statoil

PVT - Analysis

Well 34/10-14
DST no. 1

STATOIL
EXPLORATION & PRODUCTION
LABORATORY

by
Arne M.Martinsen

April-84 LAB 84

Den norske stats oljeselskap a.s

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Classification

Requested by

Ole Nygaard

Subtitle

Co-workers

Eivind Osjord, Tone Ørke, Jarle Grande

Title

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April-84

LAB 84.212

Prepared

6/4-84 Otto Rogne

Approved

6/4 84 for Per Thomassen

9.03.21 A

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PVT-ANALYSE BRØNN NR 34/10-14
DST NR 1.

1 04. 84
D-4.4
gass - væskeanalyser

På side 16 fra og med nest siste linje, skal stå:

Density at bubble point: 0.734 g/cm^3
2 Density of STO: 0.879 g/cm^3 at 15^{o}C
Gas gravity (air = 1)

CONTENTS

INTRODUCTION

The present report gives the results of a PVT analysis of a separator sample from DST no. I on well 34/10-14 obtained by Otis.

Two RFT samples, one bottom hole sample and two separator samples, were initially checked for consistency.
RFT sample no. I (1917.5 m) contained approx. 20 cc of water and only traces of hydrocarbons. RFT sample no. II (1947.5 m) was transferred to a PVT cell, subjected to a constant mass expansion at 73.3°C and then flashed to standard conditions (page 4). One month later a new RFT no. II sample was transferred to the PVT cell for differential depletion. The bubble point from the constant mass expansion (page 7) was lower than the bubble point from the first constant mass cm expansion, 159 bars and 195 bars respectively. This difference in bubble point is probably due to a small leakage in a valve or valve connection on the sampling bottle.

The bottom hole sample was transferred to a PVT-cell and subjected to a constant mass expansion at 73.3°C and flashed to standard conditions (page 9).

The separator sample set no. 2 was analysed separately (page 12 and 13), recombined and subjected to a constant mass expansion at 73.3°C (page 14). The obtained bubble point indicates that the separator samples is the most representativ of both the RFT sample and the BHS.
Differential liberation of the separator samples was performed through a series of pressure steps. Results given in page 17.

The density difference obtained between the single flash & diff. lib is somewhat greater than should be expected due to experimental abnormalities. The z-factor plot (page 21) shows some irregularities as well.

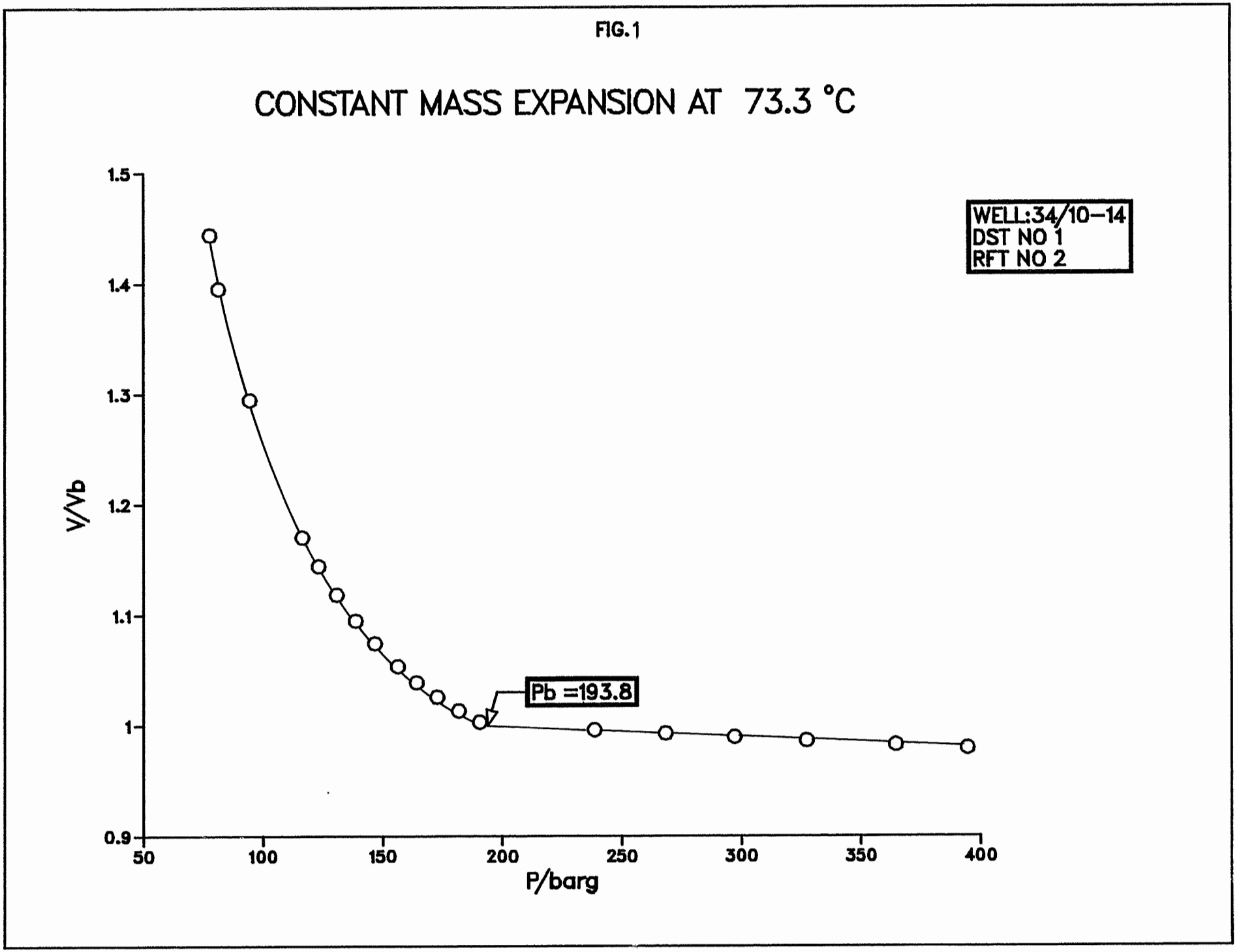
Geco has performed a PVT-study on a recombined sample from the same separator set.
Data from this study are given in a report from Geco, dated July 12, 1982, and is believed to give the most reliable figures.

