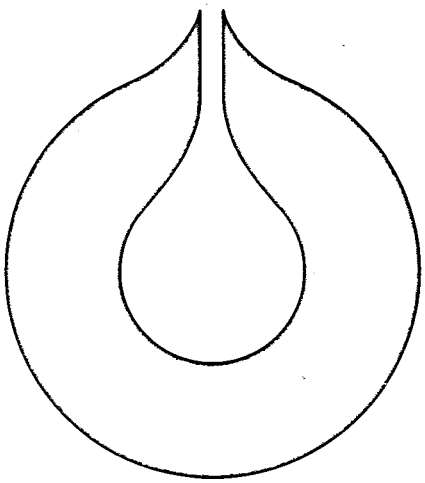

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Classification

Requested by

Arne M. Martinsen LET-S

Subtitle

Co-workers

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Eivind Osjord

Title

PVT - Analysis
Well 15/12-4
FMT - sample

STATOIL
EXPLORATION & PRODUCTION
LABORATORY

by

Otto Rogne

December 1984

LAB 84.250

Prepared

10.12.84 Otto Rogne

Otto Rogne

Approved

10.12.84

Per Thomassen

9.03.21 A

CONTENTS

INTRODUCTION

The present report gives the results of a PVT analysis of an oil sample from well 15/12-4. The original sample was from an FMT tool and had been transfered to four high pressure bottles by SOS. The bubble point of the contents in two of the bottles was measured at room temperature and found to be equal, and in agreement with the reported field values. A sample from one of the bottles was transfered to a PVT cell where a constant mass and differential liberation were carried out at 120 C, as requested. A portion of the sample was flashed to standard conditions to determine the reservoir fluid composition. An additional sample from the bottle was transfered to a rolling ball viscosimeter for viscosity measurements.

The reservoir fluid density was also measured directly by a high pressure pycnometer giving a value of 0.702 g/cm3 at the bubble point, in good agreement with that obtained from the single flash.

The measured bubble point of 256 bar at 120 C is considerably lower than the reported resevoir pressure of 347 bar, indicating either an undersaturated reservoir or a non-representative sample.

1)

SAMPLE

WELL	15/12-4
TEST	4B
Interval tested	2912 mRKB
Date	22-10-84
Sample type	FMT
Reservoir fluid	Oil
Oil bottle, sample No 3	810823
Field bubble point	2890 psig/55 °F
Reservoir temp 2)	120 °C
Reservoir pressure 2)	347 Bar

1) Data from SOS sampling report
2) Data supplied by Statoil LET/S

Bubble point at ambient temperature
of contents in bottles

Bottle No 810695		Bottle No 810823	
Pressure/Bar	Pump reading	Pressure/Bar	Pump reading
349.5	55.906	327.8	66.524
320.5	53.958	305.4	65.131
290.4	51.745	274.2	63.255
260.9	49.460	243.0	61.315
231.3	47.190	216.3	59.349
202.2	44.938	201.8	58.104
197.7	42.077	191.6	54.965
189.6	38.490	183.1	50.759
Bubble point :	200 Bar		202 Bar
Field bubble point at 13 C:	199 Bar		199 Bar

WELL :15/12-4
DST #:
FMT

CONSTANT MASS EXPANSION AT 120C

	PRESSURE BARG	REL VOL V/Vb	COMPRESSIBILITY 1/BAR	Y-FACTOR
	399.3	0.9712	1.66E-04	
	370.5	0.9765	1.81E-04	
	340.7	0.9818	1.97E-04	
	321.6	0.9855	2.06E-04	
	307.1	0.9885	2.14E-04	
	294.6	0.9909	2.20E-04	
	284.8	0.9933	2.25E-04	
	274.8	0.9957	2.30E-04	
	265.2	0.9980	2.34E-04	
Pb =	256.1	1.0000	2.39E-04	
	255.8	1.0003		3.60
	243.5	1.0164		3.15
	195.5	1.1016		3.05
	160.8	1.2078		2.85
	123.1	1.4135		2.61
	104.1	1.5841		2.50
	89.4	1.7720		2.42
	80.9	1.9182		2.36

FOR P < Pb Y = 1.863 +6.10E-03 x P
FOR P > Pb V/Vb = 1.07895 -3.7763E-04xP +2.7084E-07xPxP

