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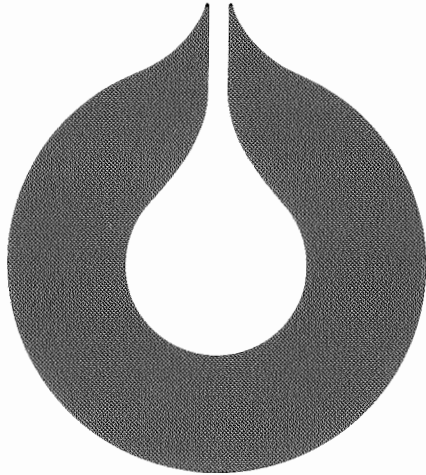
 **STATOIL**

99.395.274-21  
**L&U DOK. SENTER**

L.NR. 20084110011

KODE Well 34/10-16 nr 29

Returneres etter bruk



**statoil**



Classification

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Subtitle

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Title

PVT - Analysis  
Well: 34/10-16  
DST no. 1  
STATOIL  
EXPLORATION & PRODUCTION  
LABORATORY

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## INTRODUCTION

The present report gives the results of a PVT analysis on a bottom hole sample from DST # 1 on well 34/10-16 obtained by FLOPETROL 10.09.1983.

Two bottom hole samples and one set separator samples were initially checked for consistency. The bottom hole samples were heated to ca 80 C, transferred to a PVT cell, and subjected to a constant mass expansion at reservoir temperature. The two samples showed a similar bubble point of 403 and 408 barg respectively (page 3 and 11 respectively). The sample with the highest bubble point was chosen for further study, and was flashed to standard conditions to determine the reservoir composition (page 4). The extended reservoir composition, density and molecular weights given on page 5 were calculated from a TBP distillation of the stock tank oil. The TBP distillation is reported separately.

During the single flash it was observed that the STO was solid at normal flash temperature of 15 C. The flash was therefore carried out at 28 C and atmospheric pressure. The STO density at 15 C is calculated from the measured value at 28 C (0.853 g/cm<sup>3</sup>). Similarly, the density at 15 C of the residual oil from the differential liberation is calculated from a value of 0.8529 g/cm<sup>3</sup> measured at 30 C.

The separator samples were analysed separately (page 12 and 14), recombined and subjected to a constant mass expansion (page 17). Both the bubble point and calculated reservoir fluid composition (page 16) are similar to the bottom hole samples.

Differential liberation of the bottom hole sample was carried out through a series of pressure steps with the results given on page 6,7 and 8.

A separate portion of the bottom hole sample was charged to a rolling ball viscosimeter for measuring the oil viscosity (page 9).

Separator tests were simulated with an SRK equation of state model. The results, together with an experimental single flash, are on page 10. Since separator tests were not requested a temperature equal to the test separator was assumed.

SAMPLING CONDITIONS \*)

FIELD	34/10 ALPHA
WELL	34/10-16
TEST	DST 1
PERFORATION	3397 - 3407 mRKB
DATE	10-11.09.83
RESERVOIR FLUID	OIL
SAMPLE, BHS # 1	Bottle 16251/33
BHS # 2	Bottle 9214/315
Separator oil	Bottle nr 83021412
Separator gas	Bottle nr A14693
SEPARATOR TEMP	60.0 C
SEPARATOR PRESSURE	22 Barg
FLOWING BOTTOM HOLE PRESSURE	
During BHS	450 Bara
During sep sampl	304 Bara
STATIC BOTTOM HOLE PRESSURE **	459.4 Bara
BOTTOM HOLE TEMPERATURE **	128.5 C
OIL RATE	1031.7 m <sup>3</sup> /D
GAS RATE	181.5 MSCM/D
METER FACTOR	0.9938
GAS-OIL RATIO ( Separator )	177.0 Sm <sup>3</sup> /m <sup>3</sup>

\*)

Data from Flopetrol Well Testing Report 83/2301/35

\*\*)

Data supplied by STATOIL, LET/B

WELL: 34/10-16  
BHS # 1

CONSTANT MASS EXPANSION AT 128.5 C

PRESSURE BARG	REL VOL V/Vb	COMPRESSIBILITY 1/BAR	Y-FACTOR
548.7	0.9727	1.66E-04	
524.5	0.9772	1.76E-04	
501.0	0.9809	1.86E-04	
476.5	0.9856	1.97E-04	
451.7	0.9904	2.07E-04	
429.2	0.9954	2.17E-04	
414.2	0.9987	2.23E-04	
Pb = 408.0	1.0000	2.25E-04	
404.1	1.0022		4.32
389.1	1.0112		4.32
368.0	1.0263		4.13
339.7	1.0507		3.97
307.6	1.0840		3.88
276.1	1.1277		3.74
253.8	1.1666		3.65
221.4	1.2417		3.49
202.0	1.3009		3.39
173.6	1.4168		3.24
146.2	1.5760		3.11
115.7	1.8616		2.93
82.8	2.4190		2.77