34/10-14
RFT no. 2

Constant mass expansion at 73.3°C

	Pressure barg	Rel vol V/V_b
	394.6	0.9798
	364.6	0.9829
	327.3	0.9866
	297.2	0.9898
	268.3	0.9932
	238.6	0.9963
Pb =	193.8	1.000
	190.6	1.0033
	181.8	1.0133
	172.8	1.0257
	164.2	1.0388
	156.3	1.0535
	146.7	1.0743
	138.7	1.0948
	130.8	1.1185
	123.3	1.1443
	116.5	1.1704
	94.4	1.2945
	81.3	1.3952
	77.7	1.4441

FIG. 1


CONSTANT MASS EXPANSION AT 73.3 °C
WELL:34/10-14
DST NO 1
RFT NO 2
Pb =193.8
V/Vb
P/barg
1.5
1.4
1.3
1.2
1.1
1
0.9
50
100
150
200
250
300
350
400

34/10-14
RFT no. 2

Composition of reservoir fluid
(Single flash to stock tank conditions)

	Stock tank oil	Evolved gas	Recombined liquid		
	Mol %	Mol %	Weight %	Mol wt	Mol %
Nitrogen	-	1.388	0.135	28.013	0.654
Carbondioxide	-	0.223	0.034	44.010	0.105
Methane	-	84.026	4.668	16.043	39.570
Ethane	0.259	7.848	0.847	30.070	3.833
Propane	0.299	2.352	0.411	44.097	1.266
i-Butane	0.347	1.012	0.282	58.124	0.660
n-Butane	0.561	1.090	0.346	58.124	0.810
i-Pentane	0.876	0.713	0.424	72.151	0.799
n-Pentane	0.551	0.311	0.232	72.151	0.438
Hexanes	1.943	0.407	0.750	83.586	1.219
Heptanes	5.710	0.429	2.174	91.725	3.223
Octanes	8.930	0.179	3.721	105.226	4.809
Nonanes	7.739	0.020	3.652	121.000	4.104
Decanesplus	72.785	0.002	82.324	290.707	38.510
	100.000	100.000	100.000		100.000
Mol weight	239.0	20.3			136.0

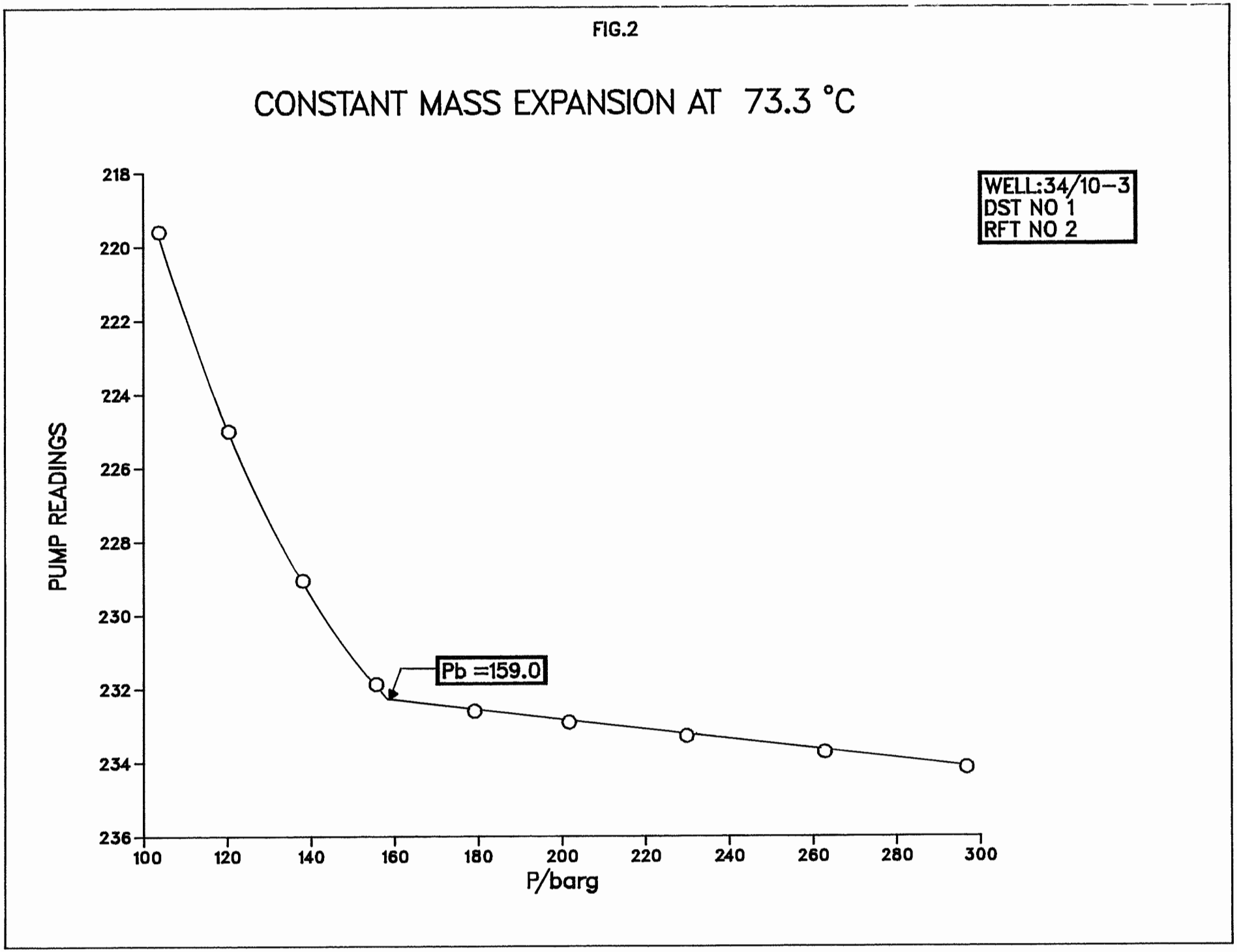
Gas oil ratio : 78.4 Sm^3/m^3
Flash formation volume
factor of bubble point liquid: 1.257 m^3/Sm^3 STO
Density at bubble point : 0.752 g/cm^3
Density of STO : 0.879 g/cm^3
Gas gravity (air=1) : 0.702

