes	3.02	3.30	.857	263.0	3.37
Eicosanes	2.48	2.84	.862	275.0	2.88
Heneicosanes	2.22	2.69	.867	291.0	2.71
Docosanes	2.03	2.57	.872	305.0	2.58
Tricosanes	1.80	2.38	.877	318.0	2.37
Tetracosanes	1.61	2.21	.881	331.0	2.19
Pentacosanes	1.57	2.26	.885	345.0	2.23
Hexacosanes	1.21	1.81	.889	359.0	1.78
Heptacosanes	1.28	1.99	.893	374.0	1.95
Octacosanes	1.19	1.92	.896	388.0	1.87
Nonacosanes	1.09	1.82	.899	402.0	1.77
Triacontanes	1.05	1.81	.902	416.0	1.76
Hentriacontanes	.89	1.60	.906	430.0	1.55
Dotriacontanes	.77	1.42	.909	444.0	1.36
Tritriacontanes	.69	1.32	.912	458.0	1.27
Tettratriacontanes	.56	1.10	.914	472.0	1.05
Pentatriacontanes	.44	.89	.917	486.0	0.85
Hexatriacontanes plus	9.64	21.97	1.047	546.8	18.35
Totals	100.00	100.00			100.00

Sample Characteristics

Cylinder No. W3A8814

Total Liquid Molecular Weight 240.4
 Total Liquid Density (gm/cc) 0.8740
 Total Liquid API Gravity 30.4

Properties of Heavy Fractions

Plus Fractions	Mol %	Wt %	Density (gm/cc)	°API	MW
Heptanes plus	100.00	100.00	0.874	30.3	240.3
Decanes plus	78.12	90.11	0.891	27.3	277.2
Undecanes plus	71.25	86.28	0.897	26.3	291.0
Pentadecanes plus	50.07	71.48	0.918	22.6	343.1
Eicosanes plus	30.52	52.60	0.948	17.8	414.0
Pentacosanes plus	20.38	39.91	0.975	13.6	470.1
Triacotanes plus	14.04	30.11	1.006	9.2	514.7
Pentatriacontanes plus	10.08	22.86	1.041	4.4	544.1

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Low Temperature Distillation Residue

(From Chromatographic Technique)

Component	Mol %	Wt %	Density (gm/cc)	MW	Vol %
Hydrogen Sulfide	.00	.00			
Carbon Dioxide	.00	.00			
Nitrogen	.00	.00			
Methane	.00	.00			
Ethane	.00	.00			
Propane	.00	.00			
iso-Butane	.00	.00			
n-Butane	.04	.01	.583	58.1	0.02
iso-Pentane	.07	.02	.624	72.2	0.03
n-Pentane	.03	.01	.630	72.2	0.02
Hexanes	.71	.25	.685	84.0	0.31
Heptanes	5.65	2.27	.722	96.0	2.74
Octanes	9.00	4.03	.745	107.0	4.73
Nonanes	7.03	3.56	.764	121.0	4.07
Decanes	6.81	3.82	.778	134.0	4.29
Undecanes	5.59	3.44	.789	147.0	3.81
Dodecanes	4.84	3.26	.800	161.0	3.56
Tridecanes	5.50	4.03	.811	175.0	4.34
Tetradecanes	5.07	4.03	.822	190.0	4.28
Pentadecanes	5.15	4.42	.832	206.0	4.67
Hexadecanes	4.00	3.72	.839	222.0	3.87
Heptadecanes	3.58	3.55	.847	237.0	3.66
Octadecanes	3.68	3.86	.852	251.0	3.96
Nonadecanes	2.99	3.29	.857	263.0	3.35
Eicosanes	2.46	2.83	.862	275.0	2.87
Heneicosanes	2.20	2.68	.867	291.0	2.70
Docosanes	2.01	2.56	.872	305.0	2.57
Tricosanes	1.78	2.37	.877	318.0	2.36
Tetracosanes	1.59	2.20	.881	331.0	2.18
Pentacosanes	1.56	2.25	.885	345.0	2.22
Hexacosanes	1.20	1.80	.889	359.0	1.76
Heptacosanes	1.27	1.98	.893	374.0	1.94
Octacosanes	1.18	1.91	.896	388.0	1.86
Nonacosanes	1.08	1.81	.899	402.0	1.76
Triacontanes	1.03	1.80	.902	416.0	1.75
Hentriacontanes	.89	1.60	.906	430.0	1.55
Dotriacontanes	.76	1.42	.909	444.0	1.36
Trtriacontanes	.69	1.32	.912	458.0	1.27
Tetratriacontanes	.56	1.10	.914	472.0	1.05
Pentatriacontanes	.44	.89	.917	486.0	0.85
Hexatriacontanes pl	9.56	21.91	1.047	546.8	18.25
Totals	100.00	100.00			100.00

Sample Characteristics

Cylinder No. W3A8814

Total Liquid Molecular Weight 239.0
 Total Liquid Density (gm/cc) 0.8736
 Total Liquid API Gravity 30.5

Properties of Heavy Fractions

Plus Fractions	Mol %	Wt %	Density (gm/cc)	°API	MW
Hexanes plus	99.86	99.96	0.874	30.4	239.2
Heptanes plus	99.15	99.71	0.874	30.3	240.4
Decanes plus	77.47	89.85	0.891	27.3	277.2
Undecanes plus	70.66	86.03	0.897	26.3	291.0
Pentadecanes plus	49.66	71.27	0.918	22.6	343.0
Eicosanes plus	30.26	52.43	0.948	17.8	414.0
Pentacosanes plus	20.22	39.79	0.975	13.6	470.1
Triacontanes plus	13.93	30.04	1.006	9.2	514.7
Pentatriacontanes plus	10.00	22.80	1.042	4.3	544.1

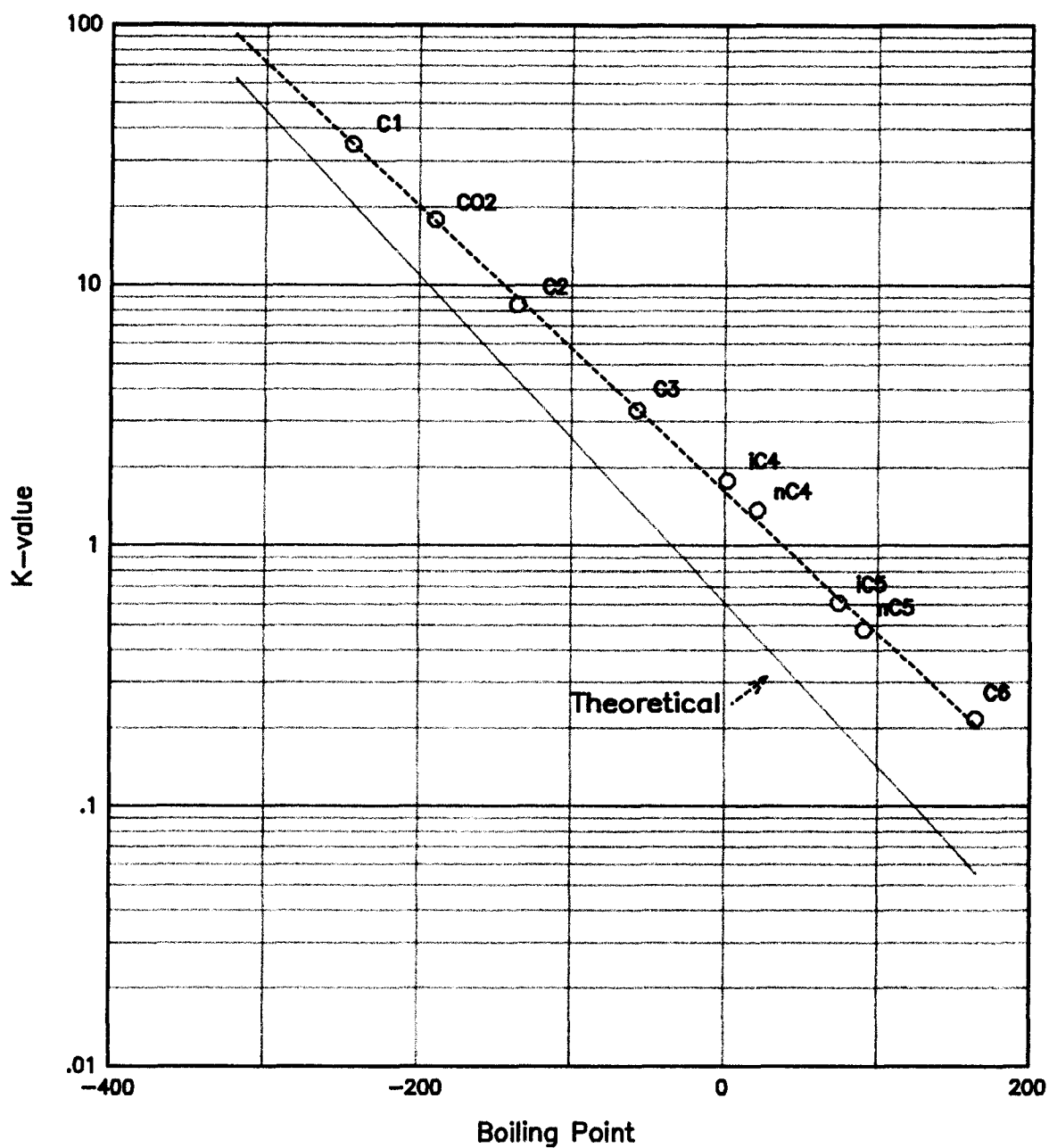
Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Equilibrium Ratios

(at 106 °F)



	K-Value Plot Figure QC-1
Separator Pressure 127 psig	

CORE LABORATORIES

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Reservoir Fluid*

Component	Mol %	Wt %	MW	Liq Dens (gm/cc)
Hydrogen	0.00			
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.27	0.110	44.010	0.8172
Nitrogen	0.07	0.020	28.013	0.8086
Methane	45.49	6.790	16.043	0.2997
Ethane	3.59	1.000	30.070	0.3558
Propane	3.75	1.540	44.097	0.5065
i-Butane	1.21	0.650	58.123	0.5623
n-Butane	2.01	1.090	58.123	0.5834
i-Pentane	0.93	0.620	72.15	0.6241
n-Pentane	1.05	0.700	72.15	0.6305
Hexanes	2.02	1.580	84.00	0.6850
Heptanes plus	39.61	85.900	233.00	0.8670
	100.00	100.00		

Sample Characteristics

Pb Adjusted Recombination

Average Molecular Weight 107.5

Sample Density (at 60 °F) 0.7397

Note: Heptanes plus MW and Density are measured values.