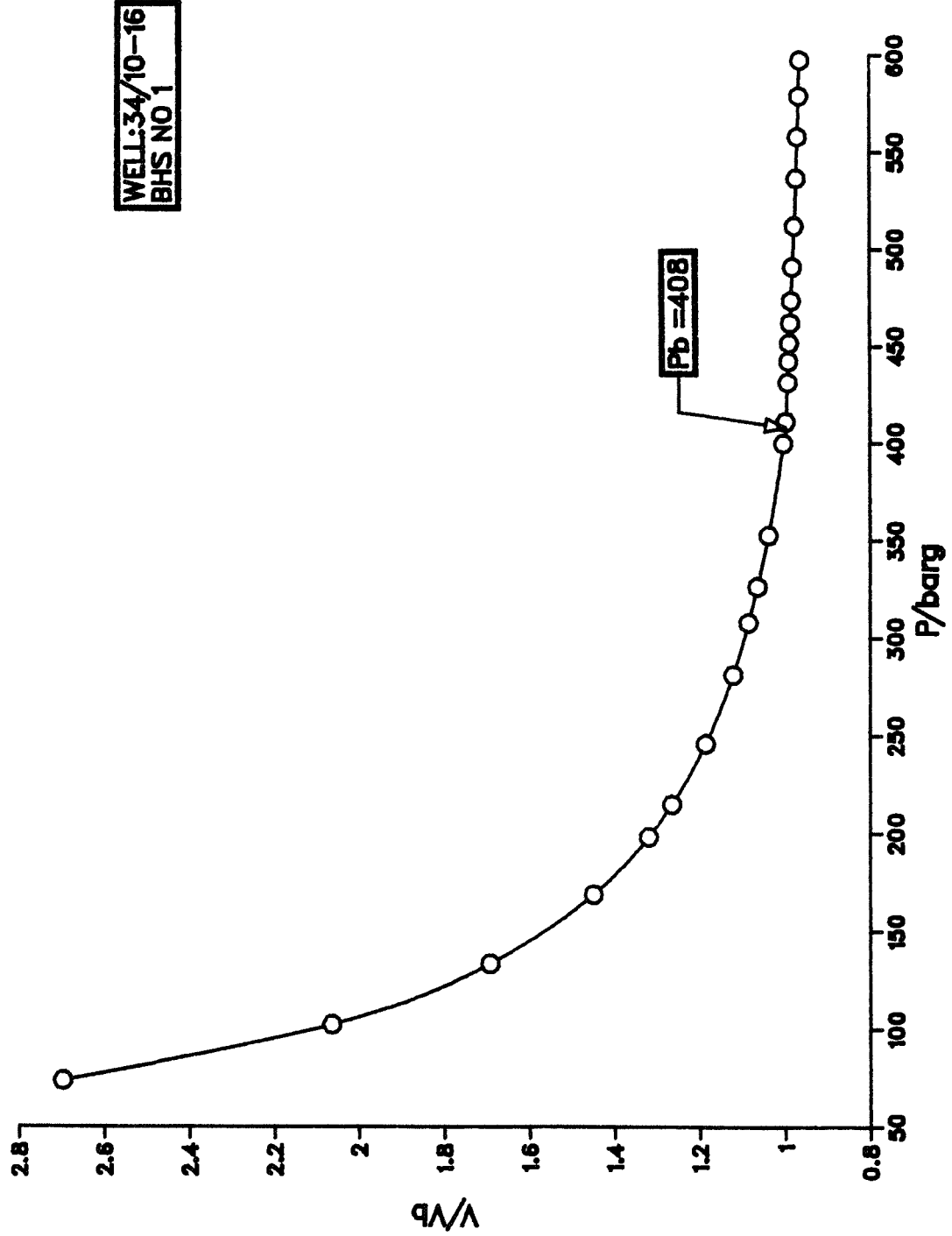
FOR P < Pb  
FOR P > Pb

$$Y = 2.398 + 4.81E-03 \times P$$

$$V/Vb = 1.12976 - 4.1095E-04 \times P + 2.2769E-07 \times P \times P$$

FIG.1

CONSTANT MASS EXPANSION AT 128.5 °C



34/10-16  
BHS # 1

COMPOSITION OF RESERVOIR FLUID  
(Single flash to stock tank conditions)

	STOCK TANK OIL	EVOLVED GAS	RECOMBINED LIQUID		
	MOL%	MOL%	WEIGHT%	MOL WT	MOL%
NITROGEN	0.00	0.15	0.04	28.0	0.11
CARBONDIOXIDE	0.00	2.22	0.84	44.0	1.62
METHANE	0.00	81.74	11.25	16.0	59.79
ETHANE	0.06	7.76	2.01	30.1	5.69
PROPANE	0.21	3.67	1.42	44.1	2.74
i-BUTANE	0.12	0.58	0.31	58.1	0.46
n-BUTANE	0.43	1.31	0.73	58.1	1.07
i-PENTANE	0.39	0.44	0.36	72.2	0.43
n-PENTANE	0.64	0.52	0.47	72.2	0.55
HEXANES	1.69	0.51	0.82	84.7	0.82
HEPTANES	5.08	0.66	1.93	89.1	1.84
OCTANES	8.03	0.37	2.89	101.6	2.43
NONANES	5.90	0.06	2.23	116.3	1.63
DECANE PLUS	77.45	0.01	74.71	306.0	20.82
	-----	-----	-----		-----
	100.00	100.00	100.00		100.00
MOL WEIGHT	259.2	21.34			85.27

Gas oil ratio	=	214.2	Sm <sup>3</sup> /Sm <sup>3</sup> STO
Flash formation volume factor of bubble point liquid	=	1.638	m <sup>3</sup> /Sm <sup>3</sup> STO
Density at bubble point	=	0.645	g/cm <sup>3</sup>
Density of STO	=	0.863	g/cm <sup>3</sup> at 15C
Gas gravity (air=1)	=	0.737	
Density of C10+	=	0.869	g/cm <sup>3</sup>



34/10-16  
BHS # 1

1)  
EXTENDED RESERVOIR FLUID COMPOSITION

COMPONENT	WEIGHT%	MOL WEIGHT	MOL%	DENSITY g/cm <sup>3</sup> at 15C
N2	0.04	28.0	0.11	
CO2	0.84	44.0	1.62	
C1	11.25	16.0	59.79	
C2	2.01	30.1	5.69	
C3	1.42	44.1	2.74	
iC4	0.31	58.1	0.46	
nC4	0.73	58.1	1.07	
iC5	0.36	72.2	0.43	
nC5	0.47	72.2	0.55	
C6	0.82	84.7	0.82	0.695
C7	1.93	89.1	1.84	0.751
C8	2.89	101.6	2.43	0.778
C9	2.23	116.3	1.63	0.793
C10	2.04	132.0	1.33	0.798
C11	1.58	147.0	0.92	0.803
C12	1.94	163.0	1.02	0.817
C13	1.72	175.0	0.85	0.836
C14	3.03	190.0	1.37	0.843
C15	3.07	205.0	1.29	0.849
C16	1.68	215.0	0.67	0.853
C17	3.41	237.0	1.24	0.844
C18	3.11	251.0	1.07	0.846
C19	2.55	263.0	0.83	0.855
C20+	50.58	425.0	10.24	0.885
	-----		-----	
	100.00		100.01	

1)  
Data to C9 based on single flash,  
remaining on TBP distillation

WELL:34/10-16  
BHS # 1

DIFFERENTIAL DEPLETION AT 128.5 C

PRESSURE	OIL FORM VOL FACT	SOLUTION GOR	GAS FORM VOL FACT	RES OIL DENSITY	COMPR FACTOR	GAS VISCOSIT
BARG	Bod	Rsd	Bg	g/cm <sup>3</sup>	Z	cP
408.0	1.655	214.5		0.644		
386.8	1.604	194.7	3.85E-03	0.653	1.062	0.0318
353.7	1.552	174.1	4.15E-03	0.662	1.045	0.0284
296.6	1.452	139.0	4.74E-03	0.686	1.003	0.0247
248.3	1.400	113.0	5.41E-03	0.696	0.958	0.0220
197.7	1.343	89.6	6.64E-03	0.711	0.938	0.0197
125.7	1.264	57.0	1.04E-02	0.734	0.936	0.0169
71.2	1.210	34.2	1.85E-02	0.750	0.951	0.0152
31.5	1.168	17.6	4.25E-02	0.763	0.981	0.0140
0	1.096			0.788		
0 *	1.000			0.864		

