STATOIL

WELL: 34/10-13

PVT - STUDY

GECO
GEOPHYSICAL COMPANY
OF NORWAY A.S

STATOIL

WELL: 34/10-13

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CONTENTS

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Reservoir Fluid Study
Well: 34/10-13
Bottom hole sample
Bottle no. 8151-31
April 22, 1982

SUMMARY

The following pages present the results of a PVT-study of a bottom hole sample of reservoir fluid from well: 34/10-13.
Single-stage flash, gas composition, viscosity, differential liberation and pressure-volume relations were determined at 74.6°C.

Main results are:

Bubble point at 74.6°C.	233.5 barg
Density at bubble point	0.662 g/cm^3
Compressibility at bubble point	1.95×10^{-4} bar^{-1}
Thermal expansion at 300 barg	1.06×10^{-3} $°C^{-1}$
Viscosity at bubble point	0.400 cP

From single-stage flash:

Gas/oil ratio	160 SM^3/M^3
Bo at bubble point	1.49 M^3/M^3
Density of oil at 15°C	0.832 g/cm^3

Standard conditions: for gas volumes = 15°C and 1 atm
for oil volumes = 15°C and atmospheric pressure

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Sample.

The bottom hole sample, bottle no. 8151-31, sampled 25-12-81, was supplied by Statoil U & P laboratory.
The opening pressure and bubble point of the sample at room temperature were 117 and 169 barg respectively.

LABORATORY PROCEDURE.

PVT-analysis. Pressure-volume relations were determined in a Ruska visual liquid PVT cell-oil bath at 74.6°C. Single flash to 15°C and atmospheric pressure was performed in a Ruska Flash Separator. Gas volumes were measured by a Ruska Gasometer. Gas samples for analysis were collected in a gas sampling tube (125 ml) connected between the separator and gasometer. The final step in the differential liberation was carried out by flashing the oil remaining from the previous step (31.3 barg and 74.6°C) to atmospheric pressure and 15°C.

Gas analysis. Gas analysis up to and including hexanes was carried out with a Perkin Elmer Sigma gaschromatograph equipped for automatic gas analysis and column switching. The analysis was carried out isothermally at 65°C with FID and hot wire detector at 150 and 100°C respectively.
Columns were 1: 15% squalane or Chromosorb P, 2: Poropak N,
3: Molekular Sieve 5 A.
The C_7+ fraction is determined by backflushing from column 1 through the FID detector.
The system is calibrated before and after each working day with a calibration gas (Air Products) containing hydrocarbons from methane through pentane, and helium, nitrogen and carbon dioxide.

Density and Molecular Weight. Density of stock tank oil was determined at 15°C with a AP Paar Density meter, calibrated with dry air and distilled water before each measurement. Molecular weight was determined by freezing point depression of benzene.

Viscosity. Liquid viscosities were determined with a ROP rolling ball viscosimeter calibrated with viscosity standards from Cannon Instrument Co. Gas viscosities are calculated from molecular composition according to Lee A.L, Gonzales M.H and Eakin B.E.,J.Petr.Techn., 1966, 997.

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FLASH OF RESERVOR LIQUID TO STOCK TANK CONDITIONS

(Molecular composition of reservoir fluid)

Component	Stock tank liquid (mol %)	Evolved gas (mol %)	Recombined reservoir liquid (mol %)
Nitrogen		1.76	1.10
Carbon dioxide		0.26	0.16
Methane	0.01	76.09	47.65
Ethane	0.05	8.93	5.61
Propane	0.35	6.51	4.21
Iso-Butane	0.28	1.12	0.81
n-Butane	1.09	2.70	2.10
iso-Pentane	1.02	0.66	0.79
n-Pentane	1.71	0.79	1.13
Hexanes	3.73	0.71	1.84
Heptanus Plus	91.76	0.47	34.60

GOR,	160	SM^3/M^3
BO at bubble point	1.49	M^3/M^3
Density of oil at 15°C	0.832	g/cm^3
Gas gravity (air=1)	0.787	
Molecular weight of oil	206	
Density at bubble point	0.662	g/cm^3