* Corrected for hexanes minus fraction identified in residue analysis.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Heptanes Plus Fraction

(From Chromatographic Technique)

Component	Mol %	Wt %	Density (gm/cc)	MW	Vol %
Hydrogen Sulfide	.00	.00			
Carbon Dioxide	.00	.00			
Nitrogen	.00	.00			
Methane	.00	.00			
Ethane	.00	.00			
Propane	.00	.00			
iso-Butane	.00	.00			
n-Butane	.00	.00			
iso-Pentane	.00	.00			
n-Pentane	.00	.00			
Hexanes	.00	.00			
Heptanes	6.54	2.70	.722	96.0	3.24
Octanes	10.25	4.70	.745	107.0	5.47
Nonanes	7.30	3.80	.764	121.0	4.31
Decanes	6.91	3.98	.778	134.0	4.44
Undecanes	5.44	3.44	.789	147.0	3.78
Dodecanes	4.75	3.29	.800	161.0	3.56
Tridecanes	5.52	4.15	.811	175.0	4.44
Tetradecanes	5.19	4.24	.822	190.0	4.47
Pentadecanes	5.35	4.74	.832	206.0	4.94
Hexadecanes	3.83	3.66	.839	222.0	3.78
Heptadecanes	3.43	3.49	.847	237.0	3.57
Octadecanes	3.39	3.66	.852	251.0	3.73
Nonadecanes	2.91	3.29	.857	263.0	3.33
Eicosanes	2.30	2.72	.862	275.0	2.74
Heneicosanes	2.03	2.54	.867	291.0	2.54
Docosanes	1.86	2.44	.872	305.0	2.43
Tricosanes	1.62	2.22	.877	318.0	2.19
Tetracosanes	1.46	2.08	.881	331.0	2.05
Pentacosanes	1.46	2.17	.885	345.0	2.12
Hexacosanes	1.09	1.68	.889	359.0	1.64
Heptacosanes	1.21	1.95	.893	374.0	1.89
Octacosanes	1.06	1.77	.896	388.0	1.72
Nonacosanes	.92	1.59	.899	402.0	1.53
Triacotanes	1.00	1.79	.902	416.0	1.72
Hentriacontanes	.85	1.58	.906	430.0	1.51
Dotriacontanes	.68	1.30	.909	444.0	1.24
Trtriacontanes	.62	1.23	.912	458.0	1.17
Tetratriacontanes	.57	1.16	.914	472.0	1.10
Pentatriacontanes	.48	1.00	.917	486.0	0.95
Hexatriacontanes plus	9.98	21.64	1.021	504.2	18.38
Totals	100.00	100.00			100.00

Sample Characteristics

Pb Adjusted Recombination

Total Liquid Molecular Weight 232.6
 Total Liquid Density (gm/cc) 0.8670
 Total Liquid API Gravity 31.7

Properties of Heavy Fractions

Plus Fractions	Mol %	Wt %	Density (gm/cc)	°API	MW
Heptanes plus	100.00	100.00	0.867	31.7	232.5
Decanes plus	75.91	88.80	0.885	28.3	271.9
Undecanes plus	69.00	84.82	0.891	27.3	285.8
Pentadecanes plus	48.10	69.70	0.912	23.6	336.8
Eicosanes plus	29.19	50.86	0.940	19.0	404.9
Pentacosanes plus	19.92	38.86	0.964	15.4	453.3
Triacotanes plus	14.18	29.70	0.988	11.7	486.7
Pentatriacontanes plus	10.46	22.64	1.016	7.8	503.4

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Low Temperature Distillation Residue

(From Chromatographic Technique)

Component	Mol %	Wt %	Density (gm/cc)	MW	Vol %
Hydrogen Sulfide	.00	.00			
Carbon Dioxide	.00	.00			
Nitrogen	.00	.00			
Methane	.00	.00			
Ethane	.00	.00			
Propane	.00	.00			
iso-Butane	.00	.00			
n-Butane	.00	.00			
iso-Pentane	.00	.00			
n-Pentane	.00	.00			
Hexanes	1.07	.39	.685	84.0	0.49
Heptanes	6.47	2.69	.722	96.0	3.23
Octanes	10.09	4.68	.745	107.0	5.44
Nonanes	7.24	3.79	.764	121.0	4.30
Decanes	6.83	3.96	.778	134.0	4.41
Undecanes	5.39	3.43	.789	147.0	3.77
Dodecanes	4.71	3.28	.800	161.0	3.55
Tridecanes	5.45	4.13	.811	175.0	4.41
Tetradecanes	5.13	4.22	.822	190.0	4.45
Pentadecanes	5.29	4.72	.832	206.0	4.91
Hexadecanes	3.80	3.65	.839	222.0	3.77
Heptadecanes	3.39	3.48	.847	237.0	3.56
Octadecanes	3.36	3.65	.852	251.0	3.71
Nonadecanes	2.88	3.28	.857	263.0	3.32
Eicosanes	2.28	2.71	.862	275.0	2.72
Heneicosanes	2.01	2.53	.867	291.0	2.53
Docosanes	1.84	2.43	.872	305.0	2.42
Tricosanes	1.61	2.21	.877	318.0	2.18
Tetracosanes	1.44	2.07	.881	331.0	2.04
Pentacosanes	1.45	2.16	.885	345.0	2.11
Hexacosanes	1.07	1.67	.889	359.0	1.63
Heptacosanes	1.20	1.94	.893	374.0	1.88
Octacosanes	1.05	1.76	.896	388.0	1.70
Nonacosanes	.91	1.58	.899	402.0	1.52
Triacontanes	.99	1.78	.902	416.0	1.71
Hentriacontanes	.84	1.57	.906	430.0	1.50
Dotriacontanes	.67	1.29	.909	444.0	1.23
Trtriacontanes	.62	1.23	.912	458.0	1.17
Tetracontanes	.57	1.16	.914	472.0	1.10
Pentatriacontanes	.48	1.00	.917	486.0	0.94
Hexatriacontanes plu	9.87	21.56	1.021	504.2	18.29
Totals	100.00	100.00			100.00

Sample Characteristics

Pb Adjusted Recombination

Total Liquid Molecular Weight 231.0

Total Liquid Density (gm/cc) 0.8664

Total Liquid API Gravity 31.8

Properties of Heavy Fractions

Plus Fractions	Mol %	Wt %	Density (gm/cc)	°API	MW
Hexanes plus	100.00	100.00	0.866	31.8	231.0
Heptanes plus	98.93	99.61	0.867	31.7	232.6
Decanes plus	75.13	88.45	0.886	28.3	272.0
Undecanes plus	68.30	84.49	0.891	27.3	285.8
Pentadecanes plus	47.62	69.43	0.912	23.6	336.8
Eicosanes plus	28.90	50.65	0.940	19.0	404.9
Pentacosanes plus	19.72	38.70	0.964	15.3	453.3
Triaccontanes plus	14.04	29.59	0.988	11.7	486.7
Pentatriacontanes plus	10.35	22.56	1.016	7.7	503.4

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

VOLUMETRIC DATA

(at 119 °F)

Saturation Pressure (Psat)	3019	psig
Density at Psat	0.7448	gm/cc
Thermal Exp @ 5000 psig	1.02791	V at 119 °F / V at 70 °F

AVERAGE SINGLE-PHASE COMPRESSIBILITIES

Pressure Range psig			Single-Phase Compressibility v/v/psi
5000	to	4500	7.64 E -6
4500	to	4000	7.95 E -6
4000	to	3500	8.31 E -6
3500	to	3019	8.65 E -6

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

PRESSURE-VOLUME RELATIONS

(at 119 °F)

Pressure psig	Relative Volume (A)	Y-Function (B)	Density gm/cc
5000	0.9840		0.7569
4500	0.9878		0.7540
4000	0.9917		0.7510
3500	0.9958		0.7479
3400	0.9967		0.7473
3300	0.9976		0.7466
3200	0.9984		0.7460
3100	0.9993		0.7453
b»3019	1.0000		0.7448
3007	1.0008		
2999	1.0014		
2990	1.0020		
2981	1.0027		
2902	1.0086		
2747	1.0219		
2535	1.0442	4.299	
2237	1.0864	4.019	
1937	1.1483	3.737	
1670	1.2297	3.486	
1438	1.3330	3.268	
1241	1.4592	3.083	
1078	1.6062	2.930	
868	1.8917	2.733	
679	2.3201	2.556	
516	2.9634	2.402	
371	4.0298	2.266	

(A) Relative Volume: V/V_{sat} or volume at indicated pressure per volume at saturation pressure.

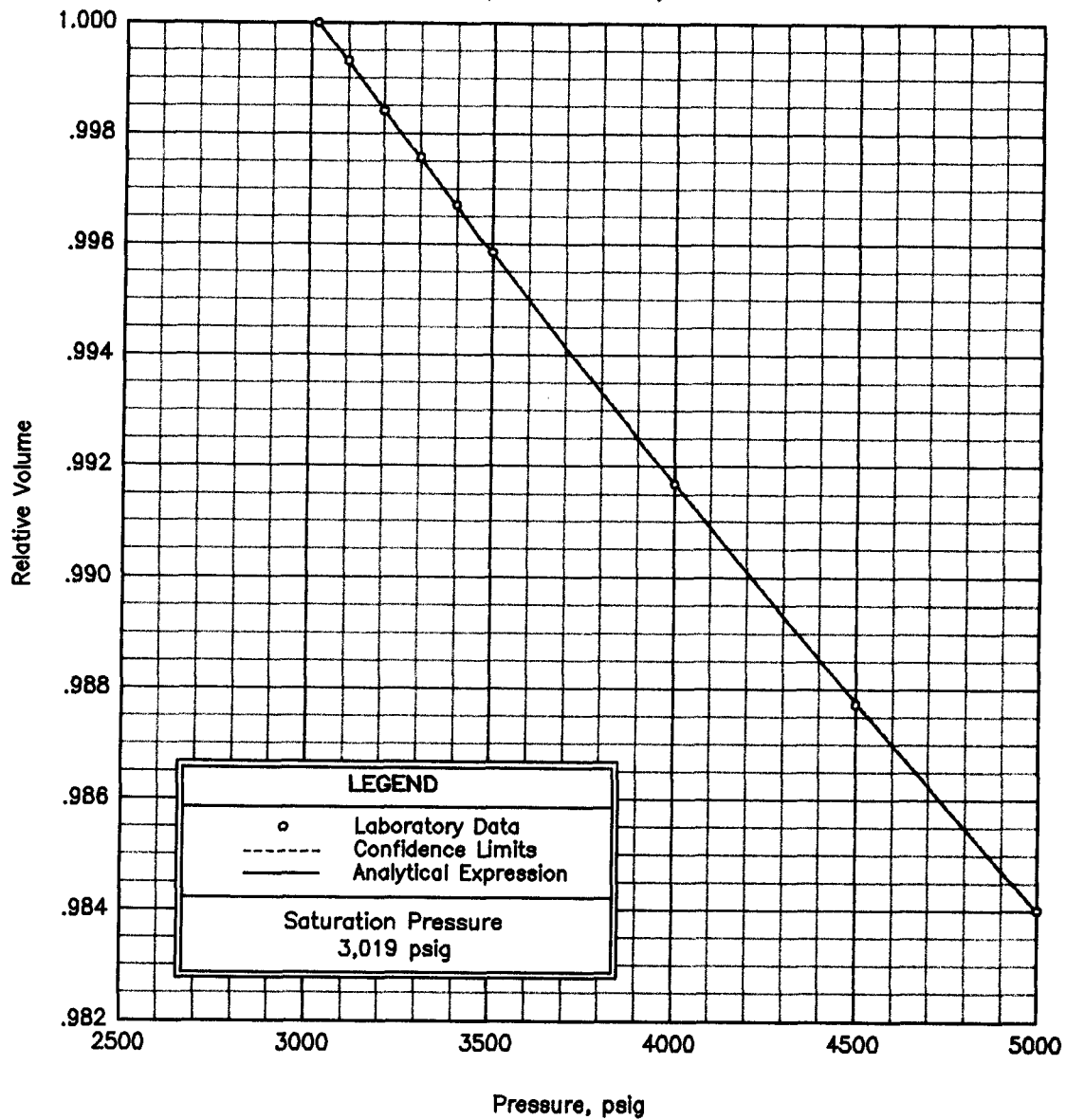
(B) Where: Y-Function =
$$\frac{(P_{sat} - P)}{(P_{abs}) * (V/V_{sat} - 1)}$$