\* AT 15 C

**Bod** : Volume of oil at P and T per volume  
of residual oil at 15 C and atm P

**Rsd** : Standard m<sup>3</sup> gas per m<sup>3</sup> residual oil  
at 15 C and atm P

**Bg** : m<sup>3</sup> gas at T and P per standard m<sup>3</sup> gas

WELL: 34/10-16

BHS # 1

DIFFERENTIAL DEPLETION AT 128.5 C

(Molecular composition of differentially liberated gas, mol%)

PRESSURE/BARG	386.8	353.7	296.6	248.3	197.7	125.7	71.2	31.5	0.0
NITROGEN	0.25	0.20	0.25	0.22	0.16	0.16	0.08	0.06	0.00
CARBONDIOXIDE	1.91	1.95	1.97	2.03	2.09	2.26	2.52	2.90	2.93
METHANE	85.06	85.73	86.19	86.79	86.77	85.60	82.79	75.62	50.23
ETHANE	5.59	5.69	5.74	5.91	6.07	6.83	8.35	11.57	18.01
PROPANE	2.18	2.21	2.19	2.22	2.24	2.51	3.19	5.00	12.16
i-BUTANE	0.31	0.33	0.32	0.31	0.31	0.33	0.42	0.68	2.08
n-BUTANE	0.68	0.68	0.66	0.65	0.63	0.68	0.85	1.41	4.65
i-PENTANE	0.23	0.23	0.22	0.21	0.20	0.20	0.25	0.40	1.54
n-PENTANE	0.28	0.28	0.26	0.25	0.23	0.24	0.28	0.47	1.74
HEXANES	0.35	0.34	0.31	0.28	0.26	0.26	0.29	0.46	1.73
HEPTANES	0.58	0.57	0.50	0.47	0.43	0.39	0.42	0.65	2.05
OCTANES	0.62	0.56	0.49	0.37	0.34	0.31	0.33	0.49	1.64
NONANES	0.41	0.27	0.22	0.13	0.13	0.12	0.12	0.15	0.69
DECANES+	1.55	0.96	0.68	0.16	0.14	0.12	0.12	0.14	0.56
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
MOLE WEIGHT	22.72	21.72	21.03	19.92	19.91	20.05	20.77	22.90	37.34
GRAVITY (Air=1)	0.784	0.750	0.726	0.688	0.687	0.692	0.717	0.791	1.289

DIFFERENTIAL DEPLETION AT 128.5 C  
(Molecular composition of residual oil)

COMPONENT	MOL%	
NITROGEN	0.00	
CARBONDIOXIDE	0.00	
METHANE	0.00	
ETHANE	0.04	
PROPANE	0.23	
i-BUTANE	0.13	
n-BUTANE	0.47	
i-PENTANE	0.38	
n-PENTANE	0.62	
HEXANES	1.44	
HEPTANES	4.37	
OCTANES	6.97	
NONANES	5.15	
DECANES+	80.20	
	-----	
	100.00	
DENSITY AT 15 C	0.864	g/cm <sup>3</sup>
MOLE WEIGHT	263.2	