Pressure - Volume Relation at constant mass and 74.6°C

Pressure bar gauge	Relative volume V/Vsat	Isothermal compressibility bar $^{-1}$	" Y "
402.4	0.9698	1.40×10^{-4}	
379.4	0.9754	1.48×10^{-4}	
352.6	0.9793	1.57×10^{-4}	
329.0	0.9832	1.64×10^{-4}	
303.0	0.9873	1.73×10^{-4}	
277.9	0.9917	1.81×10^{-4}	
254.5	0.9961	1.88×10^{-4}	
233.5	1.0000	1.95×10^{-4}	
231.2	1.0026		
212.2	1.0264		3.8893
184.8	1.0747		3.5646
165.6	1.1234		3.3478
142.1	1.2073		3.1201
118.2	1.3406		2.8766
92.3	1.5829		2.6336
63.5	2.1193		2.3989
44.6	2.8932		2.2431

Thermal expansion at 300 barg: 1.06×10^{-3}°C $^{-1}$

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Differential Liberation of Reservoir Fluid at 74.6°C

Pressure (barg)	Oil Formation Volume Factor Bo(m^3/m^3)	Solution gas-oil ratio Rs(Sm^3/m^3	Gas Formation volume factor Bg(m^3/Sm^3)	Density of sat oil g/cm^3
402.4	1.366			0.684
351.1	1.379			0.677
303.0	1.391			0.671
277.9	1.397			0.668
233.5	1.408	128.322		0.633
221.8	1.387	120.688	5.21×10^{-3}	0.669
201.8	1.352	107.314	5.51 "	0.678
177.9	1.316	92.559	6.16 "	0.687
153.4	1.282	77.986	6.95 "	0.696
128.9	1.249	63.826	8.23 "	0.705
102.9	1.212	49.269	10.8 "	0.717
72.5	1.171	32.593	15.5 "	0.730
31.3	1.113	10.162	38.0 "	0.750
0	1.052			0.785

Residual oil* density: 0.826 g/cm^3

* Residual oil is the oil obtained by flashing the liquid remaining at 31.3 barg and reservoir temperature to 15°C and atmospheric pressure.

Differential Liberation of Reservoir Fluid at 74.6°C

Molecular composition of liberated gases (mol %)

Pressure/barg:	221.8	201.8	177.9	153.4	128.9	102.9	72.5	31.3	0
Nitrogen	4.23	2.98	2.94	2.89	2.84	2.77	2.70	0.70	1.08
Carbon dioxide	0.22	0.21	0.22	0.22	0.23	0.24	0.27	0.34	0.77
Methane	85.93	85.87	86.22	86.16	86.05	85.75	84.67	80.51	74.08
Ethane	5.06	5.20	5.30	5.38	5.54	5.94	6.79	10.18	17.60
Propane	2.33	2.61	2.67	2.61	2.59	2.70	3.07	4.93	5.38
i-Butane	0.36	0.39	0.39	0.38	0.38	0.38	0.39	0.60	0.41
n-Butane	0.78	0.88	0.88	0.87	0.87	0.85	0.84	1.27	0.48
i-Pentane	0.21	0.24	0.24	0.24	0.24	0.24	0.23	0.27	0.07
n-Pentane	0.27	0.33	0.33	0.33	0.32	0.32	0.34	0.34	0.06
Hexanes	0.28	0.46	0.40	0.40	0.39	0.37	0.35	0.36	0.03
Heptanes Plus	0.33	0.83	0.41	0.52	0.55	0.44	0.37	0.50	0.04
Gas gravity (air=1)	0.662	0.685	0.671	0.675	0.675	0.674	0.679	0.720	0.721
Molecular weight	19.2	19.8	19.4	19.5	19.6	19.5	19.7	20.9	20.9

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Differential Liberation of Reservoir Fluid at 74.6°C Gas Properties

Pressure (barg)	Gas viscosity (cP)	Gas Gravity (air=1)	Compressibility factor z
221.8	0.021	0.662	0.949
201.8	0.0199	0.685	0.914
177.9	0.0185	0.671	0.901
153.4	0.0174	0.675	0.877
128.9	0.0162	0.675	0.874
102.9	0.0152	0.674	0.918
72.5	0.0141	0.679	0.932
31.3	0.0130	0.720	1.000
0	0.0125	0.721	1.000

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Viscosity of Reservoir Fluid at 74.6°C

Pressure (barg)	Viscosity (centipoise)
425	0.483
400	0.473
375	0.463
350	0.455
325	0.442
301	0.433
276	0.422
250	0.412
233	0.400
227	0.406
202	0.446
173	0.529
141	0.589
129	0.624
102	0.697
72.9	0.820
47.4	0.948
26.5	1.168
0	1.631

FIG. 1. PRESSURE-VOLUME RELATION AT CONSTANT MASS AND 74.6°C.