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

RELATIVE VOLUME (at 119 °F)



Analytical Expression

$$1 - 10^{-5.124E00 + 1.033E00 (\log(dP)) + -1.982E-04 (\log(dP))^5}$$

Note: dP is defined as | P_i - P_{sat} |, psig

Statistical Summary

r squared: 0.999981
Confidence Interval (+/-): 0.0000
Confidence: 99 %

Pressure-Volume Relations

Figure A-1

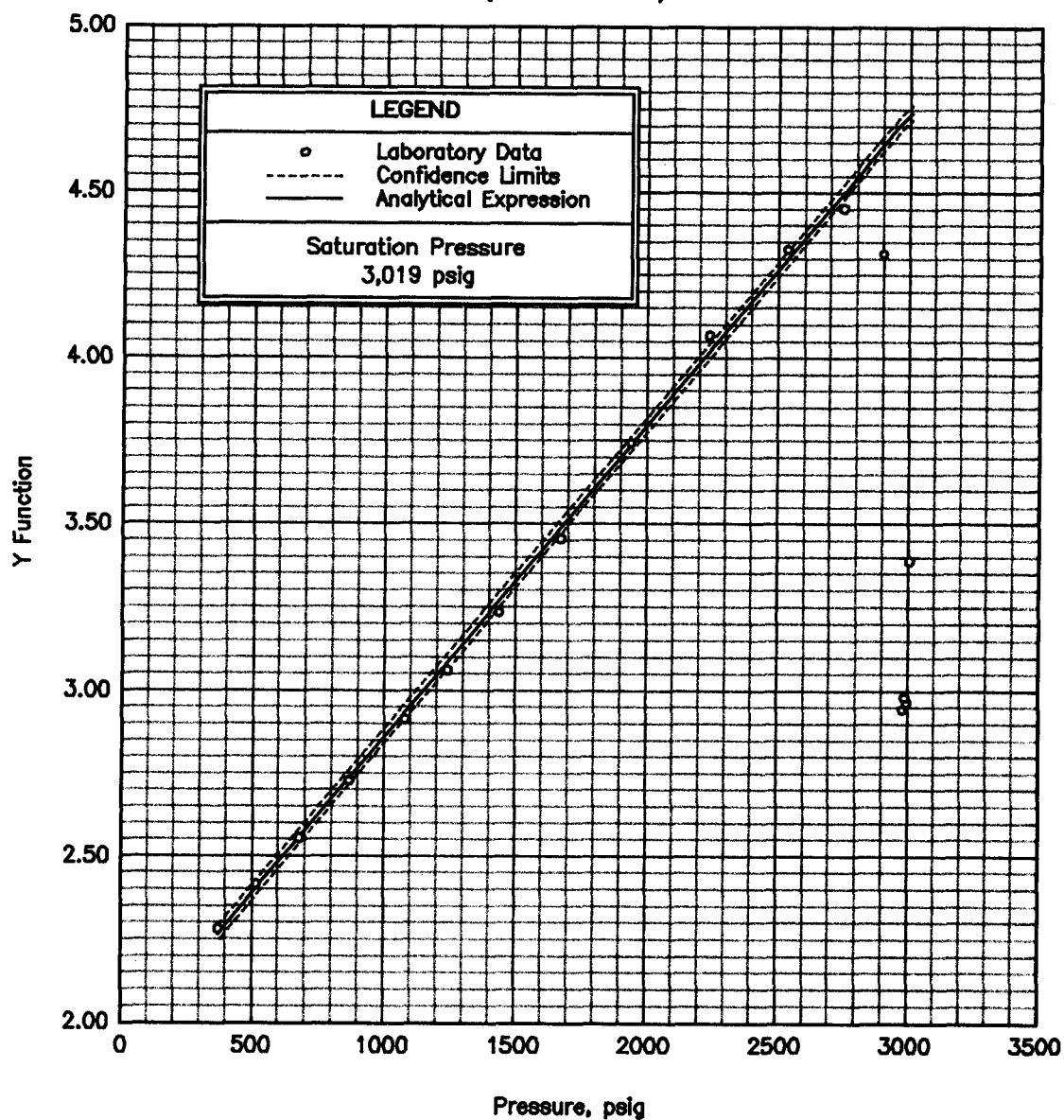
Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Y-FUNCTION

(at 119 °F)



Analytical Expression

$$9.393E-04 (X_d) + 1.918E00$$

Notes: X_d is defined as P_i / P_{act}

Statistical Summary

r squared: 0.998527
Confidence Interval (+/-): 0.0227
Confidence: 98 %

Pressure-Volume Relations

Figure A-2

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

DIFFERENTIAL VAPORIZATION

(at 119 °F)

Pressure psig	Solution Gas/Oil Ratio Rsd (A)	Relative Oil Volume Bod (B)	Relative Total Volume Btd (C)	Oil Density gm/cc	Deviation Factor Z	Gas Formation Volume Factor (D)	Incremental Gas Gravity (Air=1.000)
b»3019	612	1.272	1.272	0.7448			
2700	550	1.249	1.305	0.7512	0.825	0.00496	0.653
2400	493	1.228	1.344	0.7576	0.820	0.00554	0.650
2100	435	1.207	1.408	0.7644	0.828	0.00639	0.646
1800	378	1.185	1.502	0.7715	0.843	0.00758	0.642
1500	321	1.164	1.645	0.7789	0.863	0.00929	0.640
1200	264	1.142	1.880	0.7866	0.886	0.01190	0.640
900	206	1.121	2.298	0.7945	0.912	0.01627	0.645
600	148	1.099	3.163	0.8025	0.940	0.02495	0.665
300	87	1.076	5.773	0.8107	0.970	0.05028	0.720
105	42	1.059	14.767	0.8164	0.989	0.13489	0.825
0	0	1.029		0.8293			1.256
@ 60 °F = 1.000							

Gravity of Residual Oil = 34.2 °API at 60 °F

Density of Residual Oil = 0.8531 gm/cc at 60 °F

(A) Cubic Feet of gas at 14.65 psia and 60 °F per Barrel of residual oil at 60 °F.

(B) Barrel of oil at indicated pressure and temperature per Barrel of residual oil at 60 °F.

(C) Barrels of oil plus liberated gas at indicated pressure and temperature per Barrel of residual oil at 60 °F.

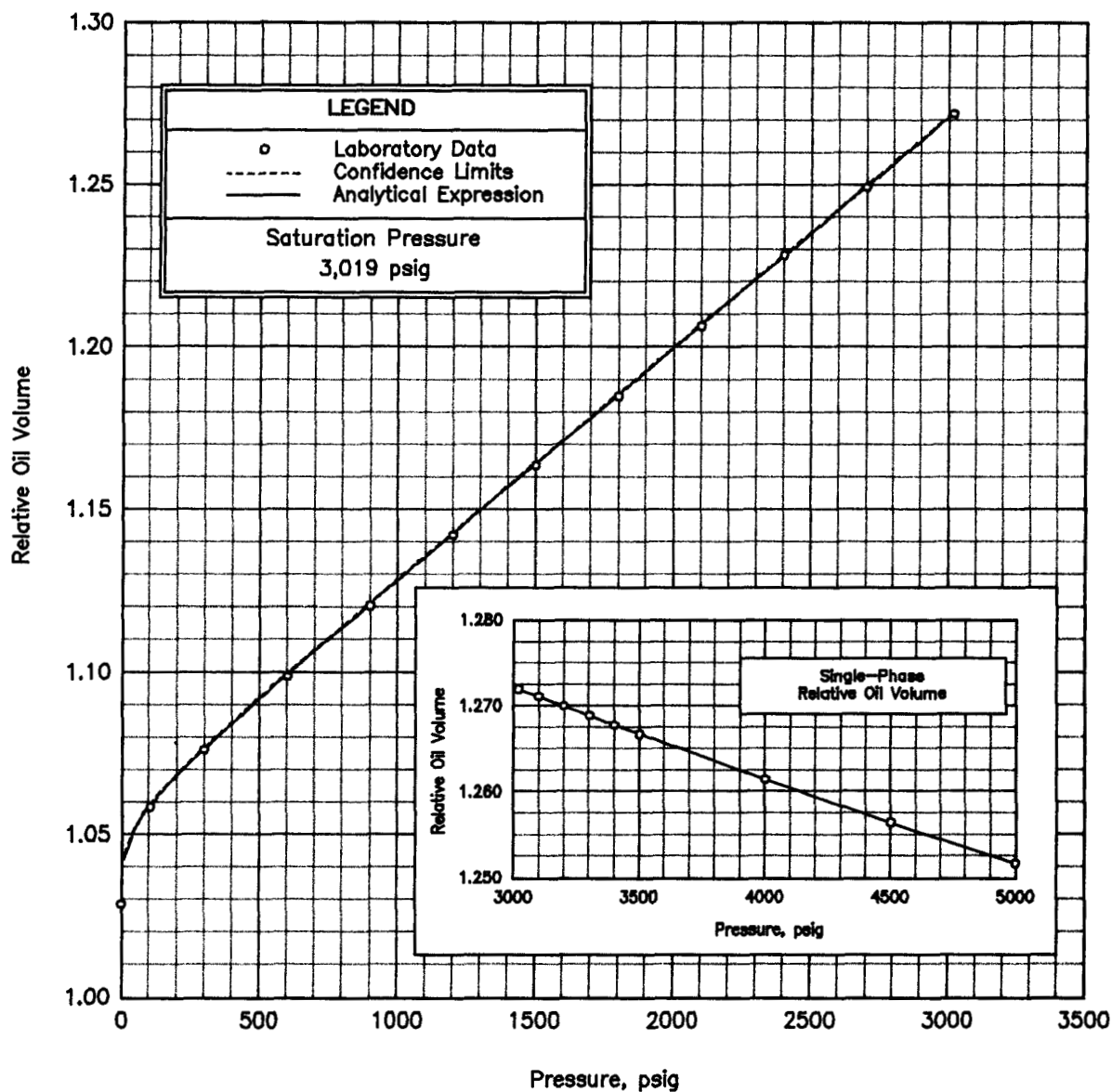
(D) Cubic Feet of gas at indicated pressure and temperature per Cubic Feet at 14.65 psia and 60 °F.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