FIG.2

DIFFERENTIAL DEPLETION AT 128.5 °C  
OIL FORMATION VOLUME FACTOR

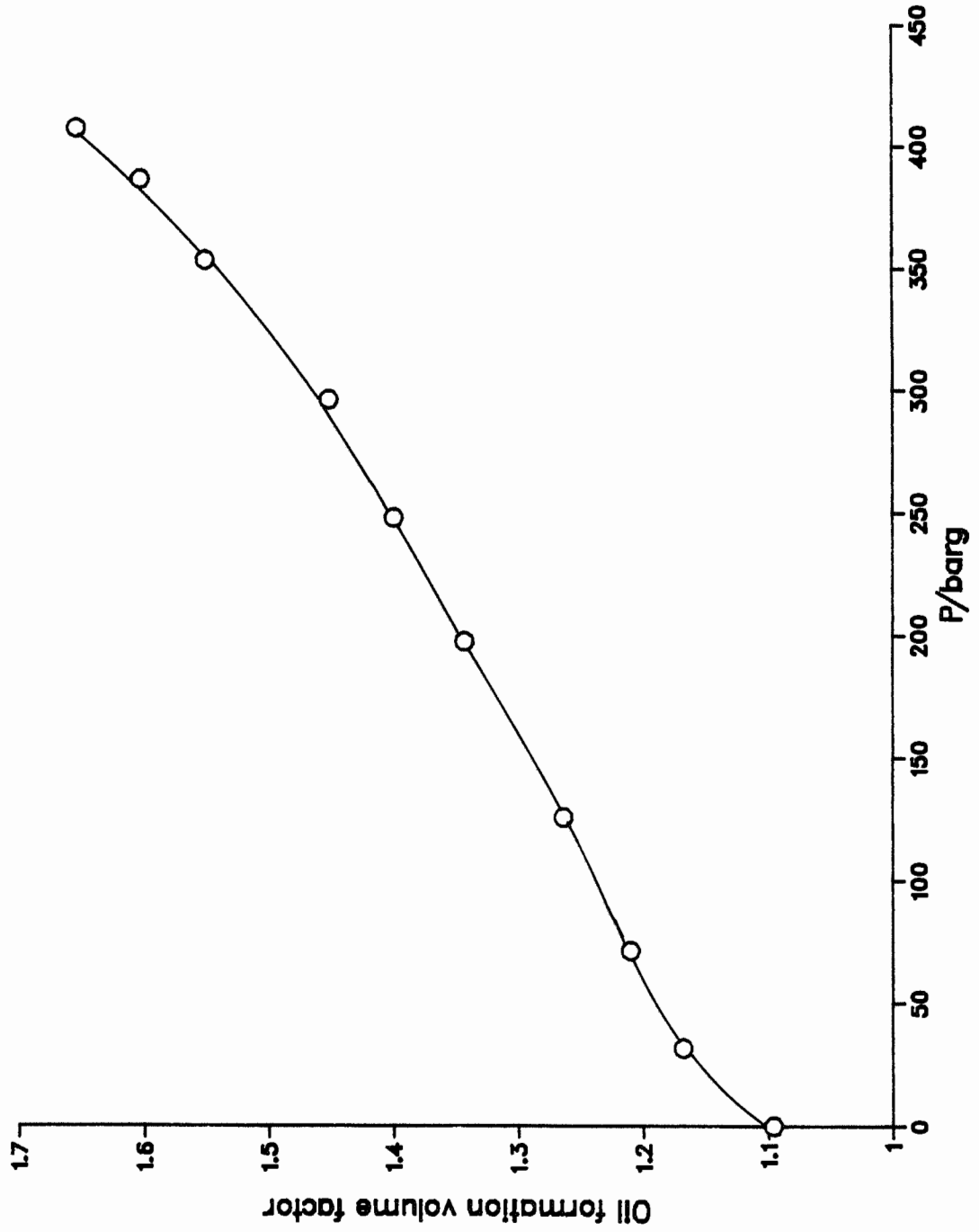


FIG.3

DIFFERENTIAL DEPLETION AT 128.5 °C  
SOLUTION GOR

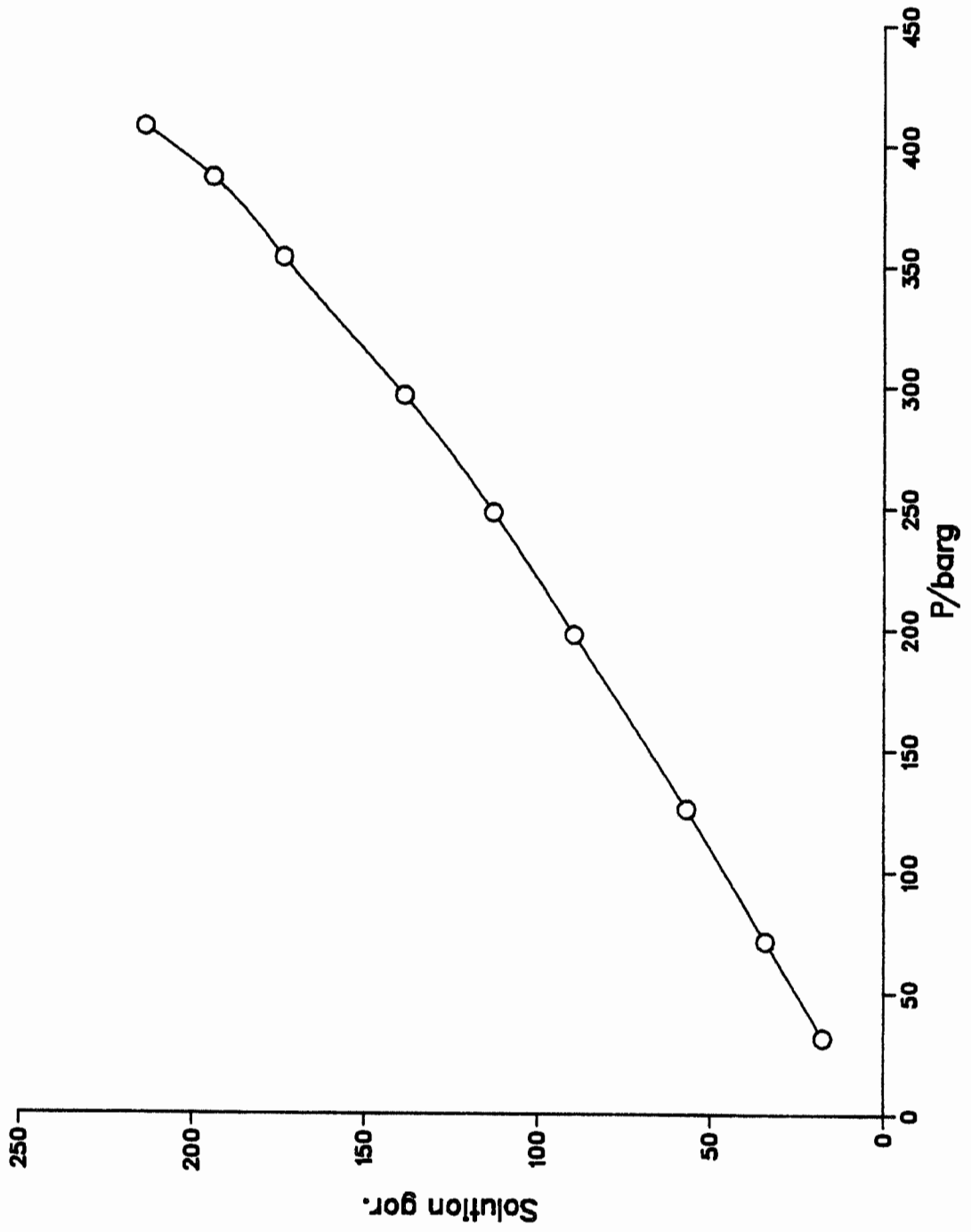


FIG. 4

DIFFERENTIAL DEPLETION AT 128.5 °C  