15/12-4
FMT

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

	STOCK TANK OIL MOL%	EVOLVED GAS MOL%	RECOMBINED LIQUID WEIGHT%	MOL WT	MOL%
NITROGEN	0.00	1.04	0.18	28.0	0.65
CARBONDIOXIDE	0.00	3.38	0.93	44.0	2.11
METHANE	0.01	69.13	6.95	16.0	43.18
ETHANE	0.09	11.63	2.20	30.1	7.30
PROPANE	0.48	7.36	2.11	44.1	4.78
i-BUTANE	0.23	1.05	0.43	58.1	0.74
n-BUTANE	1.02	2.75	1.23	58.1	2.10
i-PENTANE	0.82	0.72	0.55	72.1	0.76
n-PENTANE	1.54	1.03	0.88	72.1	1.22
HEXANES	3.42	0.79	1.51	84.4	1.78
HEPTANES	8.21	0.77	3.22	90.1	3.56
OCTANES	10.05	0.30	4.12	103.7	3.96
NONANES	7.42	0.03	3.30	117.4	2.80
DECANE PLUS	66.71	0.02	72.37	287.8	25.06
	100.00	100.00	100.00		100.00
MOL WEIGHT	224.2	24.79			99.65

Gas oil ratio	=	149.9	Sm3/Sm3 STO
Flash formation volume factor of bubble point liquid	=	1.445	m3/Sm3 STO
Density at bubble point	=	0.700	g/cm3
Density of STO	=	0.854	g/cm3 at 15C
Gas gravity (air=1)	=	0.856	
Density of C10+	=	0.877	g/cm3

WELL: 15/12-4
DST :
FMT

DIFFERENTIAL DEPLETION AT 120 C

PRESSURE BARG	OIL FORM VOL FACT Bod	SOLUTION GOR Rsd	GAS FORM VOL FACT Bg	RES OIL DENSITY g/cm3	COMPR FACTOR Z	GAS VISCOSITY cP
256.0	1.539	157.3		0.690		
241.2	1.509	147.3	5.62E-03	0.698	0.988	0.0218
220.6	1.476	134.7	5.97E-03	0.705	0.960	0.0209
202.1	1.440	122.4	6.11E-03	0.716	0.900	0.0204
156.4	1.375	97.0	7.26E-03	0.734	0.830	0.0188
109.9	1.286	72.4	1.10E-02	0.767	0.888	0.0164
58.4	1.214	46.0	2.10E-02	0.792	0.905	0.0146
19.7	1.152	25.1	6.59E-02	0.815	0.989	0.0131
0	1.046			0.831		
0 *	1.000			0.870		

* AT 15 C
Bod : Volume of oil at P and T per volume of residual oil at 15 C and atm P
Rsd : Standard m3 gas per m3 residual oil at 15 C and atm P
Bg : m3 gas at T and P per standard m3 gas

WELL: 15/12-4
DST :
FMT

DIFFERENTIAL DEPLETION AT 120 C
(Molecular composition of differentially liberated gas, mol%)

PRESSURE/BARG	241.2	220.6	202.1	156.4	109.9	58.4	19.7	0.0 *
NITROGEN	2.06	2.32	2.24	1.88	1.39	0.74	0.29	0.02
CARBONDIOXIDE	1.88	1.80	1.55	1.60	1.69	1.90	2.11	1.12
METHANE	80.16	80.11	81.70	81.72	79.64	75.23	61.34	20.74
ETHANE	8.02	8.11	7.81	8.19	9.60	12.01	17.70	14.88
PROPANE	3.83	3.84	3.63	3.73	4.37	5.79	10.57	14.57
i-BUTANE	0.49	0.48	0.45	0.45	0.51	0.67	1.32	2.64
n-BUTANE	1.19	1.18	1.07	1.06	1.21	1.60	3.18	7.72
i-PENTANE	0.33	0.32	0.28	0.26	0.29	0.38	0.73	2.90
n-PENTANE	0.49	0.48	0.41	0.38	0.42	0.54	1.02	4.61
HEXANES	0.50	0.48	0.37	0.33	0.36	0.45	0.79	6.14
HEPTANES	0.73	0.56	0.37	0.30	0.36	0.48	0.69	8.95
OCTANES	0.28	0.28	0.12	0.10	0.15	0.19	0.24	7.01
NONANES	0.03	0.03	0.00	0.00	0.01	0.02	0.02	3.06
DECANES+	0.01	0.01	0.00	0.00	0.00	0.00	0.01	5.64
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
MOLE WEIGHT	21.37	21.22	20.53	20.45	21.04	22.31	26.26	64.68
GRAVITY (Air=1)	0.738	0.733	0.709	0.706	0.726	0.770	0.907	2.233

* liquid dropout included in composition

WELL: 15/12-4
DST :
FMT

DIFFERENTIAL DEPLETION AT 120 C
(Molecular composition of residual oil)

COMPONENT	MOL%	
NITROGEN	0.00	
CARBONDIOXIDE	0.00	
METHANE	0.00	
ETHANE	0.00	
PROPANE	0.13	
i-BUTANE	0.11	
n-BUTANE	0.54	
i-PENTANE	0.52	
n-PENTANE	0.98	
HEXANES	2.20	
HEPTANES	6.71	
OCTANES	7.96	
NONANES	7.06	
DECANES+	73.79	
	100.00	
DENSITY AT 15 C	0.870	g/cm3
MOLE WEIGHT	234.0	