RELATIVE OIL VOLUME (at 119 °F)



Analytical Expression (below bubblepoint)

$$1.029E00 + 8.010E-05 (P_i) + 2.150E-02 (P_i)^{0.4} + -1.435E-02 (P_i)^{0.45}$$

Note: P_i is defined as pressure, psig

Statistical Summary

r squared: 0.999995
Confidence Interval (+/-): .0002
Confidence: 99 %

Differential Vaporization

Figure B-1

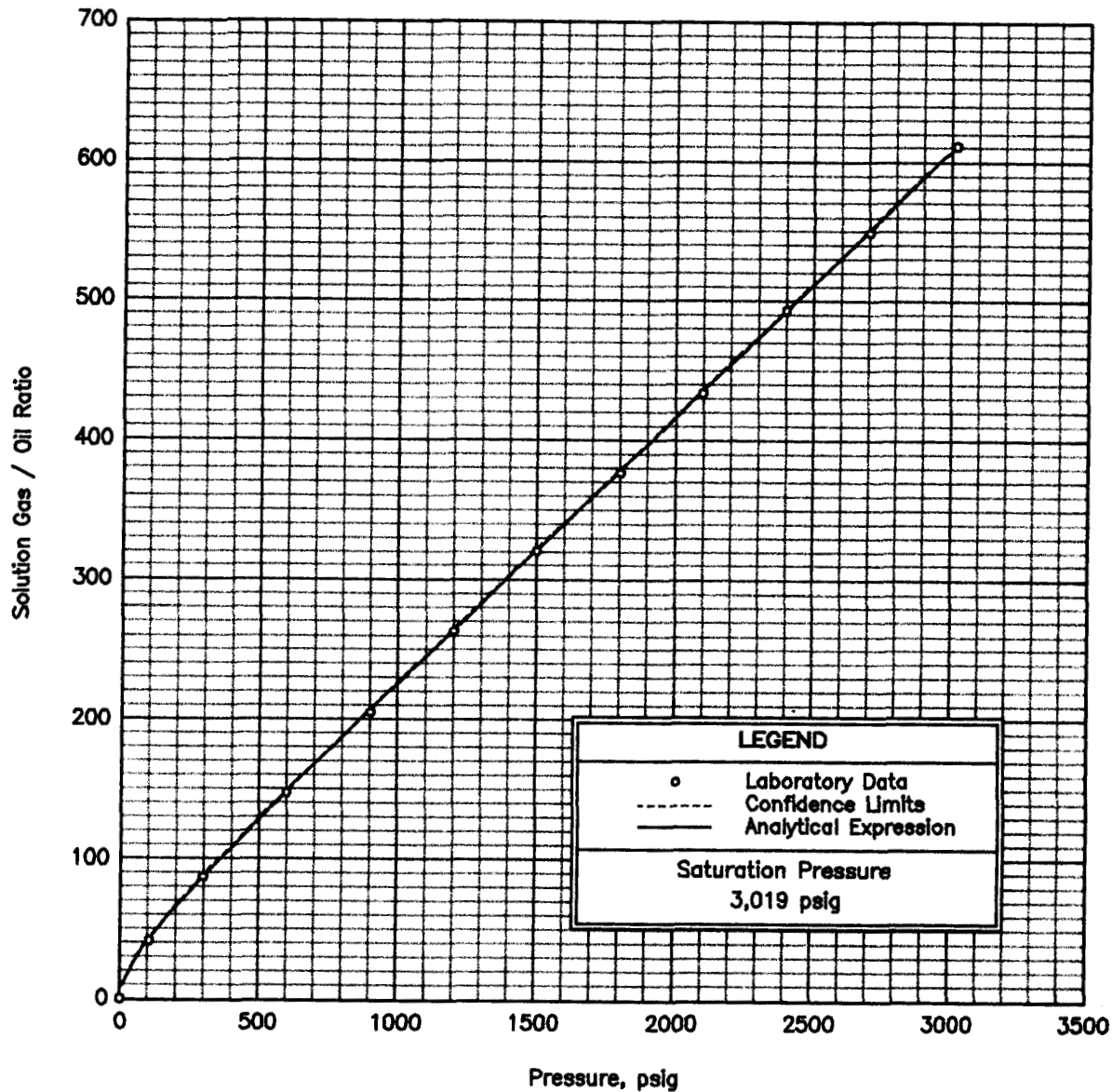
Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

SOLUTION GAS/OIL RATIO

(scf/bbl at 119 °F)



Analytical Expression (below bubblepoint)

$$6.418E-02 (P_i)^{-1.1} + 3.038E00 (P_i)^{-0.5} + 1.460E-06 (P_i)^{-2}$$

Note: P_i is defined as pressure, psig

Statistical Summary

r squared: 0.999990
Confidence Interval (+/-): 1
Confidence: 99 %

Differential Vaporization

Figure B-2

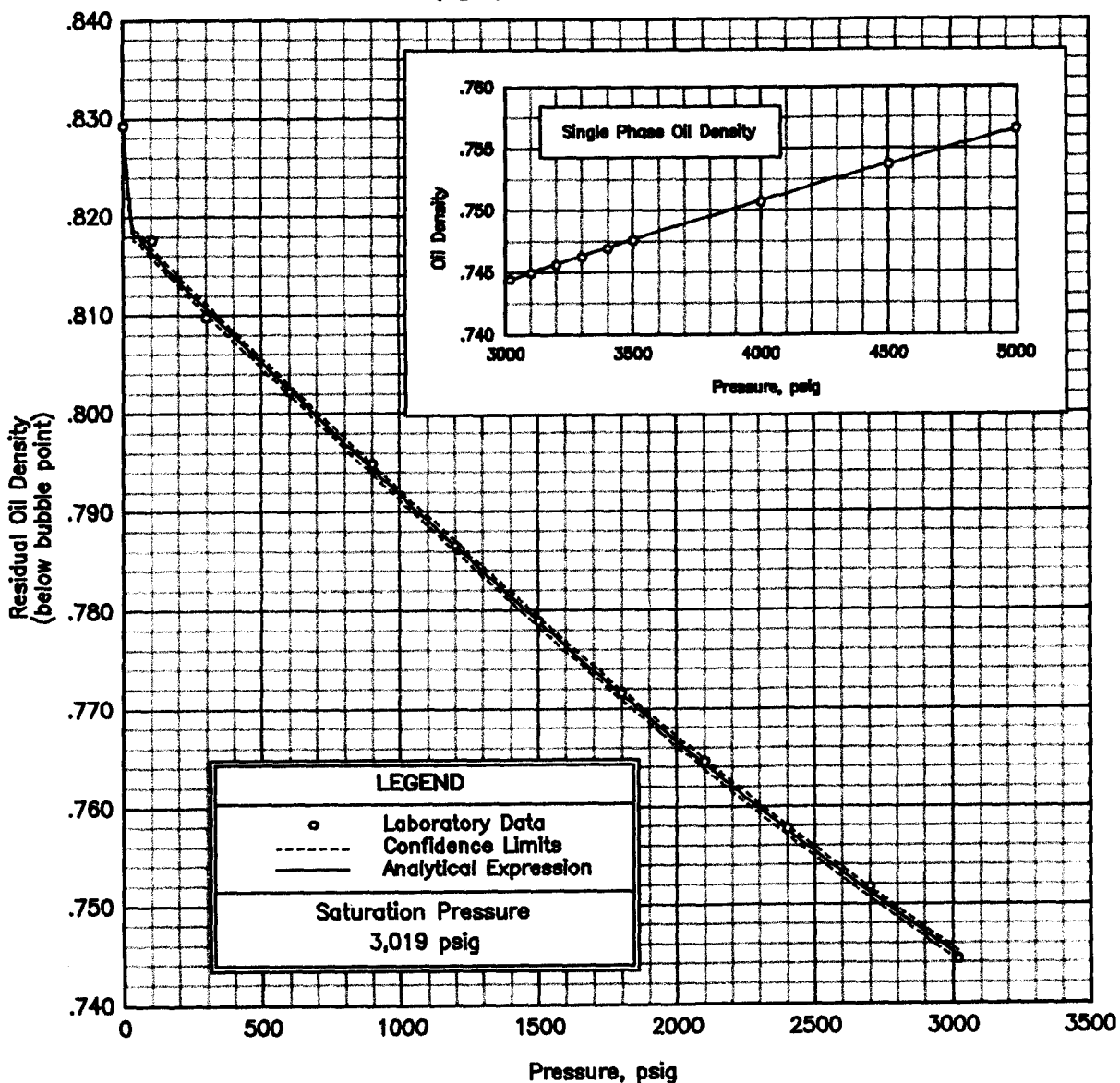
Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

OIL DENSITY

(gm/cc at 119 °F)



Analytical Expression (below bubblepoint)

$$0.82934 + -6.833E-03 (P_i)^{-0.1} + -1.241E-05 (P_i)^{-1.1} + 2.820E-11 (P_i)^{-2.5}$$