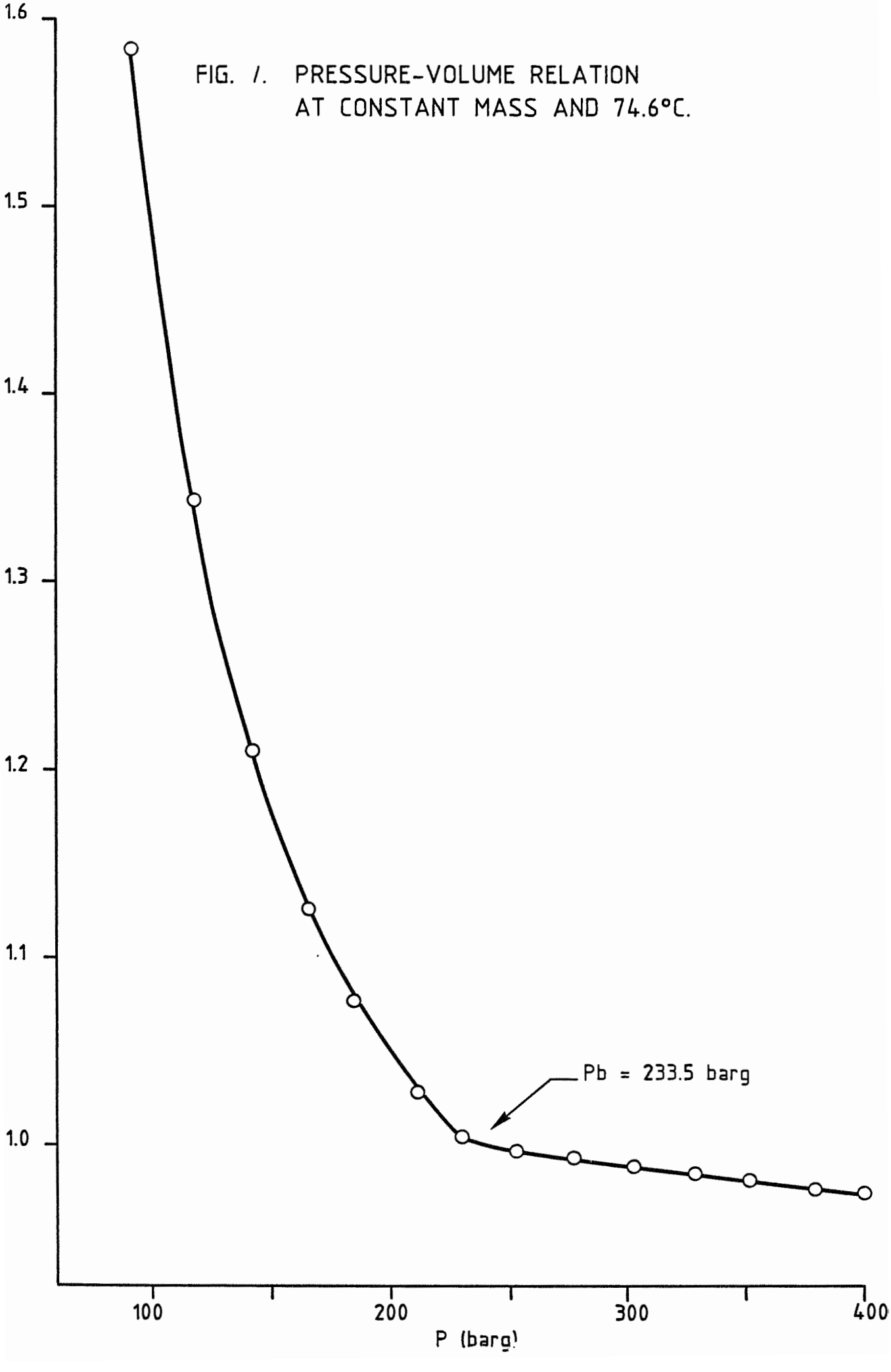

FIG.2. VISCOSITY OF RESERVOIR FLUID AT 74.6°C.