WELL: 15/12-4
FMT

VISCOSITY OF RESERVOIR FLUID AT 120.0 C

	PRESSURE (Barg)	VISCOSITY (Centipoise)
	379.9	0.412
	349.3	0.405
	322.8	0.399
	299.6	0.388
	275.8	0.376
	258.5	0.369
Pb=	256.1	0.368
	247.5	0.368
	222.5	0.375
	201.5	0.384
	173.6	0.411
	144.3	0.452
	110.8	0.513
	73.2	0.615
	34.7	0.764
	21.1	0.856
	1.9	1.052

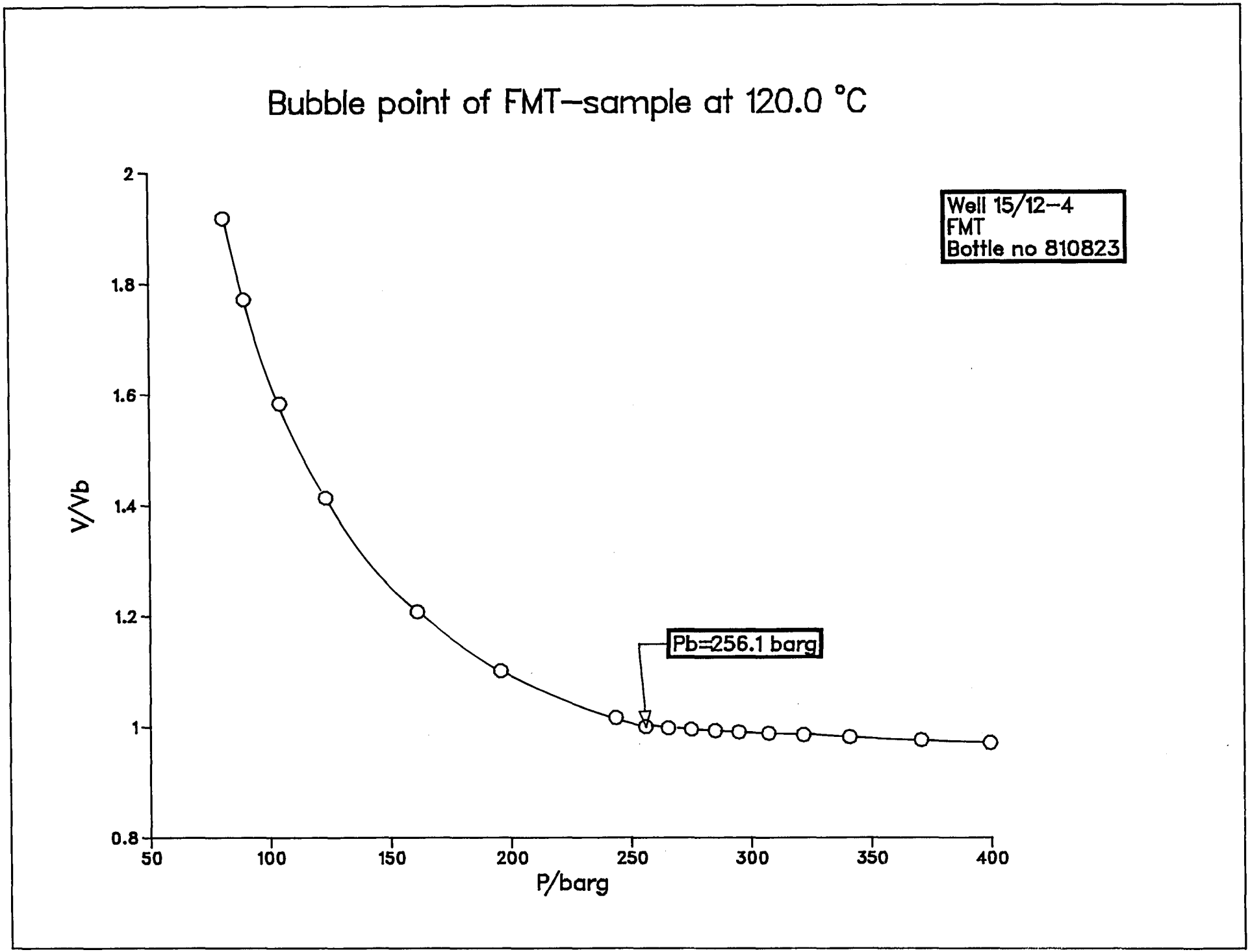

Bubble point of FMT–sample at 120.0 °C
Well 15/12–4
FMT
Bottle no 810823
Pb=256.1 barg
V/Vb
P/barg
2
1.8
1.6
1.4
1.2
1
0.8
50
100
150
200
250
300
350
400

FIG.