Note: P_i is defined as pressure, psig

Statistical Summary

r squared: 0.999603
 Confidence Interval (+/-): 0.0005
 Confidence: 99 %

Differential Vaporization

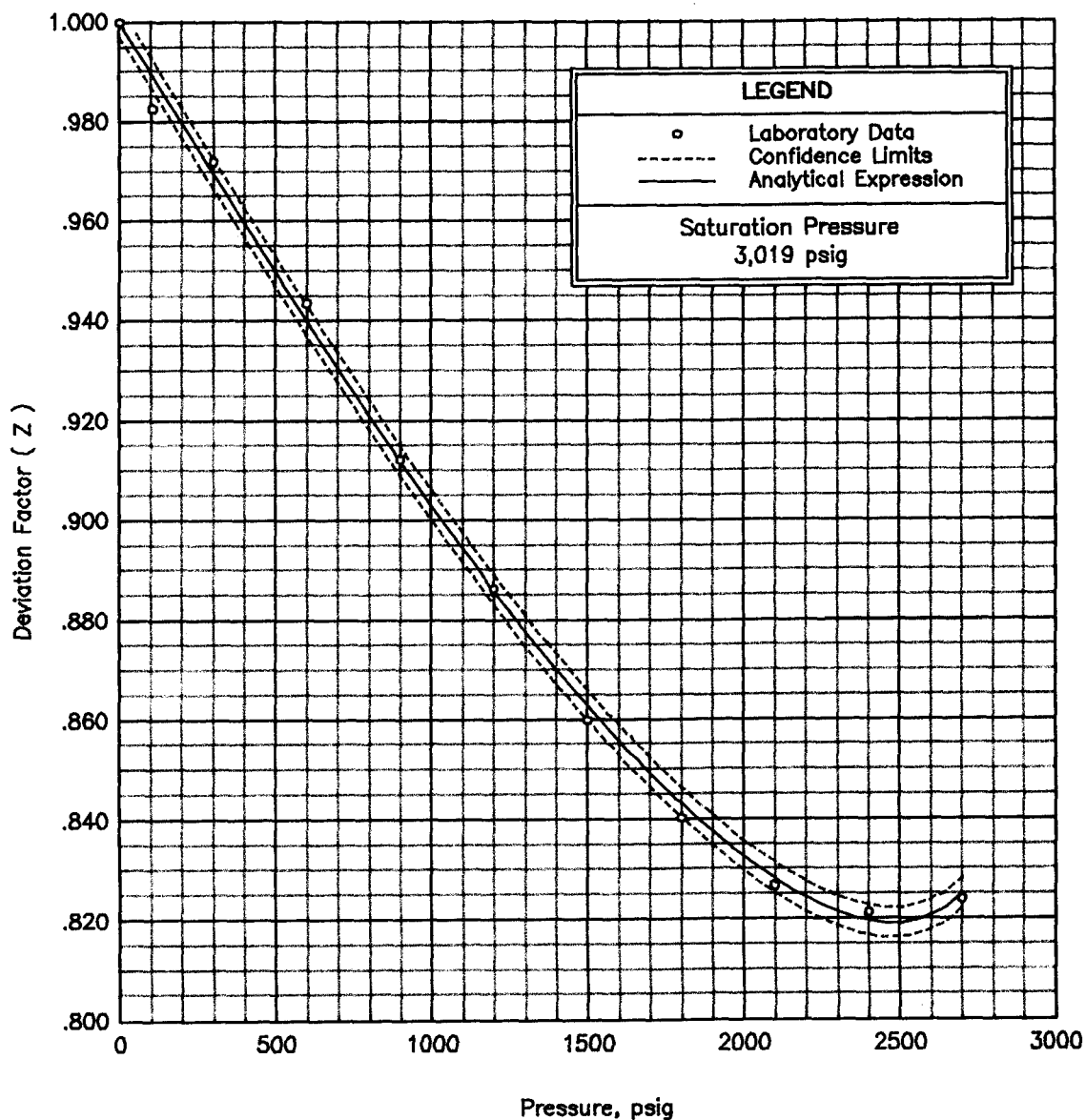
Figure B-3

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Z-FACTOR (at 119 °F)



Analytical Expression

$$1 + -1.012E-04 (P_i) + 4.173E-54 (P_i)^{15} + 4.377E-12 (P_i)^3$$

Note: P_i is defined as pressure, psig

Statistical Summary

r squared: 0.998154
Confidence Interval (+/-): 0.003
Confidence: 99 %

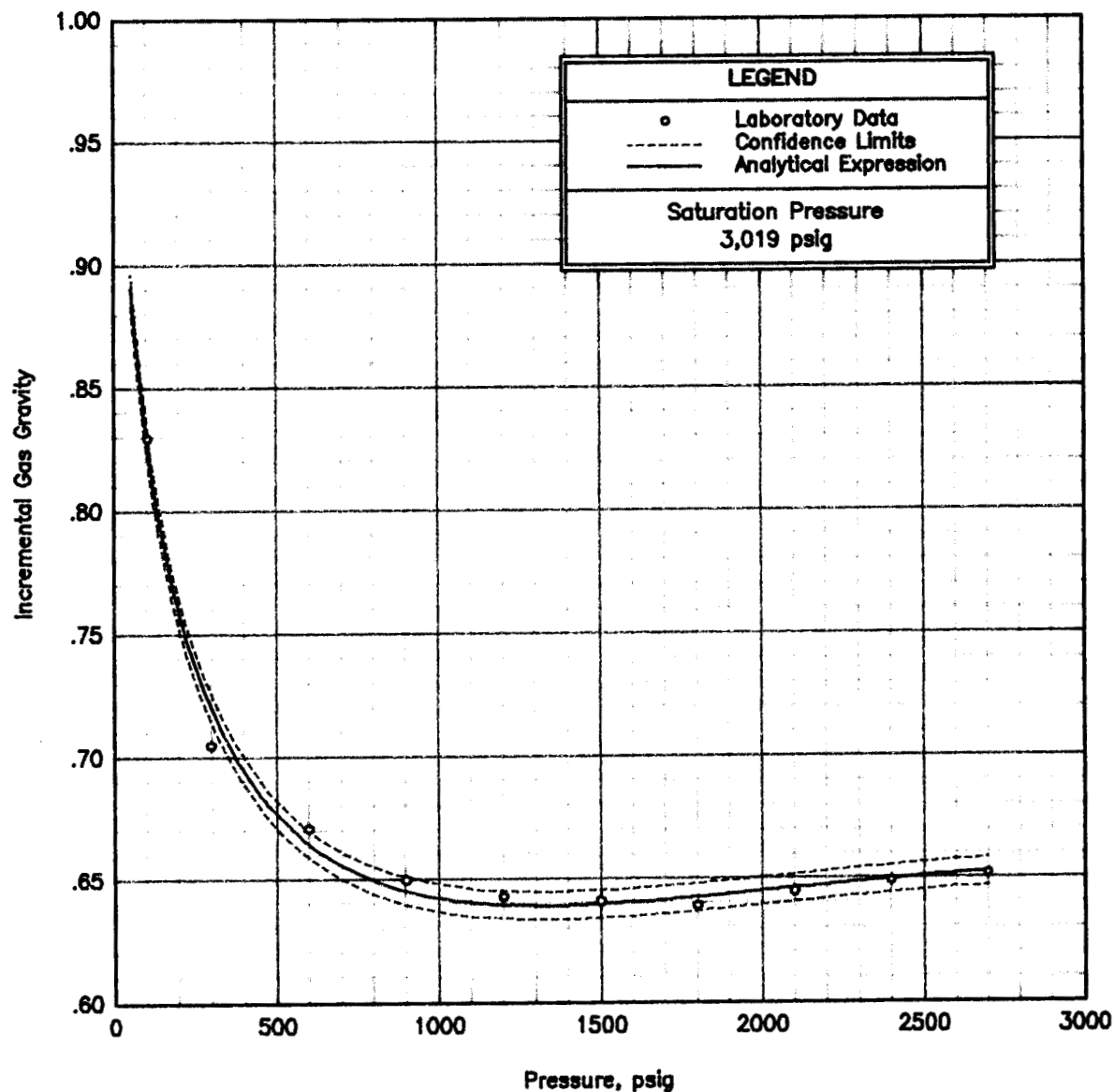
Differential Vaporization

Figure B-5

Arco Exploration & Production Technology

Brad Berg #1
RFL 920279

GAS GRAVITY (at 119 °F)



Analytical Expression

$$2.177E00 + -1.221E-01 (P1)^{-0.300} + 3.054E-03 (P1)^{-0.500} + -9.210E-01 (\exp(-X_d))$$

Note: X_d is defined as $P1 / P_{sat}$

Statistical Summary

r squared: 0.999009
Confidence Interval (+/-): 0.0056
Confidence: 99 %

Differential Vaporization

Figure B-4

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

RESERVOIR FLUID VISCOSITY

(at 119 °F)

Pressure psig	Oil Viscosity cp	Calculated Gas Viscosity* cp	Oil/Gas Viscosity Ratio
5000	1.18		
4500	1.14		
4000	1.10		
3600	1.06		
3200	1.03		
b»3019	1.01		
2700	1.11	0.0200	55.8
2400	1.22	0.0186	65.7
2100	1.36	0.0172	78.8
1800	1.52	0.0160	95.0
1500	1.70	0.0149	114
1200	1.92	0.0140	138
900	2.18	0.0132	165
600	2.47	0.0125	198
300	2.84	0.0118	242
105	3.19	0.0110	289
0	3.62		

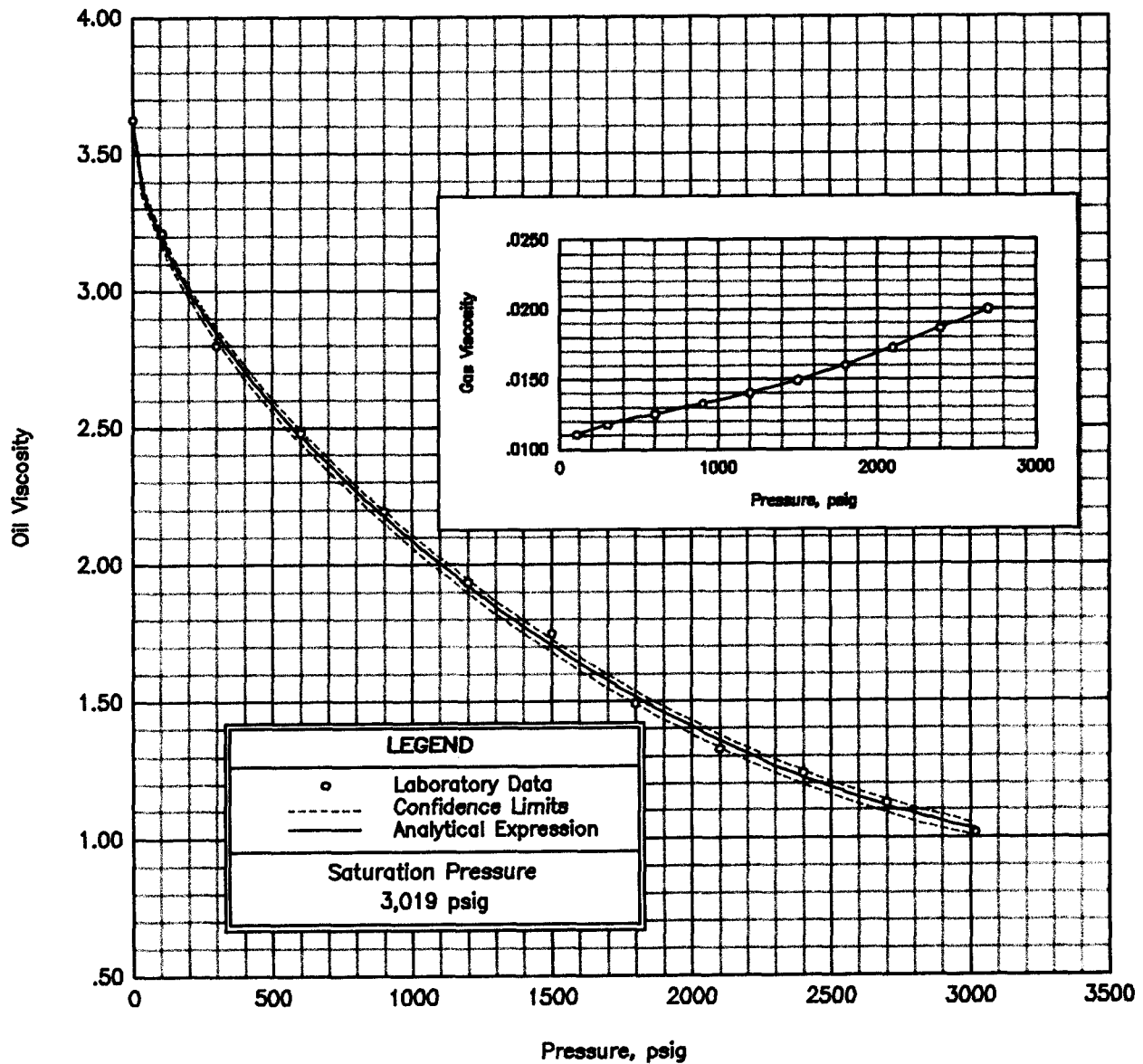
* Gas Viscosity data calculated from correlation of Lee A.L., Gonzalez M.H., and Eakin B.E., "The Viscosity of Natural Gases", Journal of Petroleum Technology, August, 1966, pp. 997-1000.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