34/10-14
RFT no. 2

Constant mass expansion at 73.3°C

	Pressure Barg	Pump readings cm^3
	296.7	234.147
	262.8	233.716
	229.8	233.275
	201.7	232.900
	179.1	232.595
Pb =	159.0	
	155.6	231.875
	138.1	229.057
	120.4	225.004
	103.7	219.587

FIG.2

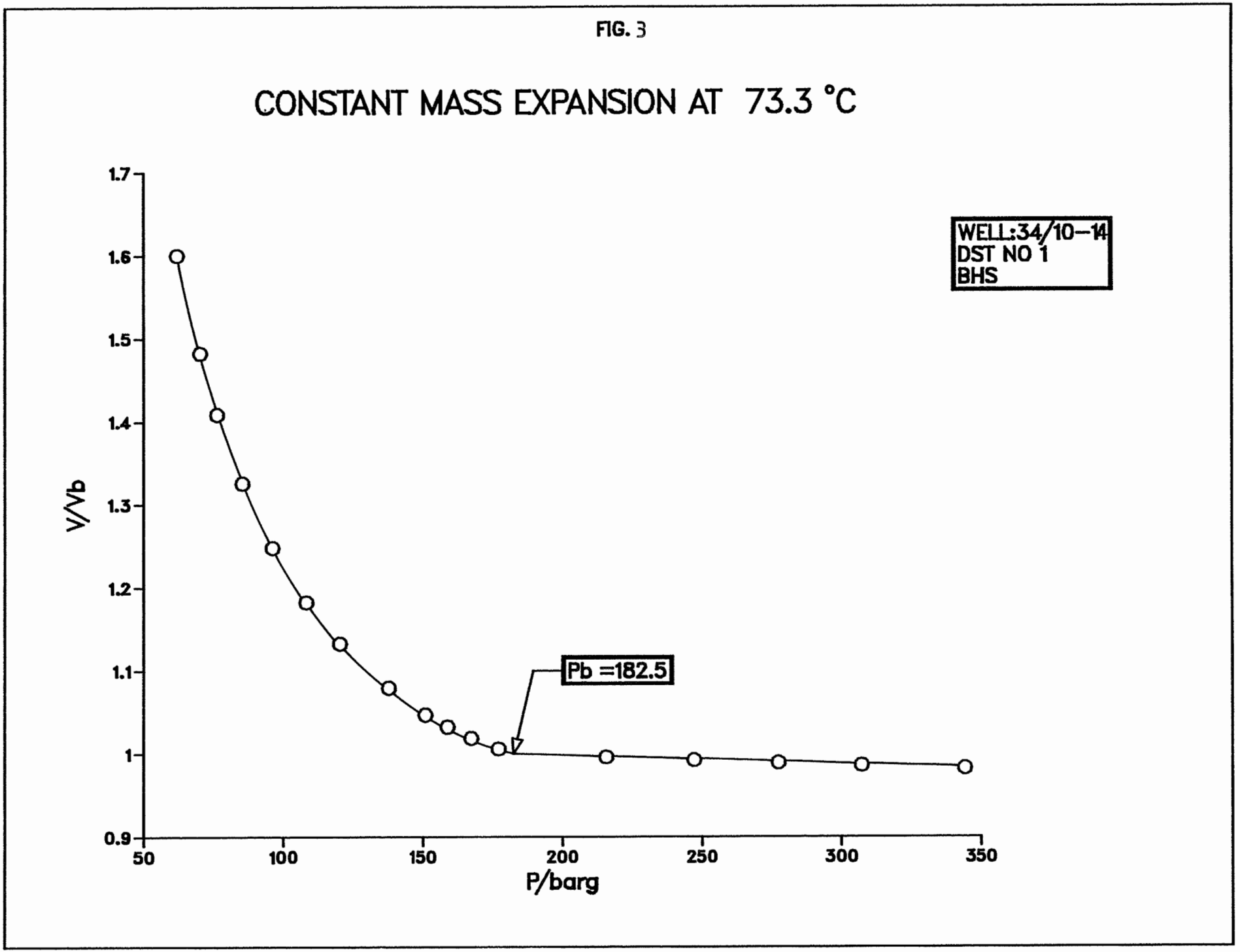

CONSTANT MASS EXPANSION AT 73.3 °C
WELL:34/10-3
DST NO 1
RFT NO 2
PUMP READINGS
218
220
222
224
226
228
230
232
234
236
Pb =159.0
100
120
140
160
180
200
220
240
260
280
300
P/barg

34/10-14
BHS

Constant mass expansion at 73.3°C

	Pressure barg	Rel vol V/V_b
	344.2	0.9824
	307.2	0.9861
	277.4	0.9892
	247.2	0.9925
	215.7	0.9961
Pb =	182.5	1.0000
	177.1	1.0062
	167.3	1.0191
	158.8	1.0328
	150.9	1.0472
	137.8	1.0791
	120.3	1.1326
	108.3	1.1826
	96.2	1.2483
	85.4	1.3256
	76.3	1.4085
	70.2	1.4822
	61.9	1.6004