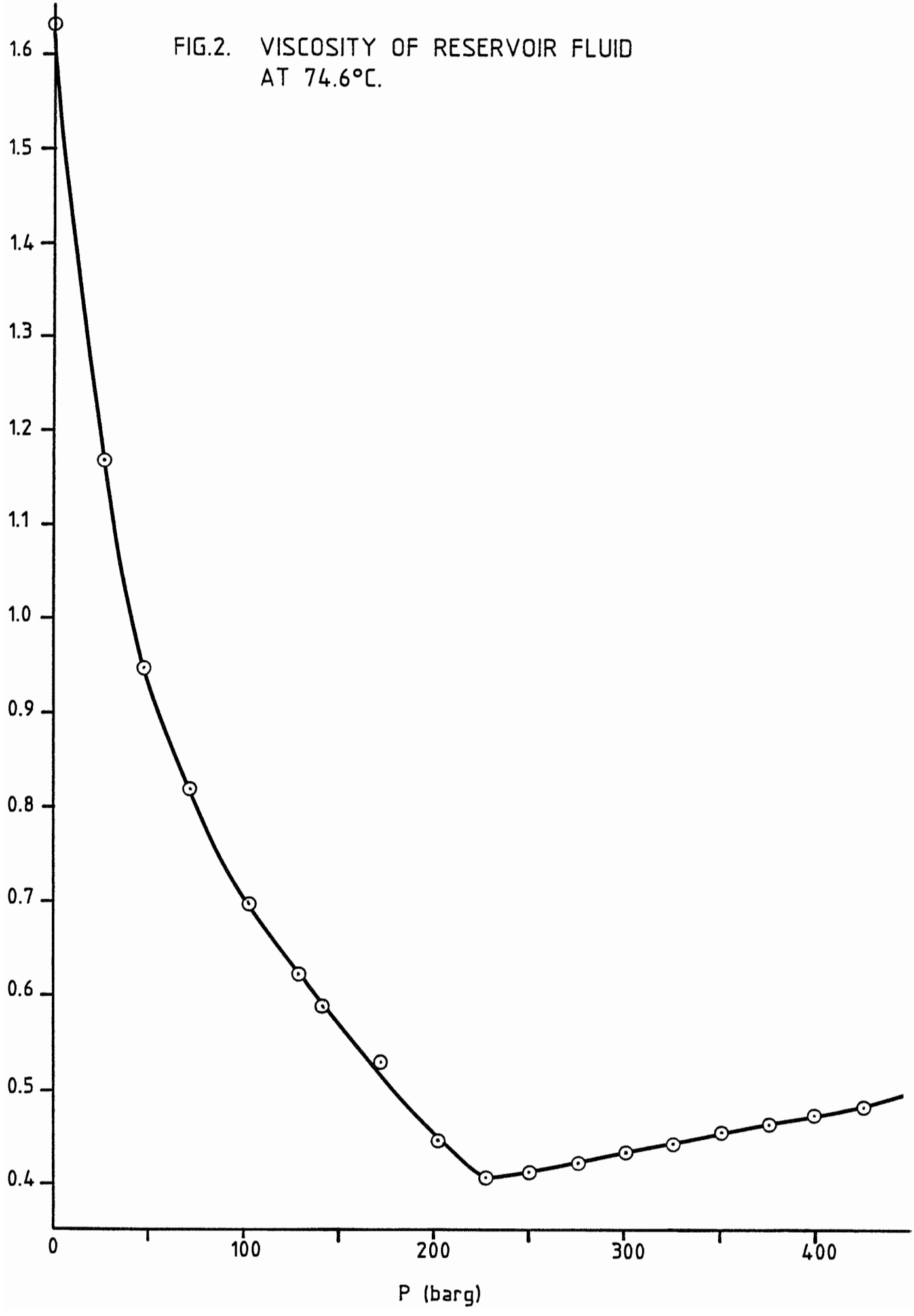

FIG.3. DIFFERENTIAL LIBERATION AT 74.6°C
OIL FORMATION VOLUME FACTOR.