COMPRESSIBILITY FACTOR

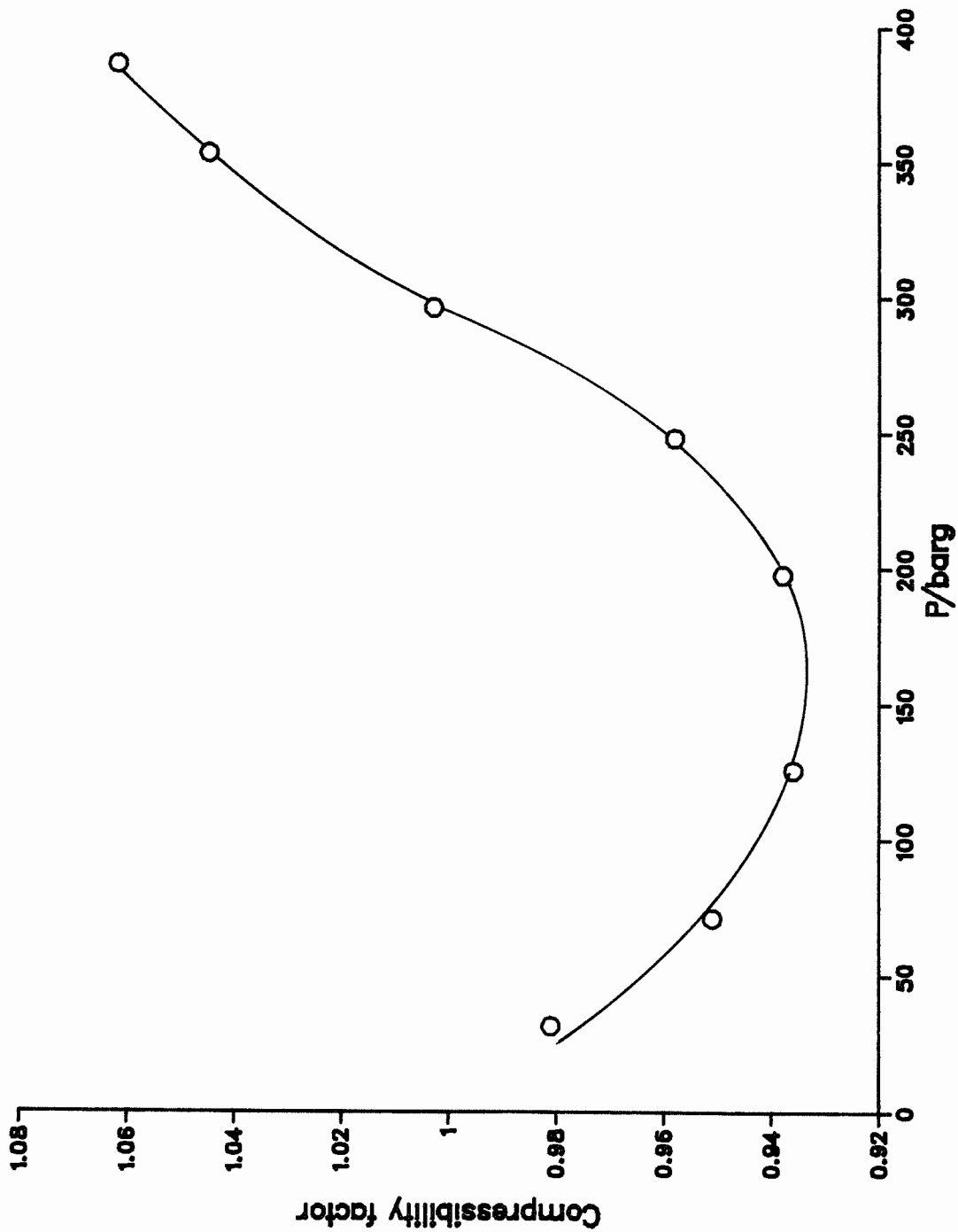


FIG 5

DIFFERENTIAL DEPLETION AT 128.5 °C  
GAS FORMATION VOLUME FACTOR

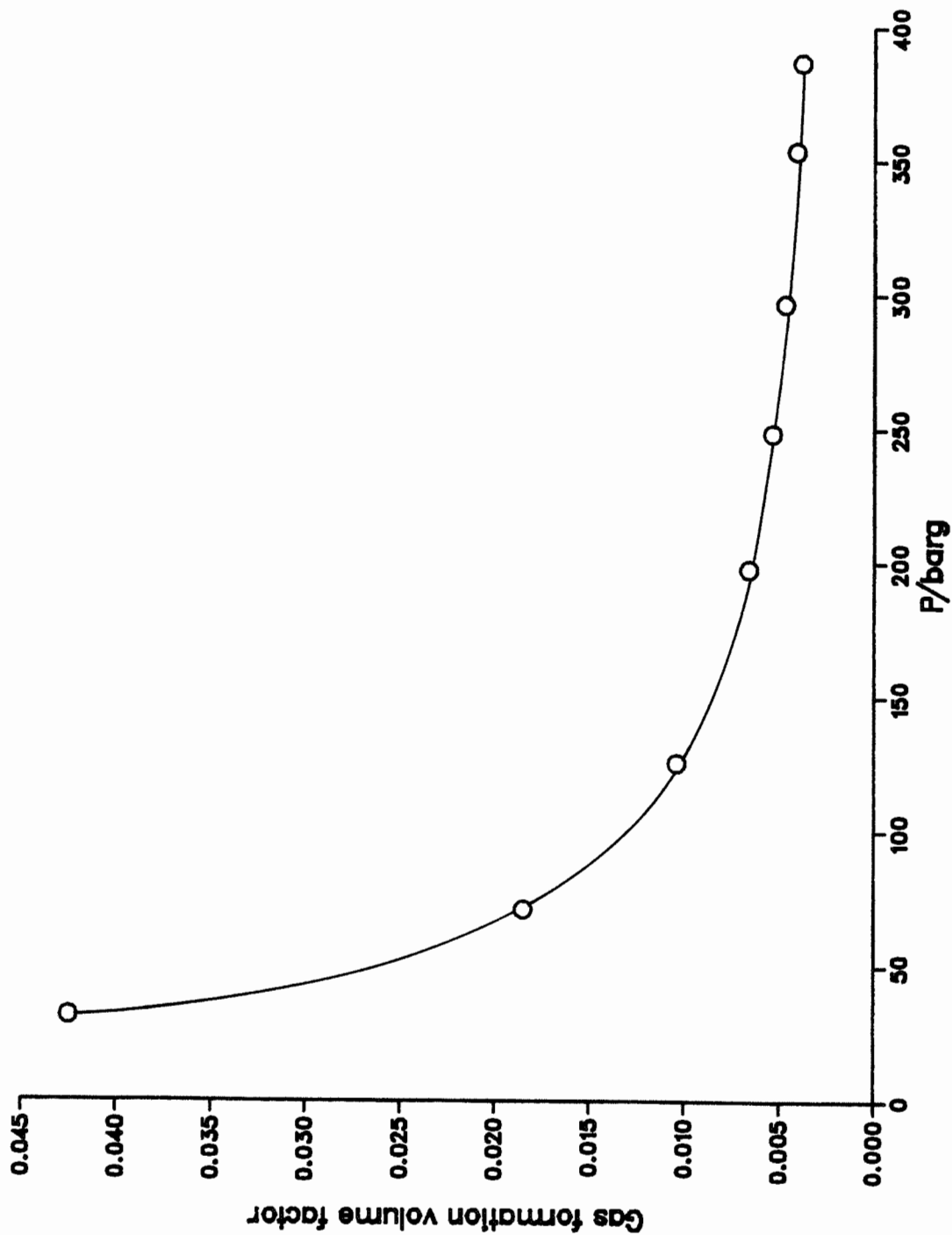
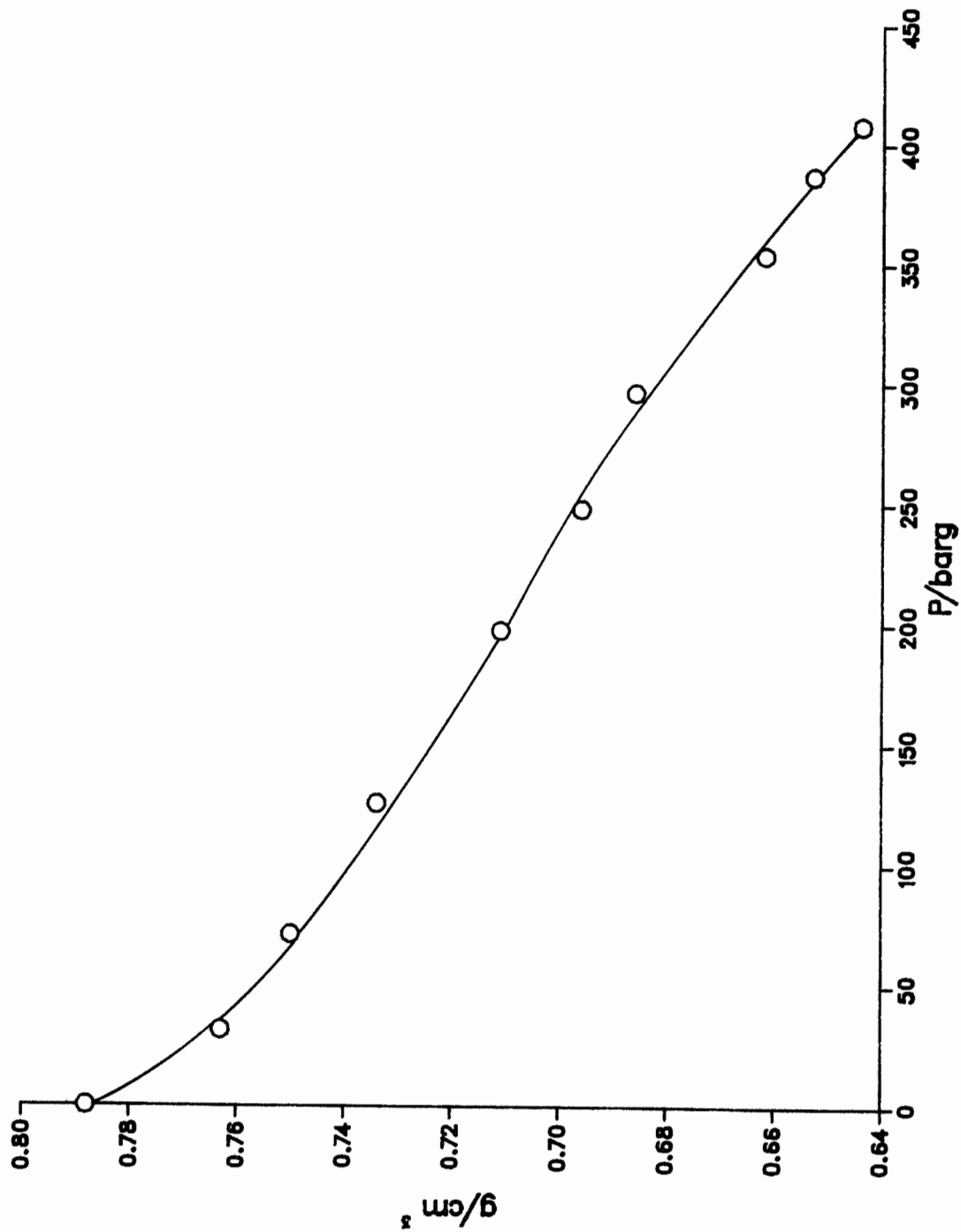