FIG. 3


CONSTANT MASS EXPANSION AT 73.3 °C
WELL:34/10-14
DST NO 1
BHS
Pb =182.5
V/Vb
P/barg
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
50
100
150
200
250
300
350

34/10-14
BHS

Composition of reservoir fluid
(Single flash to stock tank conditions)

	Stock tank oil	Evolved gas	Recombined liquid		
	Mol %	Mol %	Weight %	Mol wt	Mol %
Nitrogen	-	1.074	0.102	28.013	0.499
Carbondioxide	-	0.300	0.045	44.010	0.139
Methane	-	83.353	4.548	16.043	38.699
Ethane	0.288	8.246	0.877	30.070	3.982
Propane	0.264	2.526	0.425	44.097	1.314
i-Butane	0.318	1.097	0.289	58.124	0.679
n-Butane	0.515	1.151	0.345	58.124	0.811
i-Pentane	0.848	0.717	0.416	72.151	0.787
n-Pentane	0.526	0.341	0.232	72.151	0.440
Hexanes	1.910	0.462	0.759	83.739	1.238
Heptanes	5.731	0.499	2.218	91.709	3.302
Octanes	9.296	0.195	3.912	105.305	5.071
Nonanes	8.417	0.035	4.012	121.000	4.526
Decanesplus	71.887	0.003	81.818	289.992	38.513
	100.000	100.000	100.000		100.000
Mol weight	237.0	20.5			136.5

Gas oil ratio : 76.0 Sm^3/Sm^3 STO
Flash formation volume
factor of bubble point liquid: 1.244
Density at bubble point : 0.760 g/cm^3
Density of STO : 0.879 g/cm^3 at 15^oC
Gas gravity (air=1) : 0.713

WELL 34/10-14
DST NO. 1

Composition of separator gas, bottle 00I 124.

Component	Mol %
Nitrogen	1.748
Carbondioxide	0.287
Methane	91.234
Ethane	4.953
Propane	0.873
i-Butane	0.269
n-Butane	0.236
i-Pentane	0.122
n-Pentane	0.054
Hexanes	0.077
Heptanes	0.094
Octanes	0.048
Nonanes	0.005
Decanesplus	-
Mol weight	17.75
Gravity (air=1)	0.61

34/10-14
DST NO. 1

Composition of separator liquid, bottle 00I AF
(Single flash to stock tank conditions)

	Stock tank oil	Evolved gas	Recombined liquid		
	Mol %	Mol %	Weight %	Mol wt	Mol %
Nitrogen	-	0.038	0.001	28.013	0.007
Carbondioxide	-	0.463	0.020	44.010	0.088
Methane	-	73.566	1.162	16.043	14.032
Ethane	0.279	15.051	0.481	30.070	3.096
Propane	0.497	5.089	0.313	44.097	1.373
i-Butane	0.536	1.942	0.241	58.124	0.804
n-Butane	0.821	1.790	0.302	58.124	1.006
i-Pentane	1.089	0.872	0.390	72.151	1.047
n-Pentane	0.669	0.362	0.227	72.151	0.610
Hexanes	2.114	0.404	0.772	83.617	1.788
Heptanes	5.945	0.336	2.313	91.872	4.875
Octanes	9.321	0.087	4.110	105.292	7.559
Nonanes	8.136	-	4.113	121.000	6.584
Decanesplus	70.593	-	85.555	290.039	57.131
	100.000	100.000	100.000		100.000
Mol weight	234.0	22.6			193.7

Gas oil ratio : 20.9 Sm^3/Sm^3 STO
Flash formation volume
factor of bubble point liquid: 1.107 m^3/Sm^3 STO
Density of STO : 0.878 g/cm^3 at 15^oC
Gas gravity (air=1) : 0.78