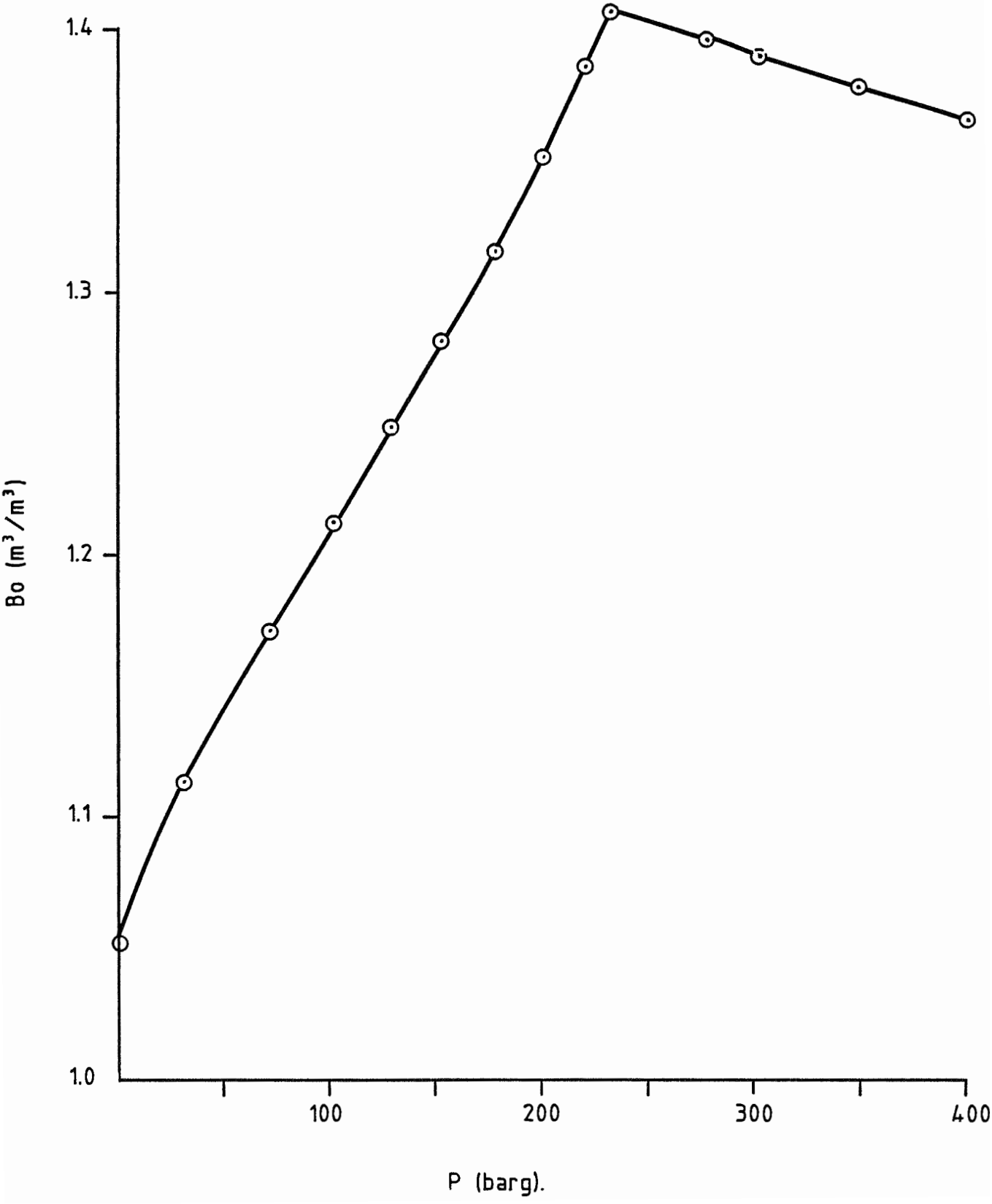

FIG.4. DIFFERENTIAL LIBERATION AT 74.6°C
SOLUTION GAS-OIL RATIO.