FIG. 6

DIFFERENTIAL DEPLETION AT 128.5 °C  
RESERVOIR OIL DENSITY



WELL:34/10-16

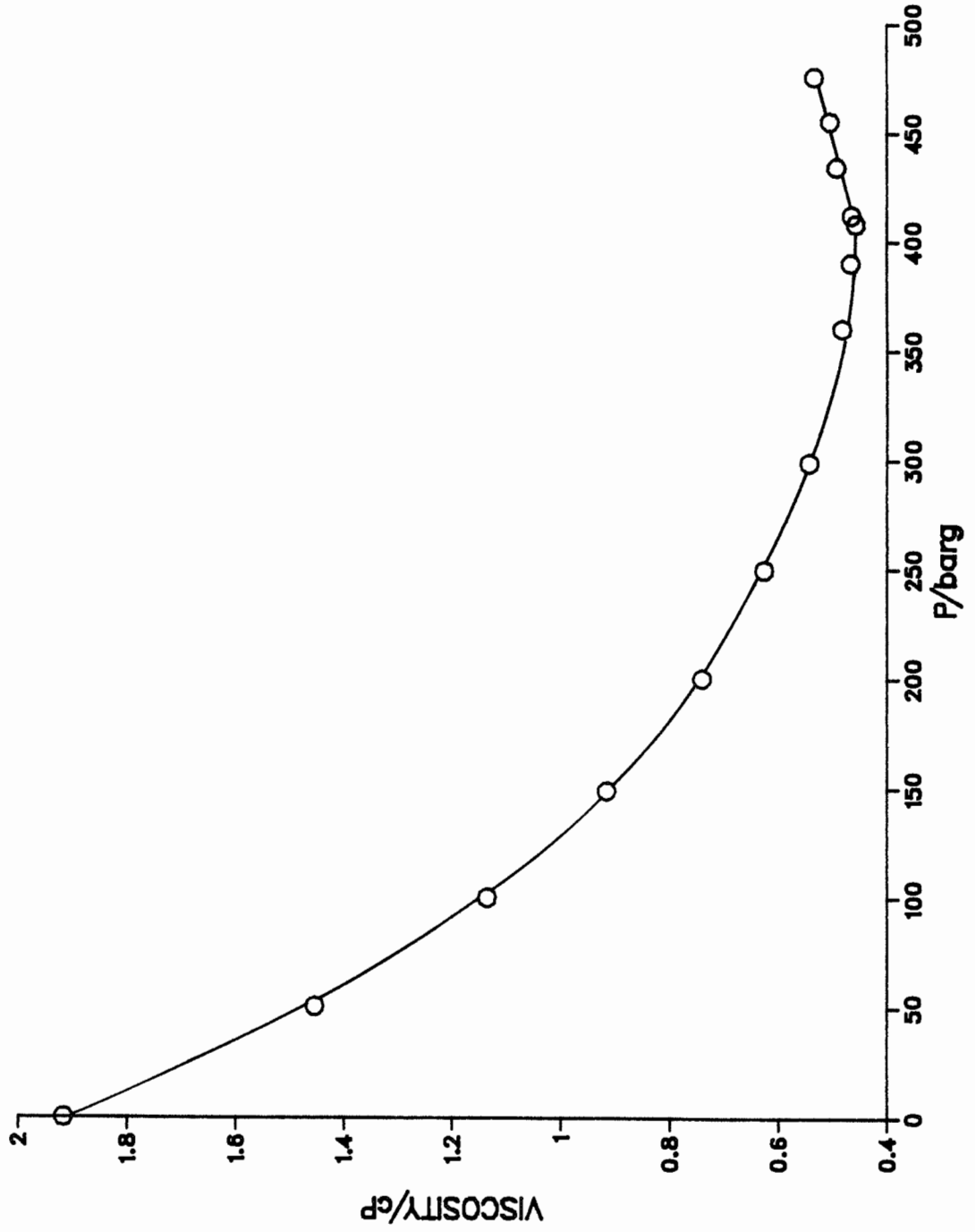
BHS # 1

VISCOSITY OF RESERVOIR FLUID AT 128.5 C

	PRESSURE (Barg)	VISCOSITY (Centipoise)
	475.6	0.535
	455.1	0.506
	434.1	0.494
	412.1	0.466
Pb =	408.0	0.458
	390.2	0.467
	360.0	0.483
	298.7	0.544
	249.7	0.627
	200.2	0.740
	149.0	0.916
	100.3	1.136
	50.6	1.454
	0	1.917