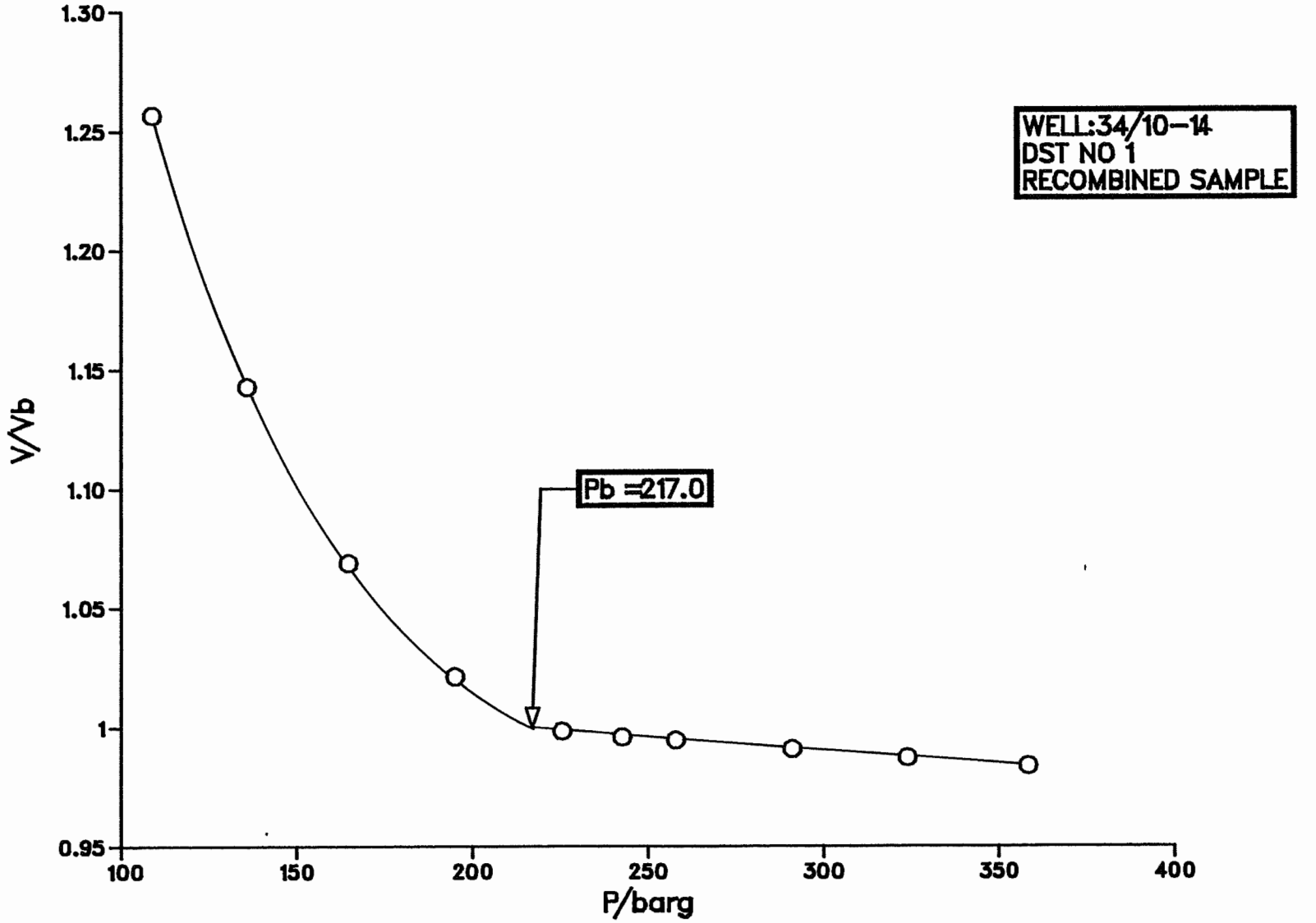
34/10-14
Recombined sample

Constant mass expansion at 73.3°C

	Pressure barg	Rel vol V/V_b
	358.4	0.9836
	324.0	0.9871
	291.2	0.9908
	258.0	0.9946
	242.7	0.9959
	225.6	0.9985
Pb =	217.0	1.0000
	195.1	1.0212
	164.8	1.0688
	135.9	1.1428
	108.8	1.2566
	83.7	1.1462

FIG.4

CONSTANT MASS EXPANSION AT 73.3 °C



34/10-14
DST no. 1
Recombined sample

Composition of recombined fluid
(Single flash to stock tank conditions)

	Stock tank oil	Evolved gas	Recombined liquid		
	Mol %	Mol %	Weight %	Mol wt	Mol %
Nitrogen	-	1.443	0.158	28.013	0.724
Carbondioxide	-	0.353	0.061	44.010	0.177
Methane	-	84.816	5.320	16.043	42.522
Ethane	0.128	7.336	0.877	30.070	3.742
Propane	0.230	2.179	0.415	44.097	1.207
i-Butane	0.289	0.940	0.279	58.124	0.615
n-Butane	0.484	0.996	0.336	58.124	0.741
i-Pentane	0.812	0.623	0.404	72.151	0.717
n-Pentane	0.544	0.298	0.237	72.151	0.421
Hexanes	1.951	0.403	0.766	83.594	1.175
Heptanes	5.810	0.416	2.223	91.759	3.106
Octanes	9.616	0.180	4.009	105.234	4.885
Nonanes	8.745	0.017	4.123	121.000	4.369
Decane plus	71.391	-	80.792	291.009	35.599
	100.000	100.000	100.000		100.000
Mol weight	237.0	20.04			128.5

Gas oil ratio : 88.2 Sm^3/m^3 STO
Flash formation volume
factor of bubble point liquid : 1.299 m^3/Sm^3 STO
Density at bubble point : 0.734 g/cm^3
Density of STO : 0.879 g/cm^3 at 15^oC
Gas gravity (air = 1) : 0.695

WELL 34/10-14
Recombined sample

Differential depletion at 73.3°C

Pressure Barg	Oil form Vol Fact Bod	Solution Gor Rs	Gas Form Vol Fact Bg	Res Oil Density g/cm3	Compr Factor Z	Gas Viscosity cP
217.0	1.241	86.1		0.766		
194.5	1.223	78.0	5.49E-03	0.773	0.883	0.0189
160.7	1.196	65.3	6.64E-03	0.782	0.884	0.0172
129.7	1.172	54.1	8.29E-03	0.791	0.892	0.0159
99.7	1.149	42.7	1.06E-02	0.799	0.882	0.0148
69.9	1.124	30.9	1.55E-02	0.809	0.907	0.0139
40.2	1.107	19.4	2.78E-02	0.814	0.945	0.0131
25.5	1.088	13.6	4.42E-02	0.824	0.963	0.0127
0	1.049			0.838		
0 *	1.000			0.879		

* AT 15 C
Bad: Volume of oil at P and T per volume of residual oil at 15°C and atm P
Rs : Standard m^3 gas per m^3 residual oil at 15°C
Bg : m^3 gas at T and P per standard m^3 gas

WELL 34/10-14
Recombined sample

Differential depletion at 73.3°C
(Molecular composition at differentially liberated gas, mol %)