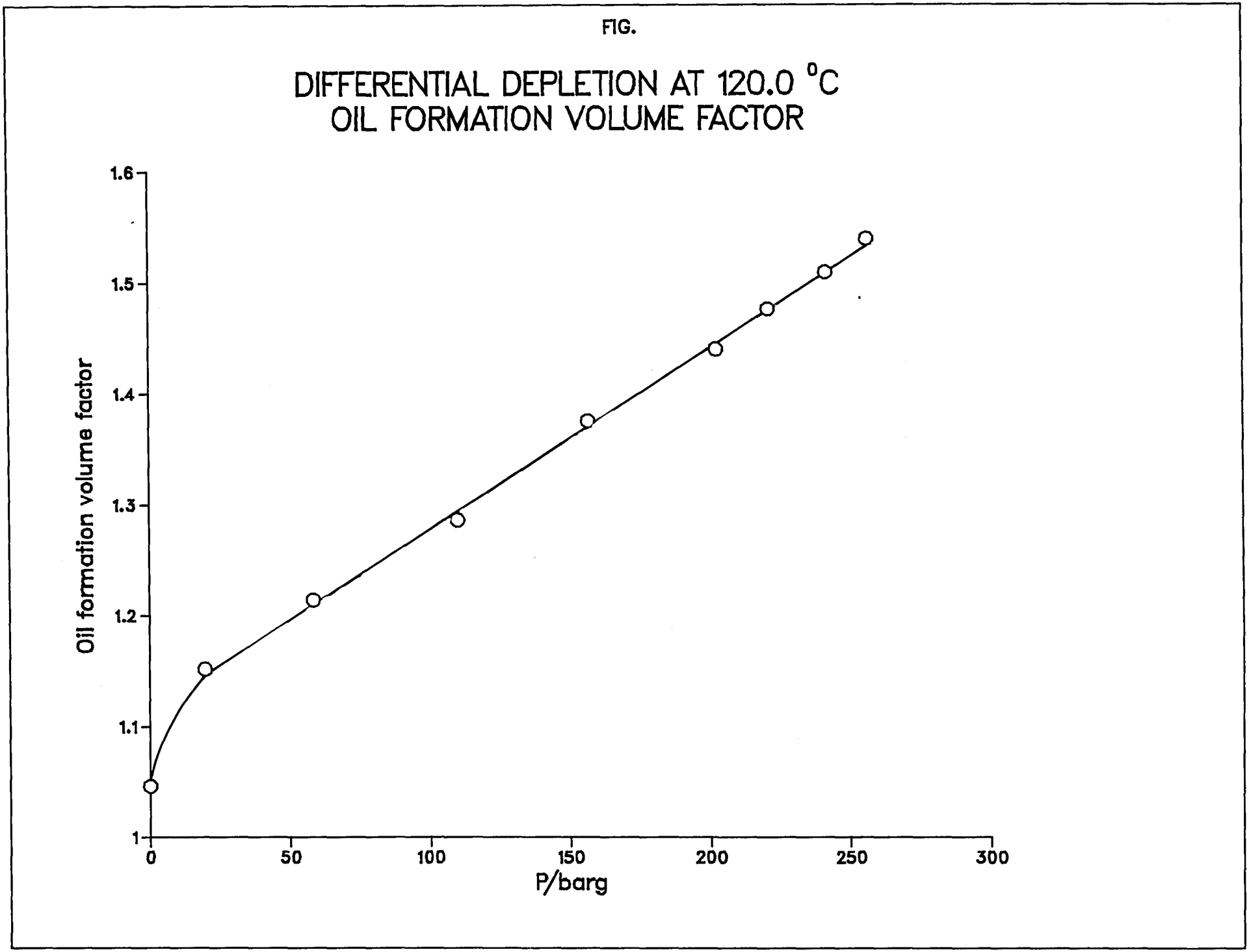

DIFFERENTIAL DEPLETION AT 120.0 °C
OIL FORMATION VOLUME FACTOR
Oil formation volume factor
1.6
1.5
1.4
1.3
1.2
1.1
1
0
50
100
150
200
250
300
P/barg

FIG.