FIG. 7

# VISCOSITY OF RESERVOIR FLUID AT 128.5 °C



WELL:34/10-16

DST 1

SEPARATOR TEST OF RESERVOIR FLUID

Calculated values from EOS simulation

SEPARATOR		GAS-OIL RATIO		GAS GRAVITY		FORM	DENSITY
Pressure	Temp	(Sm <sup>3</sup> /m <sup>3</sup> )		(Air = 1)		FACTOR	STO 15C
Barg	C	Separator	Stock tank	Separator	Stock Tank	Bof	g/cm <sup>3</sup>
* 0	28	214		0.737		1.638	0.863
0	28	211		0.727		1.635	0.879
65	60	166	36	0.645	0.853	1.595	0.873
40	60	179	22	0.665	0.883	1.582	0.873
22	60	190	11	0.669	0.890	1.584	0.873

\* Experimental, density of STO at 28 C is 0.853 g/cm<sup>3</sup>

GOR : Std m<sup>3</sup> gas per m<sup>3</sup> STO at 15 C

Bof : m<sup>3</sup> bubble point oil at indicated P and T per m<sup>3</sup> STO at 15 C

WELL:34/10-16  
BHS # 2

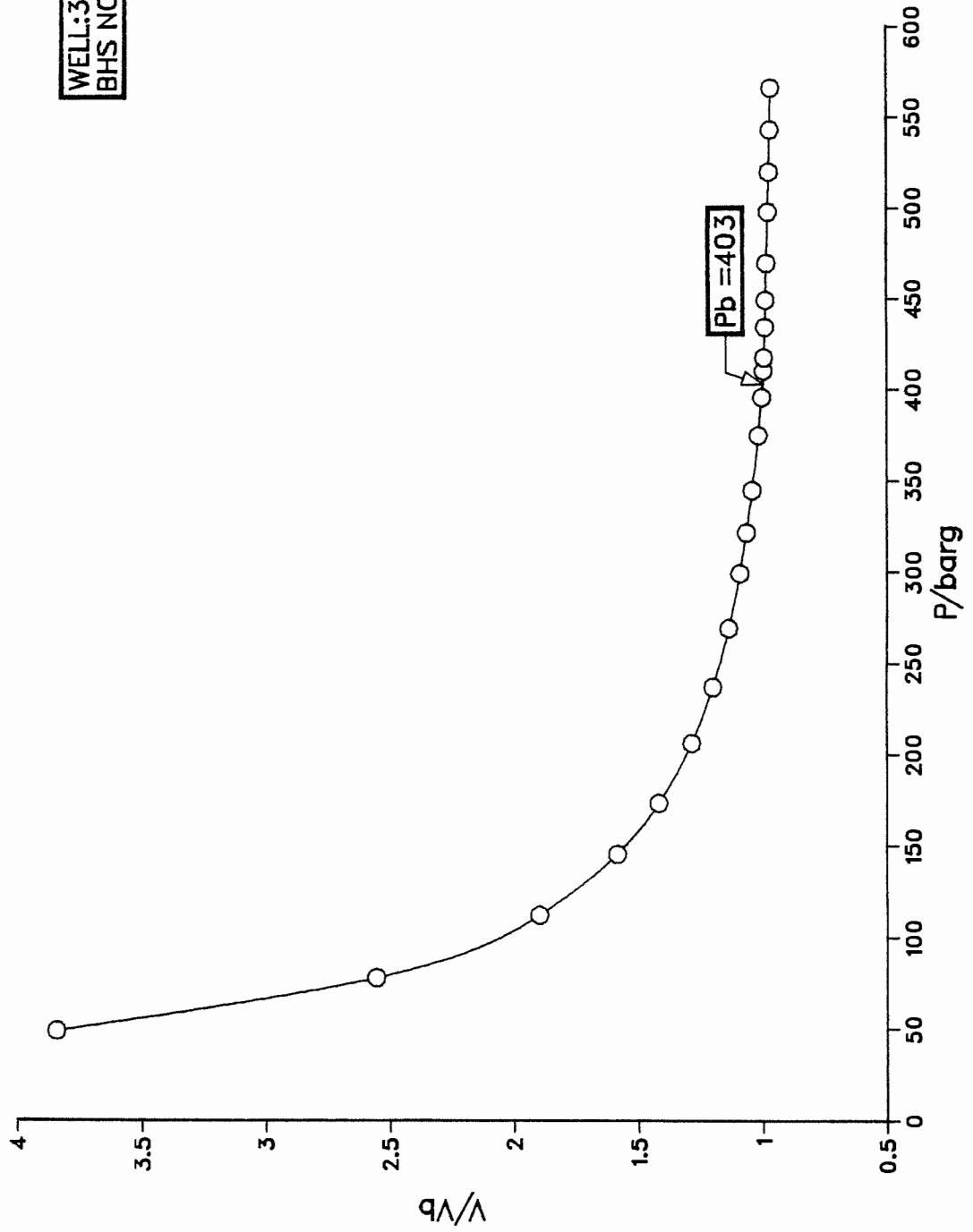
CONSTANT MASS EXPANSION AT 128.5 C

	PRESSURE BARG	REL VOL V/Vb	COMPRESSIBILITY 1/BAR	Y-FACTOR
	565.8	0.9676	1.68E-04	
	542.7	0.9715	1.78E-04	
	519.4	0.9757	1.88E-04	
	497.4	0.9800	1.97E-04	
	469.3	0.9854	2.09E-04	
	449.0	0.9896	2.17E-04	
	434.1	0.9928	2.23E-04	
	417.4	0.9966	2.29E-04	
	410.2	0.9984	2.32E-04	
Pb =	403.0	1.0000	2.35E-04	
	395.6	1.0043		4.34
	374.7	1.0184		4.10
	344.6	1.0430		3.94
	321.4	1.0659		3.85
	299.1	1.0924		3.76
	269.0	1.1370		3.64
	236.8	1.2012		3.49
	206.1	1.2859		3.34
	173.3	1.4184		3.17
	145.4	1.5850		3.03
	112.0	1.8976		2.89
	77.7	2.5549		2.69
	48.6	3.8435		2.56