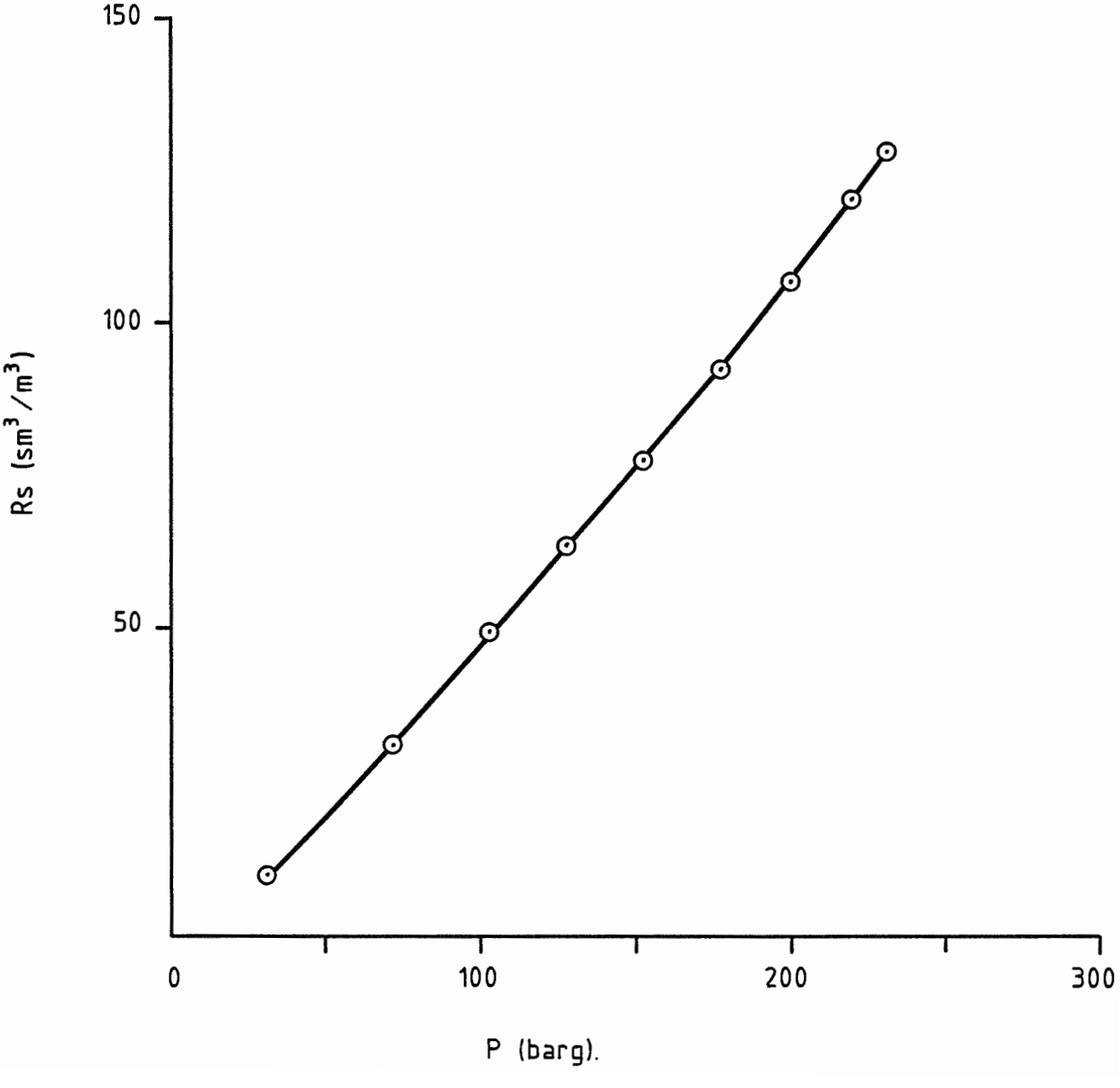

FIG 5. DIFFERENTIAL LIBERATION AT 74.6°C
LIBERATED GAS VISCOSITY.