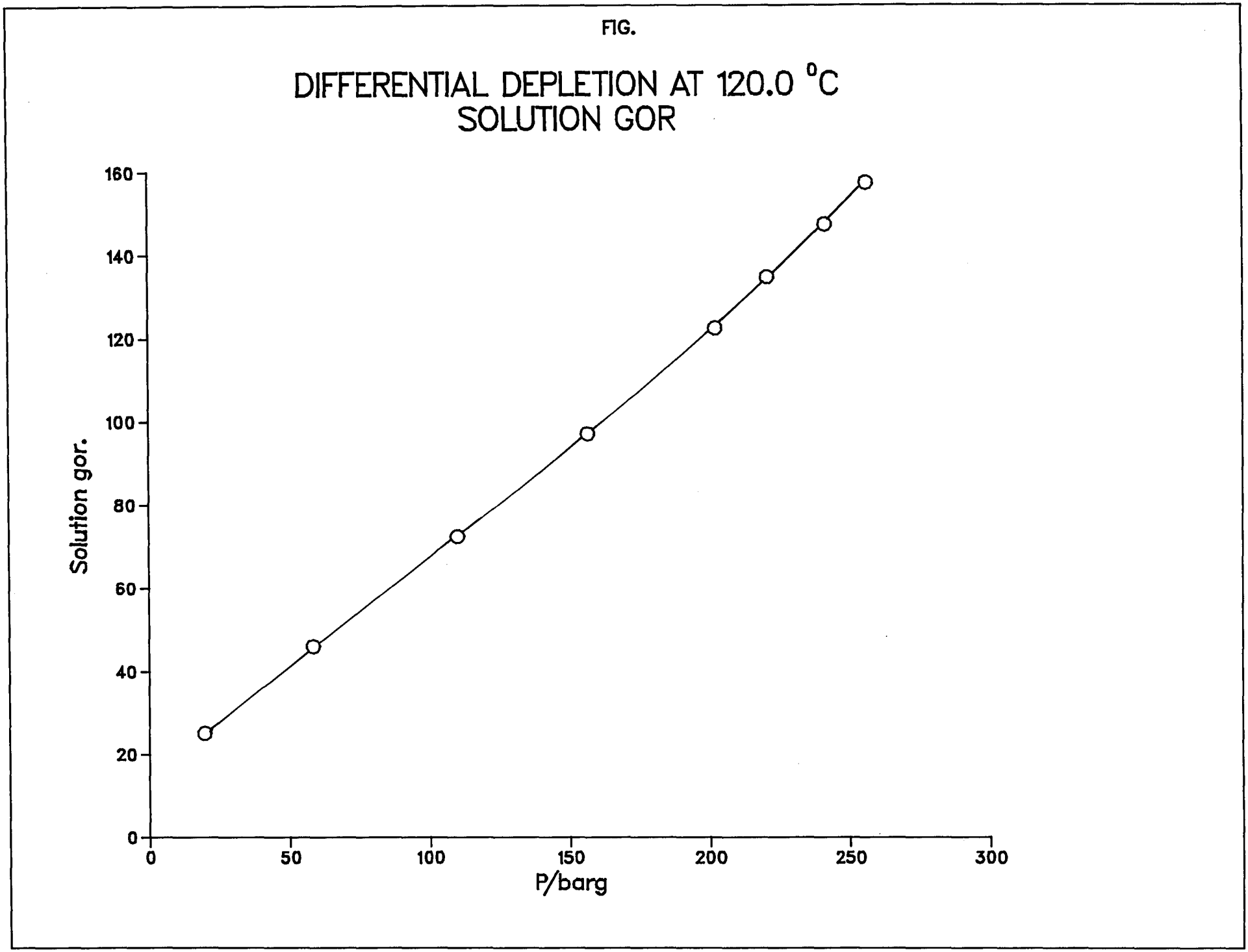

DIFFERENTIAL DEPLETION AT 120.0 °C
SOLUTION GOR
Solution gor.
160
140
120
100
80
60
40
20
0
0
50
100
150
200
250
300
P/barg

FIG.