RESERVOIR FLUID VISCOSITIES (cp at 119 °F)



Analytical Expression (below bubblepoint)

$$3.623 E00 + -3.144E-04 (P_i) + 4.742E-10 (P_i)^{-2.6} + -3.958E-02 (P_i)^{-0.5}$$

Note: P_i is defined as pressure, psig

Statistical Summary

r squared: 0.999161
Confidence Interval (+/-): 0.023
Confidence: 99 %

Viscosity Analyses

Figure C-1

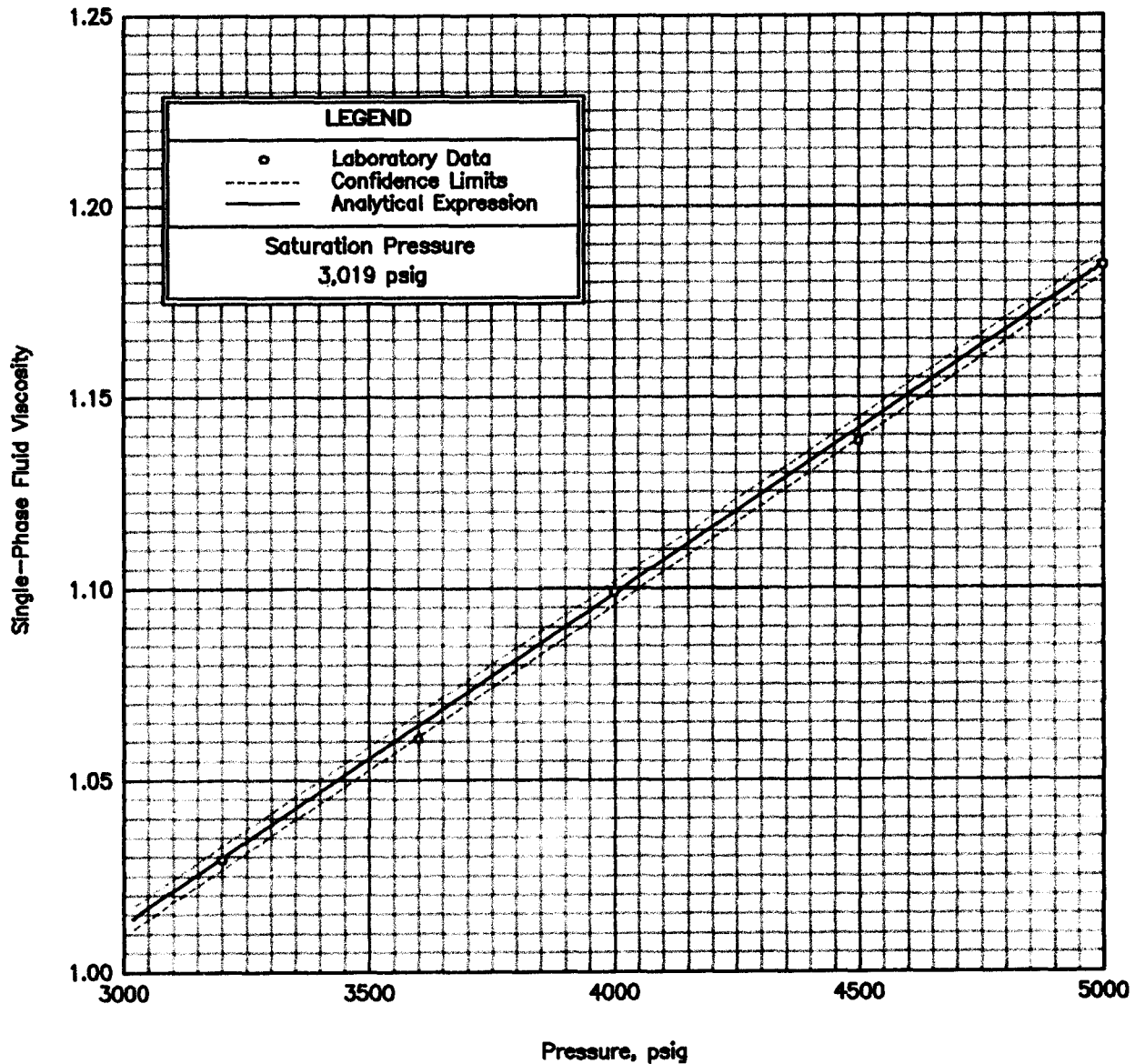
CORE LABORATORIES

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

SINGLE-PHASE VISCOSITY (cp at 119 °F)



Analytical Expression

$$1.014E00 + 1.017E00 (dP)$$

Note: dP is defined as $| P_1 - P_{sat} |$, psig

Statistical Summary

r squared: 0.998835
Confidence Interval (+/-): 0.003
Confidence: 99 %

Viscosity Analyses

Figure C-2

CORE LABORATORIES

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

SEPARATOR FLASH ANALYSIS

Flash Conditions		Gas/Oil Ratio (scf/bbl) (A)	Gas/Oil Ratio (scf/STbbl) (B)	Stock Tank Oil Gravity at 60 °F (°API)	Formation Volume Factor Bofb (C)	Separator Volume Factor (D)	Specific Gravity of Flashed Gas (Air=1.000)	Oil Phase Density (gm/cc)
psig	°F							
3019	119							0.7425
100	90	580	596			1.026	0.670 *	0.8386
25	140	17	17			1.038	0.908 *	0.8260
0	60	12	12	34.1	1.276	1.000	1.308 *	0.8538
Rsfb = 625								
3019	119							0.7448
100	140	587	615			1.048	0.745	0.8179
25	140	12	12			1.038	0.782	0.8238
0	60	4	4	34.0	1.284	1.000	1.300	0.8540
Rsfb = 632								
3019	119							0.7448
500	90	426	457			1.073	0.638	0.8160
100	90	96	99			1.033	0.749	0.8319
25	140	25	26			1.039	1.064	0.8212
0	60	10	10	34.6	1.260	1.000	1.007	0.8510
Rsfb = 593								

* Collected and analyzed in the laboratory by gas chromatography.

(A) Cubic Feet of gas at 14.65 psia and 60 °F per Barrel of oil at indicated pressure and temperature.

(B) Cubic Feet of gas at 14.65 psia and 60 °F per Barrel of Stock Tank Oil at 60 °F.

(C) Barrels of saturated oil at 3019 psig and 119 °F per Barrel of Stock Tank Oil at 60 °F.

(D) Barrels of oil at indicated pressure and temperature per Barrel of Stock Tank Oil at 60 °F.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Primary Separator Gas

(From Chromatographic Technique)

Component	Mol %	GPM	MW	Liq Dens (gm/cc)
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.46		44.010	.8172
Nitrogen	0.15		28.013	.8086
Methane	86.88		16.043	.2997
Ethane	5.85	1.556	30.070	.3558
Propane	4.17	1.143	44.097	.5065
iso-Butane	0.81	.264	58.123	.5623
n-Butane	0.96	.301	58.123	.5834
iso-Pentane	0.30	.109	72.150	.6241
n-Pentane	0.15	.054	72.150	.6305
Hexanes	0.13	.050	84.000	.6850
Heptanes	0.08	.033	96.000	.7220
Octanes	0.04	.018	107.00	.7450
Nonanes	Trace			
Decanes plus	0.02	.011	141.00	.7840
Totals	100.00	3.539		

Sampling Conditions

100 psig

90 °F

Sample Characteristics

Base Case Separator Test

Critical Pressure (psia) 664.5

Critical Temperature (°R) 380.7

Average Molecular Weight 19.39

Calculated Gas Gravity (air = 1.000) 0.670

Gas Gravity

Factor, Fg 1.2221

Super Compressibility Factor, Fpv

at sampling conditions 1.0081

Gas Z-Factor

at sampling conditions * 0.984

at 14.65 psia and 60 °F

Gross Heating Value

(BTU/scf dry gas) 1172

Properties of Plus Fractions

Component	Mol %	MW	Liq Dens (gm/cc)	API Gravity
Heptanes plus	0.14	105.6	0.739	44.2
Decanes plus	0.02	141.0	0.784	38.3

* From: Standing, M.B., "Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems", SPE (Dallas), 1977, 8th Edition, Appendix II.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Secondary Separator Gas

(From Chromatographic Technique)

Component	Mol %	GPM	MW	Liq Dens (gm/cc)
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.66		44.010	.8172
Nitrogen	0.00			
Methane	63.64		16.043	.2997
Ethane	12.86	3.421	30.070	.3558
Propane	13.50	3.700	44.097	.5065
iso-Butane	3.14	1.022	58.123	.5623
n-Butane	3.61	1.132	58.123	.5834
iso-Pentane	1.12	.408	72.150	.6241
n-Pentane	0.56	.202	72.150	.6305
Hexanes	0.46	.178	84.000	.6850
Heptanes	0.28	.117	96.000	.7220
Octanes	0.13	.059	107.00	.7450
Nonanes	0.04	.020	121.00	.7640
Decanes plus	Trace			
Totals	100.00	10.259		

Sampling Conditions

25 psig

140 °F

Sample Characteristics

'Base Case' Separator Test

Critical Pressure (psia) 654.3

Critical Temperature (°R) 456.4

Average Molecular Weight 26.30

Calculated Gas Gravity (air = 1.000) 0.908

Gas Gravity

Factor, Fg 1.0494

Super Compressibility Factor, Fpv

at sampling conditions 1.0036

Gas Z-Factor

at sampling conditions * 0.993

at 14.65 psia and 60 °F

Gross Heating Value

(BTU/scf dry gas) 1539

Properties of Plus Fractions

Component	Mol %	MW	Liq Dens (gm/cc)	API Gravity
Heptanes plus	0.45	101.4	0.732	45.1

* From: Standing, M.B., "Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems", SPE (Dallas), 1977, 8th Edition, Appendix II.