Pressure/barg	194.5	160.7	129.7	99.7	69.9	40.2	25.5	0.0
Nitrogen	3.246	2.967	2.173	1.831	1.128	0.470	0.172	0.030
Carbondioxide	0.232	0.231	0.243	0.251	0.279	0.343	0.402	0.421
Methane	90.881	91.079	91.845	91.921	91.750	90.132	87.500	52.304
Ethane	3.582	3.708	3.872	4.175	4.849	6.449	8.391	22.222
Propane	0.700	0.706	0.719	0.742	0.860	1.184	1.620	9.098
i-Butane	0.258	0.255	0.248	0.246	0.274	0.373	0.512	3.990
n-Butane	0.247	0.241	0.233	0.229	0.252	0.340	0.467	4.236
i-Pentane	0.165	0.156	0.145	0.134	0.142	0.186	0.251	2.589
n-Pentane	0.082	0.078	0.074	0.064	0.066	0.085	0.115	1.230
Hexanes	0.148	0.136	0.126	0.103	0.104	0.129	0.169	1.693
Heptanes	0.228	0.217	0.173	0.152	0.146	0.71	0.216	1.604
Octanes	0.177	0.163	0.114	0.109	0.107	0.105	0.141	0.511
Nonanes	0.036	0.051	0.027	0.028	0.030	0.024	0.029	0.057
Decanplus	0.019	0.013	0.007	0.015	0.013	0.010	0.014	0.015
Mole weight	18.03	17.99	17.79	17.76	17.83	18.22	18.87	30.26
Gravity(air=1)	0.62	0.62	0.61	0.61	0.65	0.63	0.65	1.04

FIG. 5

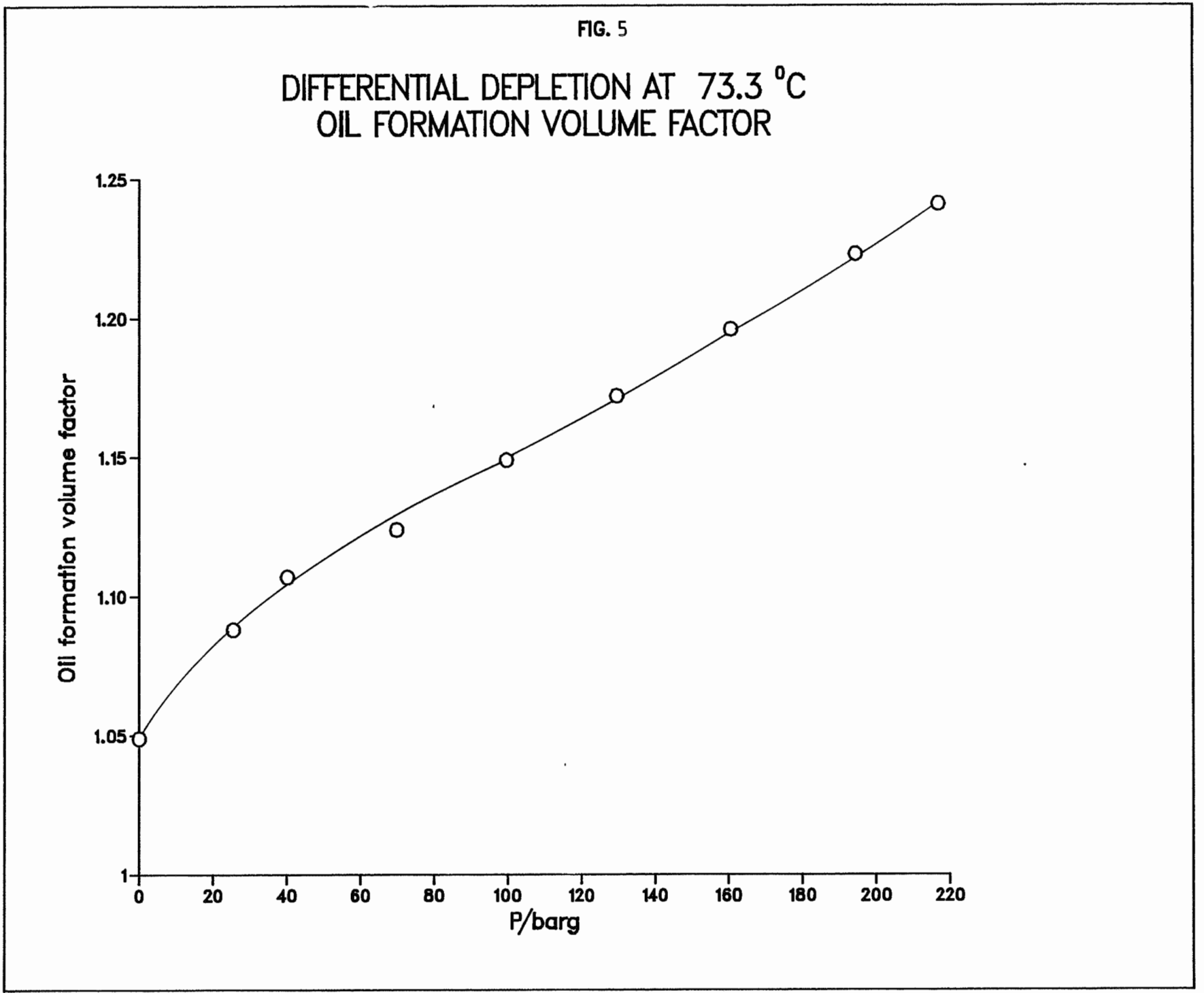

DIFFERENTIAL DEPLETION AT 73.3 °C
OIL FORMATION VOLUME FACTOR
Oil formation volume factor
1.25
1.20
1.15
1.10
1.05
1
0
20
40
60
80
100
120
140
160
180
200
220
P/barg