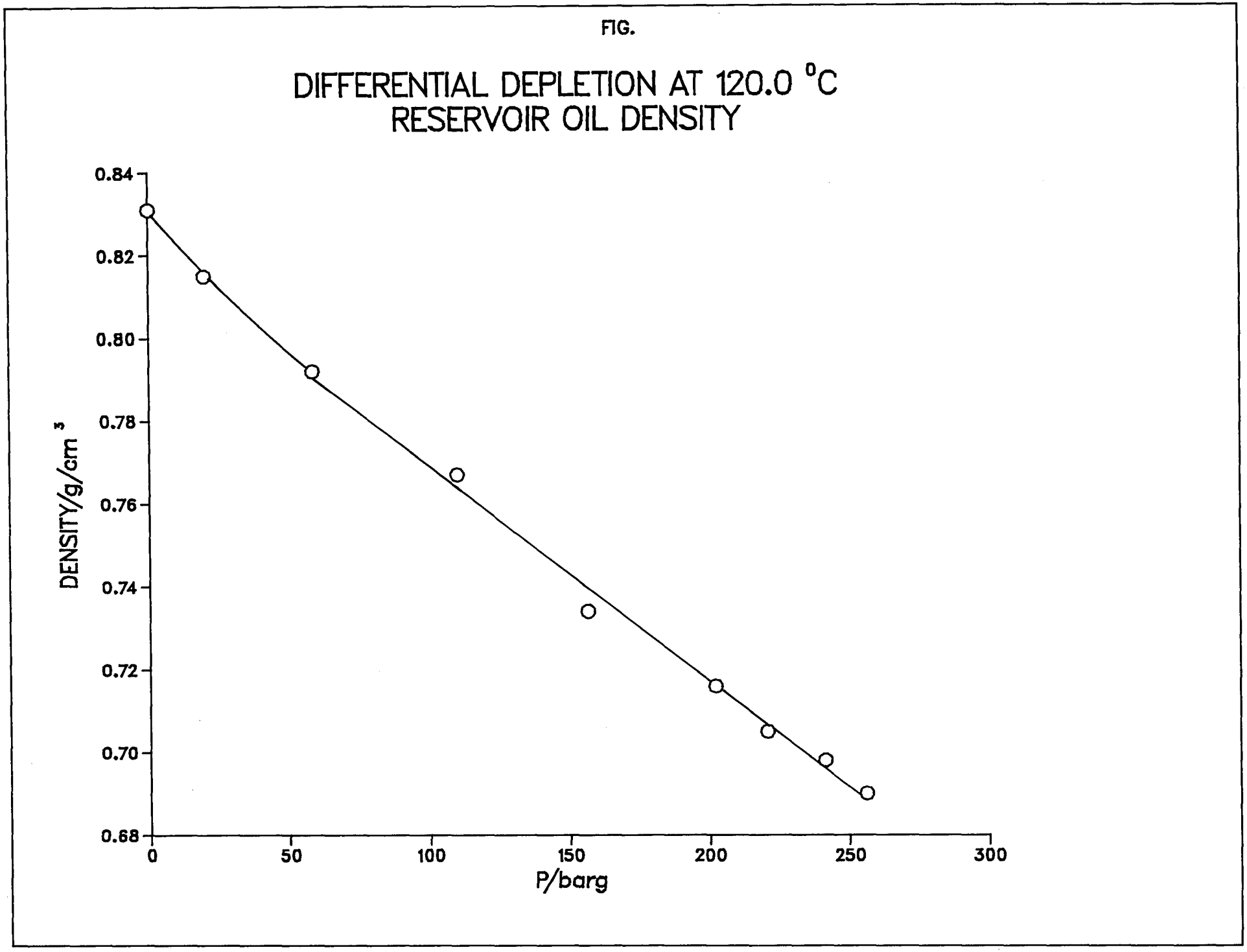

DIFFERENTIAL DEPLETION AT 120.0 °C
RESERVOIR OIL DENSITY
DENSITY/g/cm³
0.84
0.82
0.80
0.78
0.76
0.74
0.72
0.70
0.68
0
50
100
150
200
250
300
P/barg

FIG.