FOR P < Pb      Y = 2.330 + 4.84E-03 x P  
 FOR P > Pb      V/Vb = 1.13106 - 4.1528E-04 x P + 2.2351E-07 x P x P

FIG. 8

CONSTANT MASS EXPANSION AT 128.5 °C



WELL: 34/10-16  
DST 1  
Bottle A14693

COMPOSITION OF SEPARATOR GAS

COMPONENT	MOL %
NITROGEN	0.249
CARBONDIOXIDE	2.236
METHANE	85.838
ETHANE	7.059
PROPANE	2.743
i-BUTANE	0.354
n-BUTANE	0.695
i-PENTANE	0.172
n-PENTANE	0.200
HEXANES	0.157
HEPTANES	0.180
OCTANES	0.098
NONANES	0.010
DECANES PLUS	0.008
	-----
	100.000
MOL WT	19.45
GRAVITY	0.671

WELL:34/10-16  
DST # 1  
(bottle 83021412)

BUBBLE POINT OF SEPARATOR OIL AT 60.0 C

	PRESSURE Barg	RELATIVE VOLUME V/Vb
	197.8	0.9850
	163.6	0.9877
	132.2	0.9903
	101.1	0.9929
	74.4	0.9951
	55.7	0.9968
	39.4	0.9984
	30.7	0.9992
	23.9	0.9998
Pb =	22.0	1.0000
	19.8	1.0259
	16.9	1.0735
	15.7	1.1280
	13.8	1.2164
	11.1	1.3663
	7.7	1.7299



34/10-16  
DST 1

COMPOSITION OF SEPARATOR LIQUID  
(Single flash to stock tank conditions)

	STOCK TANK OIL	EVOLVED GAS	RECOMBINED LIQUID		
	MOL%	MOL%	WEIGHT%	MOL WT	MOL%
NITROGEN	0.00	0.24	0.00	28.0	0.04
CARBONDIOXIDE	0.00	2.10	0.06	44.0	0.31
METHANE	0.00	59.55	0.63	16.0	8.69
ETHANE	0.13	16.58	0.34	30.1	2.53
PROPANE	0.67	11.70	0.46	44.1	2.27
i-BUTANE	0.32	1.91	0.15	58.1	0.56
n-BUTANE	1.15	3.98	0.41	58.1	1.56
i-PENTANE	0.75	1.04	0.26	72.2	0.80
n-PENTANE	1.19	1.08	0.39	72.2	1.17
HEXANES	2.27	0.75	0.80	84.7	2.05
HEPTANES	5.80	0.75	2.07	89.2	5.07
OCTANES	8.18	0.30	3.29	101.9	7.03
NONANES	5.57	0.02	2.52	115.6	4.76
DECANE PLUS	73.97	0.00	88.62	306.0	63.16
	-----	-----	-----		-----
	100.00	100.00	100.00		100.00
MOL WEIGHT	250.8	27.26			218.19

Gas oil ratio	=	13.5	Sm <sup>3</sup> /Sm <sup>3</sup> STO
Flash formation volume factor of bubble point liquid	=	1.084	m <sup>3</sup> /Sm <sup>3</sup> STO
Density at bubble point	=	0.797	g/cm <sup>3</sup>
Density of STO	=	0.849	g/cm <sup>3</sup> at 15C
Gas gravity (air=1)	=	0.941	
Density of C10+	=	0.869	g/cm <sup>3</sup>

### RECOMBINATION OF SEPARATOR SAMPLES

#### FIELD VALUES

GOR = 177.0 Sm<sup>3</sup>/m<sup>3</sup> separator liquid  
Gas gravity = 0.670 (air = 1)  
Z factor = 0.9615

#### LAB VALUES

Gas gravity = 0.671 (air = 1)  
Z factor = 0.9598

#### CORRECTED GOR

$$\text{GOR} = \text{GOR}(\text{field}) \times \sqrt{\frac{\text{Grav}(\text{field}) \times Z(\text{field})}{\text{Grav}(\text{lab}) \times Z(\text{lab})}}$$

GOR = 177. Sm<sup>3</sup>/m<sup>3</sup> separator liquid

#### RECOMBINATION

The surface samples were physically recombined in the ratio of 177.1 standard cm<sup>3</sup> of separator gas per cm<sup>3</sup> of bubble point separator liquid.

WELL: 34/10-16  
DST 1

COMPOSITION OF RECOMBINED RESERVOIR FLUID

	Separator gas (mol%)	Separator liquid (mol%)	Recombined fluid (mol%)
NITROGEN	0.249	0.04	0.18
CARBONDIOXIDE	2.236	0.31	1.60
METHANE	85.838	8.69	60.54
ETHANE	7.059	2.53	5.57
PROPANE	2.743	2.27	2.59
i-BUTANE	0.354	0.56	0.42
n-BUTANE	0.695	1.56	0.98
i-PENTANE	0.172	0.80	0.38
n-PENTANE	0.200	1.17	0.52
HEXANES	0.157	2.05	0.78
HEPTANES	0.180	5.07	1.78
OCTANES	0.098	7.03	2.37
NONANES	0.010	4.76	1.57
DECANES PLUS	0.008	63.16	20.72

WELL: 34/10-16  
 RECOMBINED SAMPLE

CONSTANT MASS EXPANSION AT 128.5 C

PRESSURE BARG	REL VOL V/V <sub>b</sub>	COMPRESSIBILITY 1/BAR	Y-FACTOR
557.8	0.9701	1.62E-04	
533.7	0.9738	1.72E-04	
506.0	0.9788	1.83E-04	
480.4	0.9835	1.93E-04	
460.5	0.9872	2.00E-04	
441.5	0.9913	2.07E-04	
424.8	0.9944	2.13E-04	
415.0	0.9970	2.17E-04	
407.4	0.9982	2.20E-04	
P <sub>b</sub> = 400.0	1.0000	2.22E-04	
392.3	1.0045		4.33
385.8	1.0089		4.16
376.5	1.0153		4.09
368.5	1.0212		4.03
352.3	1.0341		3.97
326.1	1.0583		3.89
301.3	1.0860		3.81
277.3	1.1196		3.70
246.8	1.1745		3.56
222.0	1.2329		3.44
193.2	1.3240		3.30
166.4	1.4436		3.16
140.8	1.6065		3.04
115.7	1.8487		2.90
96.8	2.1296		2.77
73.1	2.6662		2.68
53.5	3.2989		2.82

FOR P < P<sub>b</sub>  
 FOR P > P<sub>b</sub>

$$Y = 2.414 + 4.55E-03 \times P$$

$$V/V_b = 1.12172 - 3.8631E-04 \times P + 2.0501E-07 \times P \times P$$

FIG. 9

# CONSTANT MASS EXPANSION AT 128.5 °C