FIG. 6

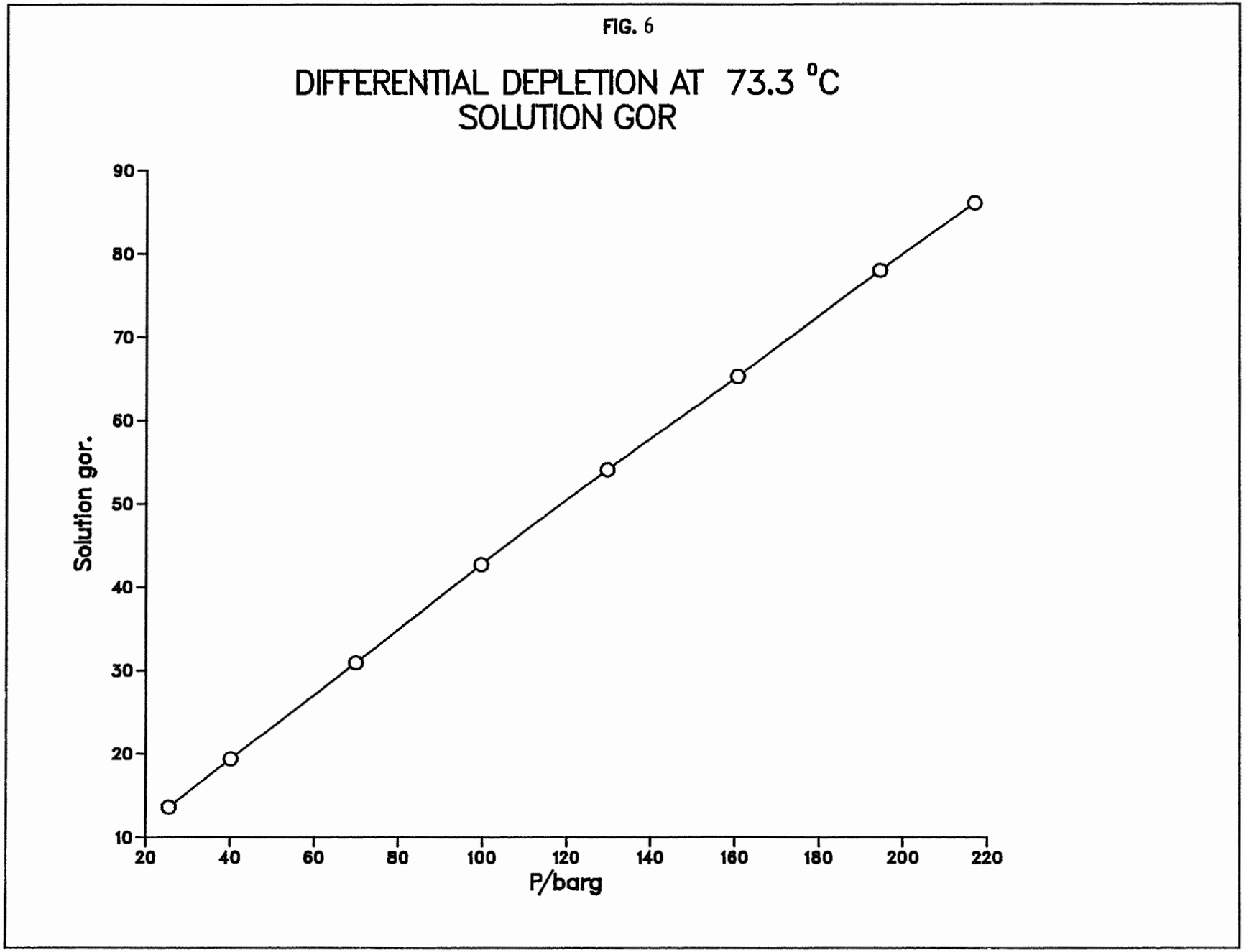

DIFFERENTIAL DEPLETION AT 73.3 °C
SOLUTION GOR
Solution gor.
90
80
70
60
50
40
30
20
10
20
40
60
80
100
120
140
160
180
200
220
P/barg