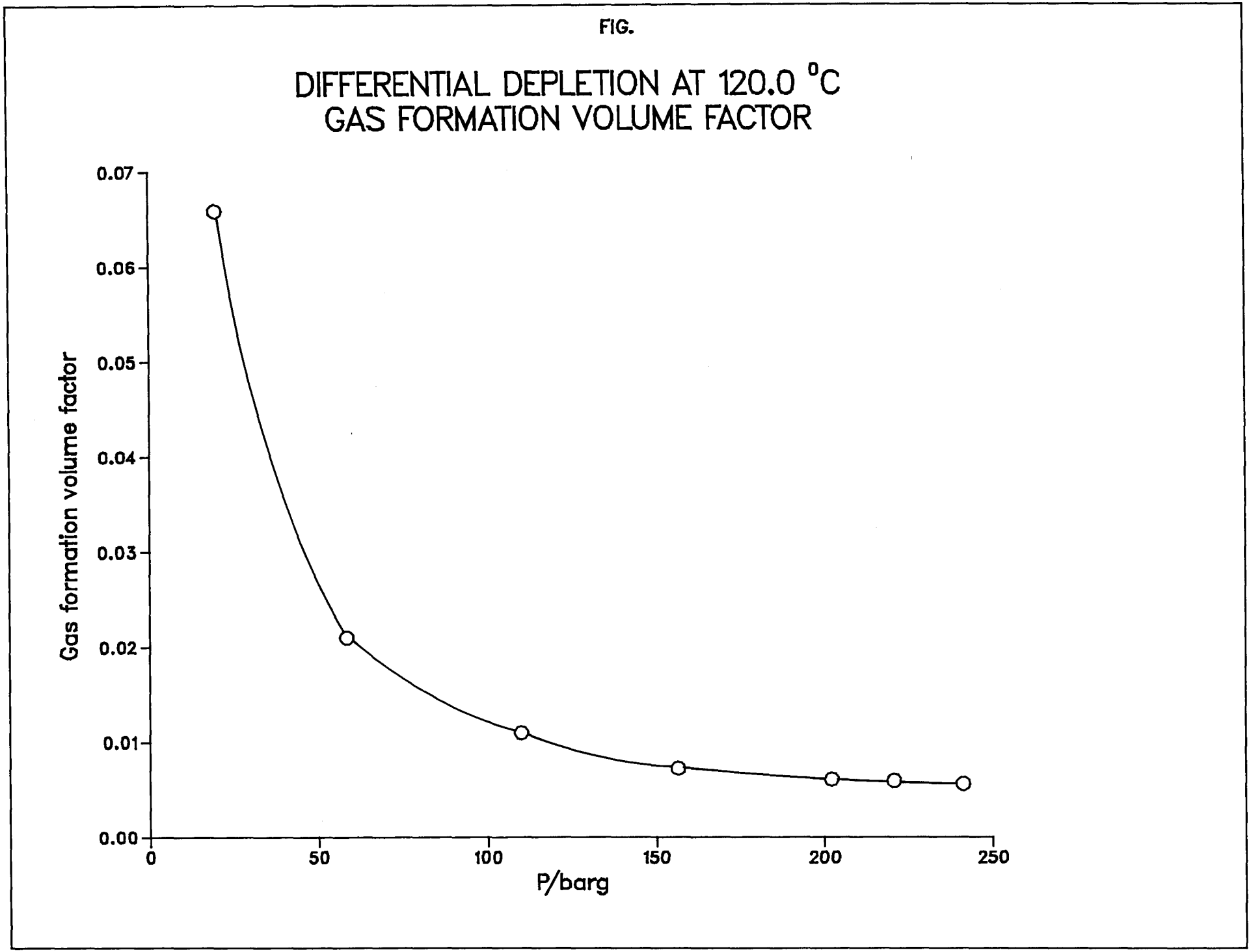
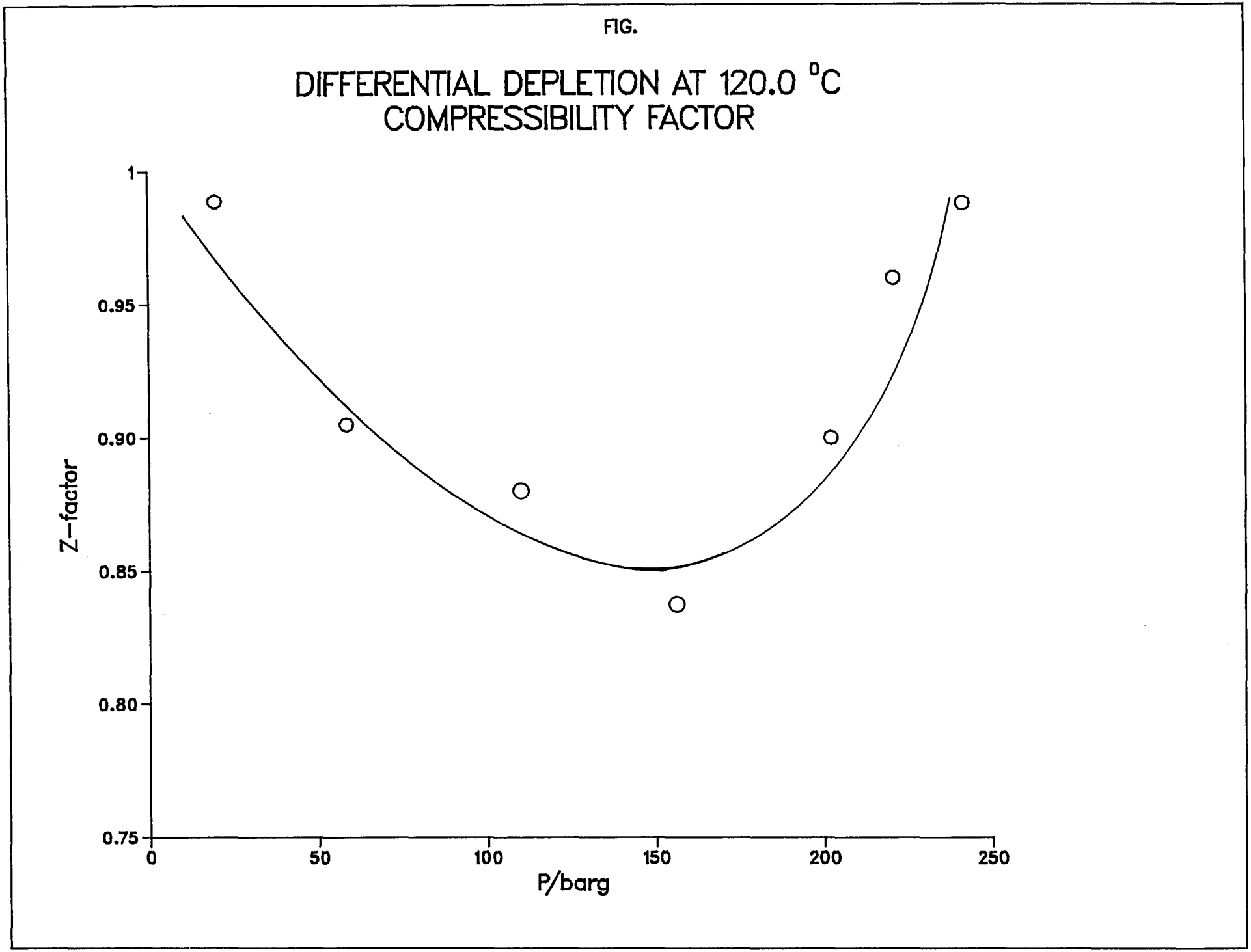
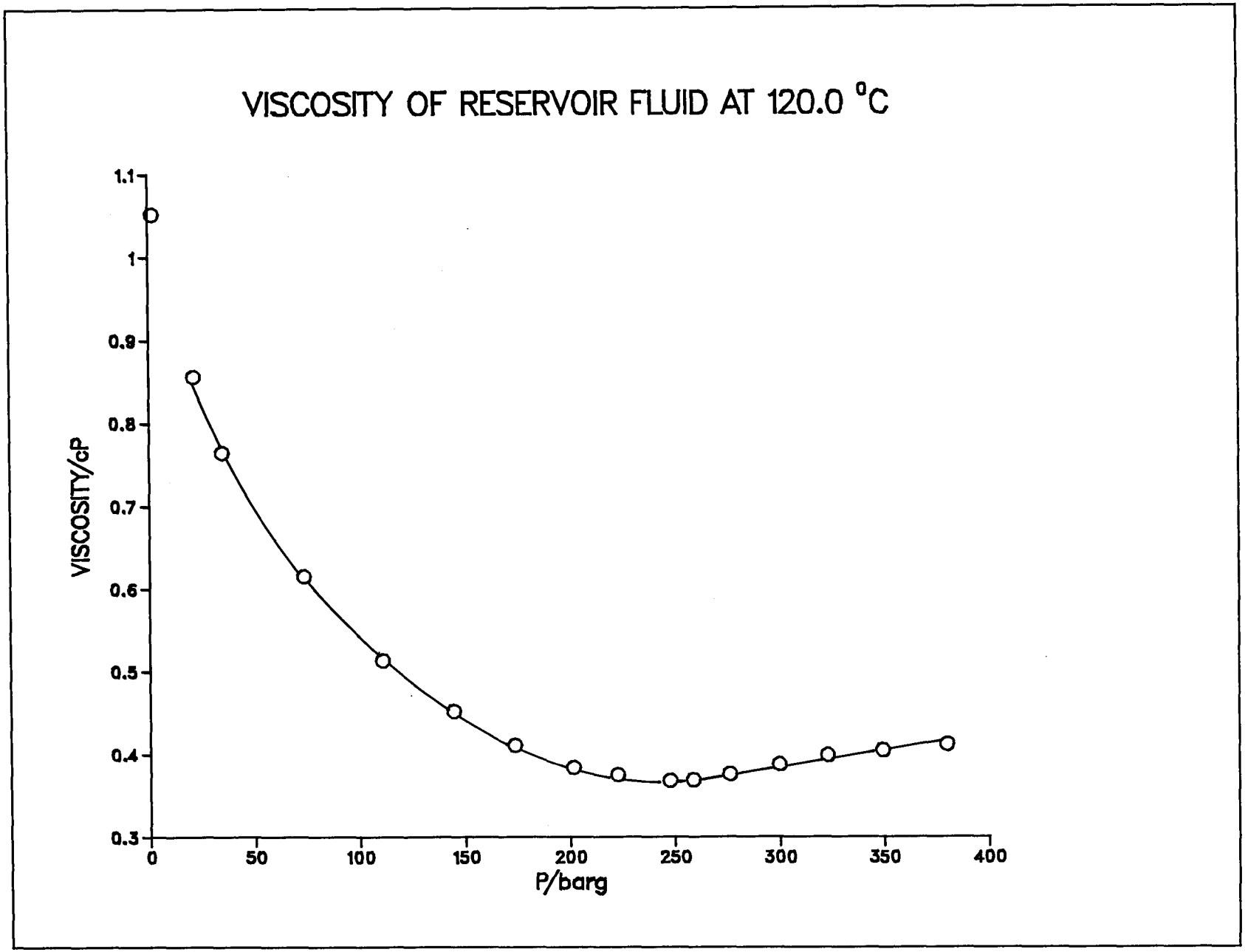

DIFFERENTIAL DEPLETION AT 120.0 °C
GAS FORMATION VOLUME FACTOR
Gas formation volume factor
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
50
100
150
200
250
P/barg

FIG.


DIFFERENTIAL DEPLETION AT 120.0 °C
COMPRESSIBILITY FACTOR
Z-factor
1
0.95
0.90
0.85
0.80
0.75
0
50
100
150
200
250
P/barg


VISCOSITY OF RESERVOIR FLUID AT 120.0 °C
VISCOSITY/cP
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
50
100
150
200
250
300
350
400
P/barg