Arco Exploration & Production Technology

Brad Berg

RFL 920279

Composition of Stock Tank Gas

(From Chromatographic Technique)

Component	Mol %	GPM	MW	Liq Dens (gm/cc)
Hydrogen Sulfide	0.00			
Carbon Dioxide	0.54		44.010	.8172
Nitrogen	0.12		28.013	.8086
Methane	32.39		16.043	.2997
Ethane	16.07	4.274	30.070	.3558
Propane	26.17	7.172	44.097	.5065
iso-Butane	7.06	2.297	58.123	.5623
n-Butane	9.63	3.020	58.123	.5834
iso-Pentane	3.42	1.245	72.150	.6241
n-Pentane	1.78	.641	72.150	.6305
Hexanes	1.50	.579	84.000	.6850
Heptanes	0.88	.368	96.000	.7220
Octanes	0.40	.181	107.00	.7450
Nonanes	0.04	.020	121.00	.7640
Decanes plus	Nil			
Totals	100.00	19.797		

Sampling Conditions

0 psig

60 °F

Sample Characteristics

Base Case Separator Test

Critical Pressure (psia) 624.6

Critical Temperature (°R) 572.7

Average Molecular Weight 37.87

Calculated Gas Gravity (air = 1.000) 1.308

Properties of Plus Fractions

Component	Mol %	MW	Liq Dens (gm/cc)	API Gravity
Heptanes plus	1.32	100.1	0.730	45.4

at 14.65 psia and 60 °F

Gross Heating Value

(BTU/scf dry gas) 2156

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

Composition of Stock Tank Oil

(From Chromatographic Technique)

Component	Mol %	Wt %	Density (gm/cc)	MW	Vol %
Hydrogen Sulfide	.00	.00			
Carbon Dioxide	.00	.00			
Nitrogen	.00	.00			
Methane	.00	.00			
Ethane	.00	.00			
Propane	2.23	.48	.506	44.1	0.81
iso-Butane	.00	.00			
n-Butane	3.88	1.10	.583	58.1	1.61
iso-Pentane	2.56	.90	.624	72.2	1.23
n-Pentane	1.76	.62	.630	72.2	0.84
Hexanes	4.10	1.68	.685	84.0	2.09
Heptanes	6.66	3.12	.722	96.0	3.69
Octanes	9.13	4.79	.745	107.0	5.48
Nonanes	6.74	3.98	.764	121.0	4.45
Decanes	6.32	4.13	.778	134.0	4.53
Undecanes	4.99	3.58	.789	147.0	3.88
Dodecanes	4.33	3.40	.800	161.0	3.63
Tridecanes	4.93	4.21	.811	175.0	4.43
Tetradecanes	4.59	4.25	.822	190.0	4.41
Pentadecanes	4.68	4.70	.832	206.0	4.82
Hexadecanes	3.39	3.67	.839	222.0	3.73
Heptadecanes	3.02	3.49	.847	237.0	3.52
Octadecanes	3.01	3.68	.852	251.0	3.69
Nonadecanes	2.53	3.24	.857	263.0	3.23
Eicosanes	2.15	2.88	.862	275.0	2.85
Heneicosanes	1.84	2.61	.867	291.0	2.57
Docosanes	1.69	2.51	.872	305.0	2.46
Tricosanes	1.49	2.31	.877	318.0	2.25
Tetracosanes	1.33	2.15	.881	331.0	2.08
Pentacosanes	1.27	2.14	.885	345.0	2.07
Hexacosanes	.98	1.72	.889	359.0	1.65
Heptacosanes	1.08	1.97	.893	374.0	1.89
Octacosanes	.97	1.83	.896	388.0	1.74
Nonacosanes	.83	1.62	.899	402.0	1.54
Triacotanes	.88	1.79	.902	416.0	1.69
Hentriacotanes	.76	1.59	.906	430.0	1.49
Dotriacotanes	.60	1.29	.909	444.0	1.21
Tritriacotanes	.56	1.24	.912	458.0	1.16
Tetratriacontanes	.50	1.15	.914	472.0	1.08
Pentatriacontanes	.35	.84	.917	486.0	0.79
Hexatriacontanes plu	3.87	15.34	1.149	811.5	11.41
Totals	100.00	100.00			100.00

Sample Characteristics

"Base Case" Separator Test

Total Liquid Molecular Weight 205.0
 Total Liquid Density (gm/cc) 0.8538
 Total Liquid API Gravity 34.2

Properties of Heavy Fractions

Plus Fractions	Mol %	Wt %	Density (gm/cc)	°API	MW
Hexanes plus	89.57	96.90	0.866	31.9	221.8
Heptanes plus	85.47	95.22	0.870	31.1	228.4
Decanes plus	62.94	83.33	0.892	27.2	271.5
Undecanes plus	56.62	79.20	0.899	26.0	286.8
Pentadecanes plus	37.78	63.76	0.924	21.6	346.1
Eicosanes plus	21.15	44.98	0.962	15.6	436.1
Pentacosanes plus	12.65	32.52	1.002	9.7	527.0
Triacotanes plus	7.52	23.24	1.054	2.7	633.3
Pentatriacontanes plus	4.22	16.18	1.134	-6.7	784.5

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

SEPARATOR FLASH ANALYSIS*

Flash Conditions		Gas/Oil Ratio (scf/bbl)	Gas/Oil Ratio (scf/STbbl)	Stock Tank Oil Gravity at 60 °F (°API)	Formation Volume Factor Bofb (C)	Separator Volume Factor (D)	Specific Gravity of Flashed Gas (Air=1.000)	Oil Phase Density (gm/cc)
psig	°F	(A)	(B)					
2200	119							0.7557
100	90	453	466			1.030	0.733	0.8365
25	140	28	29			1.038	0.952	0.8242
0	60	15	15	34.4	1.238	1.000	**	0.8518
		Rsfb =		510				
1500	119							0.7706
100	90	314	324			1.033	0.772	0.8359
25	140	33	35			1.039	0.985	0.8239
0	60	10	10	34.6	1.191	1.000	**	0.8537
		Rsfb =		369				
800	119							0.7822
100	90	153	159			1.038	0.817	0.8258
25	140	35	36			1.039	1.032	0.8172
0	60	10	10	34.8	1.132	1.000	**	0.8467
		Rsfb =		206				

* Performed on prepared differential vaporization fluids.

** Insufficient quantity for measurement.

(A) Cubic Feet of gas at 14.65 psia and 60 °F per Barrel of oil at indicated pressure and temperature.

(B) Cubic Feet of gas at 14.65 psia and 60 °F per Barrel of Stock Tank Oil at 60 °F.

(C) Barrels of saturated oil at indicated pressure and 119°F per Barrel of Stock Tank Oil at 60°F.

(D) Barrels of oil at indicated pressure and temperature per Barrel of Stock Tank Oil at 60 °F.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

DIFFERENTIAL VAPORIZATION ADJUSTED TO SEPARATOR CONDITIONS*

Pressure psig	Solution Gas/Oil Ratio Rs (A)	Formation Volume Factor Bo (B)	Gas Formation Volume Factor (C)	Oil Density gm/cc	Oil/Gas Viscosity Ratio
5000	625.	1.255		0.7569	
4500	625.	1.260		0.7540	
4000	625.	1.265		0.7510	
3500	625.	1.271		0.7479	
3400	625.	1.272		0.7473	
3300	625.	1.273		0.7466	
3200	625.	1.274		0.7460	
3100	625.	1.275		0.7453	
b» 3019	625.	1.276		0.7448	
2700	563.	1.253	0.00496	0.7512	55.8
2400	505.	1.232	0.00554	0.7576	65.7
2100	448.	1.210	0.00639	0.7644	78.8
1800	390.	1.189	0.00758	0.7715	95.0
1500	333.	1.167	0.00929	0.7789	114.0
1200	276.	1.146	0.01190	0.7866	138.0
900	218.	1.124	0.01627	0.7945	165.0
600	160.	1.102	0.02495	0.8025	198.0
300	98.	1.079	0.05028	0.8107	242.0
105	53.	1.062	0.13489	0.8164	289.0
0	11.	1.032		0.8293	

*Separator Conditions	
First Stage	100 psig at 90 °F
Second Stage	25 psig at 140 °F
Stock Tank	0 psig at 60 °F

(A) Cubic Feet of gas at 14.65 psia and 60 °F per Barrel of Stock Tank Oil at 60 °F.

(B) Barrel of oil at indicated pressure and temperature per Barrel of Stock Tank Oil at 60 °F.

(C) Cubic Feet of gas at indicated pressure and temperature per Cubic Feet at 14.65 psia and 60 °F.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

DIFFERENTIAL VAPORIZATION ADJUSTED TO SEPARATOR CONDITIONS*

Pressure psig	Solution Gas/Oil Ratio Rs (A)	Formation Volume Factor Bo (B)	Gas Formation Volume Factor (C)	Oil Density gm/cc	Oil/Gas Viscosity Ratio
5000	632.	1.264		0.7569	
4500	632.	1.269		0.7540	
4000	632.	1.274		0.7510	
3500	632.	1.279		0.7479	
3400	632.	1.280		0.7473	
3300	632.	1.281		0.7466	
3200	632.	1.282		0.7460	
3100	632.	1.284		0.7453	
b» 3019	632.	1.284		0.7448	
2700	569.	1.261	0.00496	0.7512	55.8
2400	511.	1.240	0.00554	0.7576	65.7
2100	453.	1.218	0.00639	0.7644	78.8
1800	395.	1.197	0.00758	0.7715	95.0
1500	338.	1.175	0.00929	0.7789	114.0
1200	280.	1.153	0.01190	0.7866	138.0
900	222.	1.132	0.01627	0.7945	165.0
600	163.	1.110	0.02495	0.8025	198.0
300	101.	1.087	0.05028	0.8107	242.0
105	56.	1.069	0.13489	0.8164	289.0
0	14.	1.039		0.8293	

*Separator Conditions	
First Stage Second Stage Stock Tank	100 psig at 140 °F 25 psig at 140 °F 0 psig at 60 °F

(A) Cubic Feet of gas at 14.65 psia and 60 °F per Barrel of Stock Tank Oil at 60 °F.

(B) Barrel of oil at indicated pressure and temperature per Barrel of Stock Tank Oil at 60 °F.

(C) Cubic Feet of gas at indicated pressure and temperature per Cubic Feet at 14.65 psia and 60 °F.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

DIFFERENTIAL VAPORIZATION ADJUSTED TO SEPARATOR CONDITIONS*

Pressure psig	Solution Gas/Oil Ratio Rs (A)	Formation Volume Factor Bo (B)	Gas Formation Volume Factor (C)	Oil Density gm/cc	Oil/Gas Viscosity Ratio
5000	593.	1.240		0.7569	
4500	593.	1.245		0.7540	
4000	593.	1.250		0.7510	
3500	593.	1.255		0.7479	
3400	593.	1.256		0.7473	
3300	593.	1.257		0.7466	
3200	593.	1.258		0.7460	
3100	593.	1.260		0.7453	
b» 3019	593.	1.260		0.7448	
2700	532.	1.238	0.00496	0.7512	55.8
2400	474.	1.217	0.00554	0.7576	65.7
2100	418.	1.195	0.00639	0.7644	78.8
1800	361.	1.174	0.00758	0.7715	95.0
1500	304.	1.153	0.00929	0.7789	114.0
1200	248.	1.132	0.01190	0.7866	138.0
900	191.	1.111	0.01627	0.7945	165.0
600	133.	1.089	0.02495	0.8025	198.0
300	72.	1.066	0.05028	0.8107	242.0
105	28.	1.049	0.13489	0.8164	289.0
0		1.019		0.8293	

*Separator Conditions	
First Stage	500 psig at 90 °F
Second Stage	100 psig at 90 °F
Third Stage	25 psig at 140 °F
Stock Tank	0 psig at 60 °F

(A) Cubic Feet of gas at 14.65 psia and 60 °F per Barrel of Stock Tank Oil at 60 °F.

(B) Barrel of oil at indicated pressure and temperature per Barrel of Stock Tank Oil at 60 °F.