FIG. 7

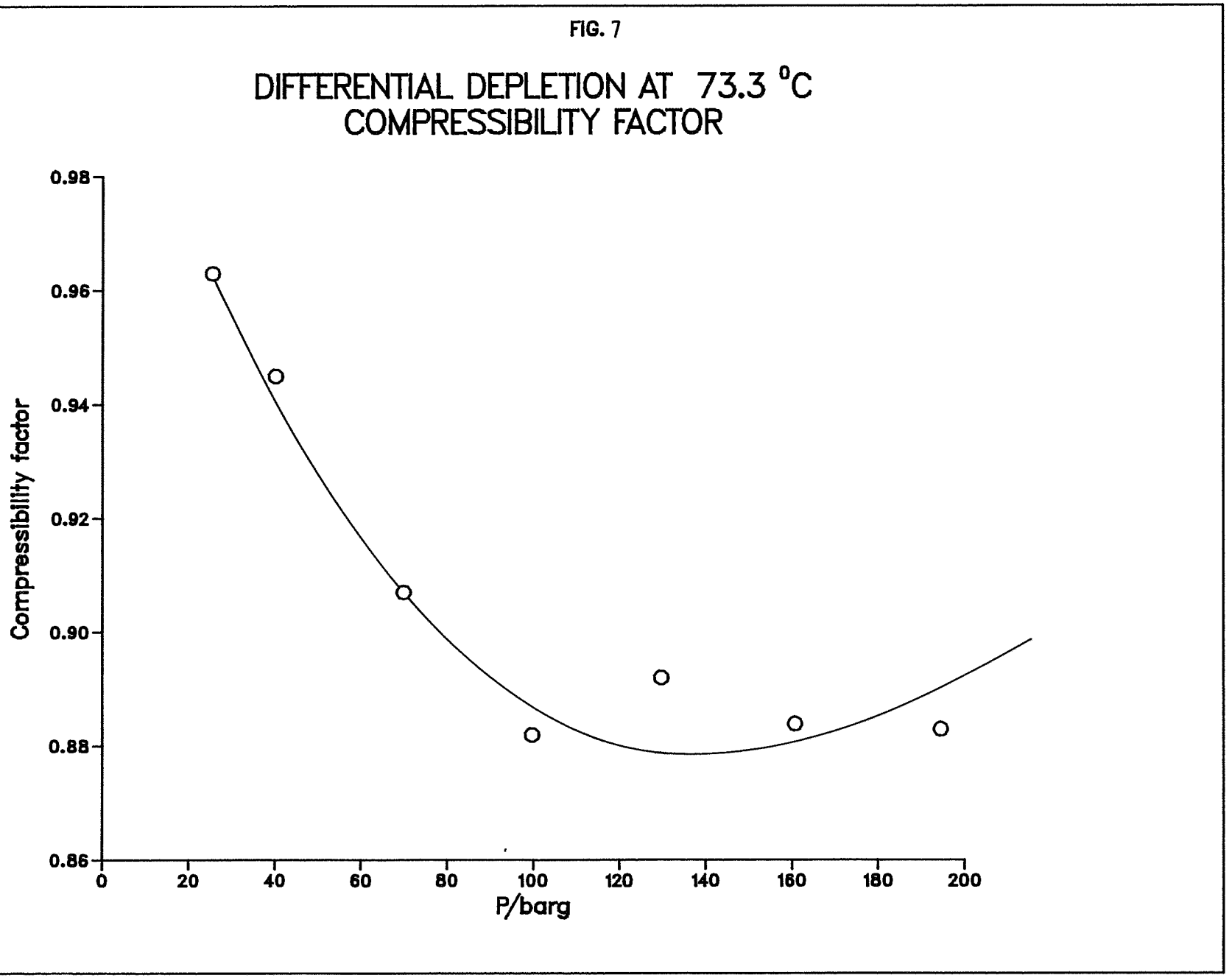
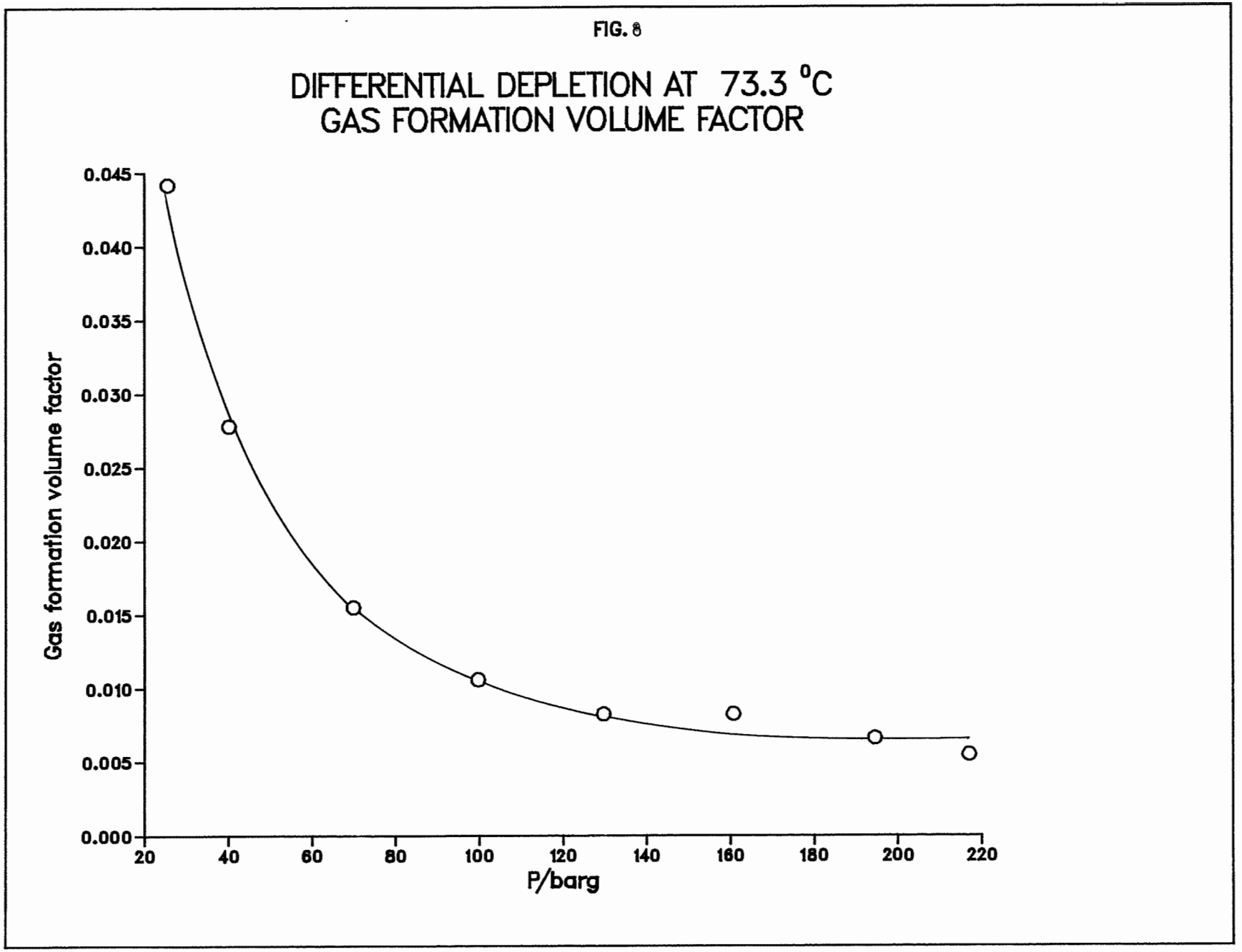

DIFFERENTIAL DEPLETION AT 73.3 °C
COMPRESSIBILITY FACTOR
Compressibility factor
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0
20
40
60
80
100
120
140
160
180
200
P/barg

FIG. 8


DIFFERENTIAL DEPLETION AT 73.3 °C
GAS FORMATION VOLUME FACTOR
Gas formation volume factor
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
20
40
60
80
100
120
140
160
180
200
220
P/barg