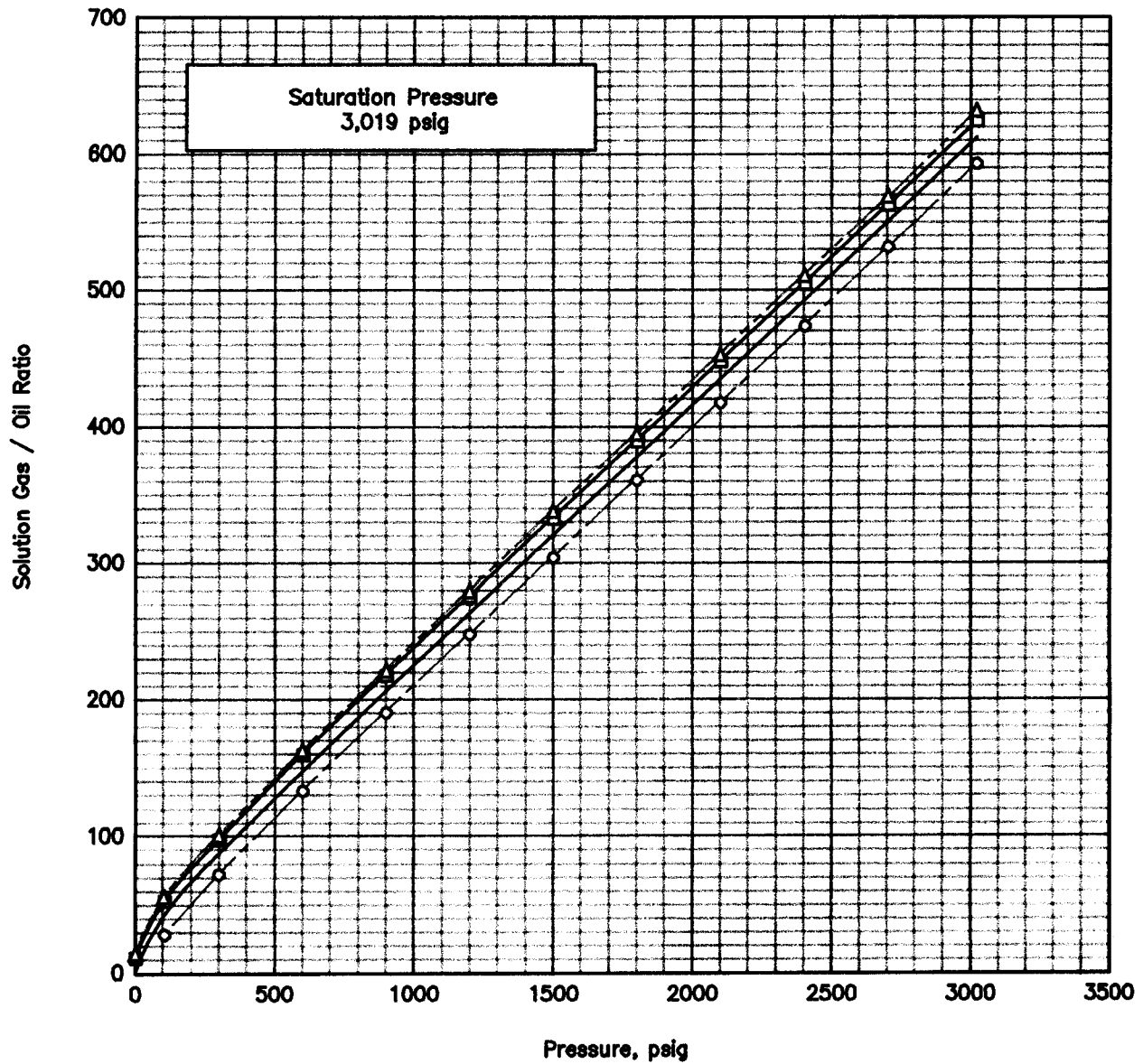
(C) Cubic Feet of gas at indicated pressure and temperature per Cubic Feet at 14.65 psia and 60 °F.

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

SOLUTION GAS/OIL RATIO (scf/STbbl)



LEGEND	
—	Differential Vaporization
□	100 psig at 90 °F
△	100 psig at 140 °F
○	500 psig at 90 °F

DV Adjusted to Separator

Figure D-1

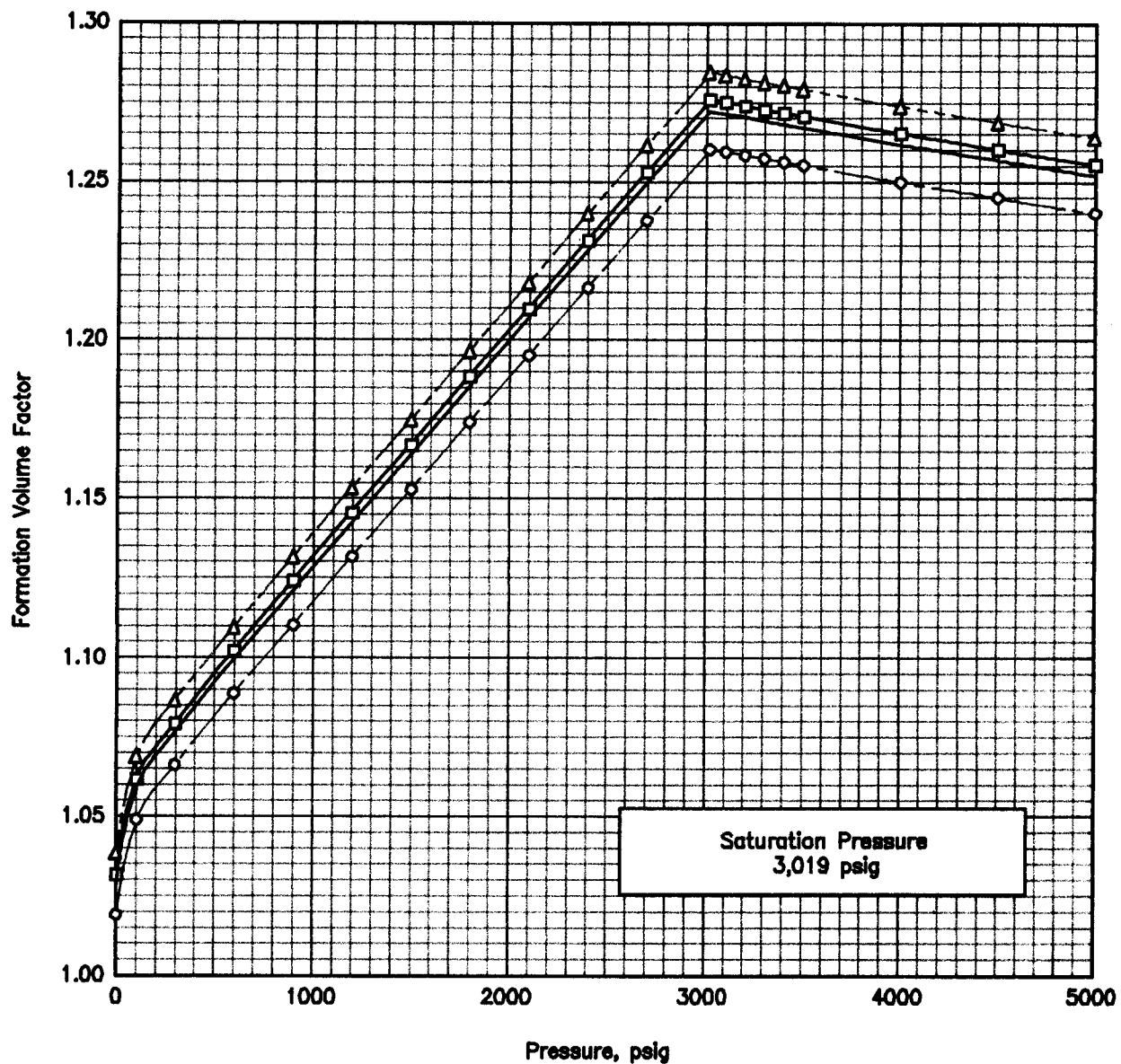
CORE LABORATORIES

Arco Exploration & Production Technology

Brad Berg #1

RFL 920279

FORMATION VOLUME FACTOR



LEGEND		DV Adjusted to Separator Figure D-2
—	Differential Vaporization	
□	100 psig at 90 °F	
△	100 psig at 140 °F	
○	500 psig at 90 °F	

CORE LABORATORIES

Appendix
Nomenclature and Equations

PRESSURE-VOLUME RELATIONS

Nomenclature and Equations

P_b	=	Bubblepoint Pressure
X_d	=	Dimensionless Pressure (P_i / P_b)
dP	=	Pressure Difference ($P_i - P_b$)
Y_f	=	Y-Function (dimensionless compressibility)
RV	=	PV Relative Volume
C_{sp}	=	Average Single-Phase Compressibility of Reservoir Fluid

For Relative Volume below bubblepoint pressure:

$$RV_i = (P_b - P_i) / Y_f$$

For Average Single-Phase Compressibility above bubblepoint pressure:

$$C_{sp} = (RV_i - RV_{i-1}) / [RV_i (P_{i-1} - P_i)]$$

DIFFERENTIAL VAPORIZATION

Nomenclature and Equations

P_b	=	Bubblepoint Pressure
P_{base}	=	Base Pressure
T_{base}	=	Base Temperature
T_{res}	=	Reservoir Temperature
X_d	=	Dimensionless Pressure (P_i / P_b)
dP	=	Pressure Difference ($P_i - P_b$)
RV	=	Relative Volume from Pressure-Volume Relations
$Dens$	=	Single-Phase Oil Density
$Dens_b$	=	Oil Density at Bubblepoint Pressure
ROV	=	Relative Oil Volume
ROV_b	=	Relative Oil Volume at Bubblepoint Pressure
B_g	=	Gas Formation Volume Factor

For Oil Density above bubblepoint pressure:

$$Dens_i = Dens_b / RV_i$$

For Relative Oil Volume above bubblepoint pressure:

$$ROV_i = ROV_b * RV_i$$

For Gas Formation Volume Factor below bubblepoint pressure:

$$B_g = P_{base} * Z_i * T_{res} / (P_i * T_{base})$$

DIFFERENTIAL VAPORIZATION DATA ADJUSTED TO SURFACE CONDITIONS

Nomenclature and Equations

P_b	=	Bubblepoint Pressure
B_o	=	Oil Formation Volume Factor
B_{ofb}	=	Formation Volume Factor from field conditions or optimum separator flash test
B_{od}	=	Relative Oil Volume from differential vaporization test
B_{odb}	=	Value of B_{od} at bubblepoint pressure
RV	=	Relative Volume from Pressure-Volume relations

For B_o above bubblepoint pressure:

$$B_o = RV * B_{ofb}$$

For B_o below bubblepoint pressure:

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

R_s	=	Gas in solution
R_{sfb}	=	Sum of separator gas and the stock tank gas from field conditions (or optimum) separator flash test
R_{sd}	=	Gas in solution from the differential vaporization test
R_{sdb}	=	R_{sd} at bubblepoint pressure

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