CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS 75207

March 19, 1974

RESERVOIR FLUID DIVISION

Phillips Petroleum Company Norway
P. O. Box 69
4001 Stavanger, Norway

Attention: Mr. B. M. Thompson

Subject: Reservoir Fluid Study
2/4-10 Well
Drill Stem Test 1, Flow Period 4
NW Tor Field
North Sea, Norway
Our File Number: RFL 74056

Gentlemen:

Samples of separator gas and liquid were collected from the subject well on November 23, 1973, during Flow Period No. 4 of Drill Stem Test No. 1. These samples were submitted to our Dallas laboratory to be used in the performance of a reservoir fluid study as requested by Phillips Petroleum Company Norway. Presented in the following report are the results of this study.

The hydrocarbon composition of the separator gas was determined by chromatography and is presented on page two. The composition of the separator liquid was determined by using chromatography in conjunction with low temperature, fractional distillation. The results of this distillation in terms of both mol percent and weight percent are given on page three. Due to the fact that the field separator gas rate was insufficient for measurement, we felt that it was reasonable to assume that the separator liquid sample is representative of the fluid in the formation. This situation was discussed with a representative of Phillips Petroleum Company in Bartlesville, and it was agreed that the separator liquid sample would be assumed to represent the reservoir fluid for the purposes of our study.

A small quantity of the fluid was examined in a high pressure windowed cell at the reported reservoir temperature of 265°F. At this temperature, the fluid was found to have a bubble point pressure of 401 psig. During differential pressure depletion at the reservoir temperature, the fluid evolved a total of 132 cubic feet of gas at 14.65 psia and 60°F. per barrel of residual oil at 60°F. The corresponding formation volume factor was 1.215 barrels of saturated fluid per barrel of residual oil. The gravity of the residual oil was determined to be 36.4° API at 60°F. The viscosity of the reservoir fluid was measured at 265°F. and pressures ranging from above the reservoir pressure to atmospheric pressure. The fluid was found to have a minimum viscosity of 0.798 centipoise at the saturation pressure.

Four single stage separator tests were performed at laboratory temperature. The data from these tests, including gas-oil ratios, stock tank oil gravities and formation volume factors are presented on page eight.

Thank you for this opportunity to be of service to Phillips Petroleum Company Norway. If we may be of assistance to you at any time in the future, please do not hesitate to call upon us.

Very truly yours,

Core Laboratories, Inc.
Reservoir Fluid Analysis

P. L. Moses (JF)

P. L. Moses
Manager

PLM:JF:vs
7 cc. - Addressee
2 cc. - Mr. B. M. Boyce
Phillips Petroleum Company
Bartlesville, Oklahoma 74004

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

File RFL 74056

Company Phillips Petroleum Company Norway — Date Sampled November 23, 1973

Well 2/4-10, DST 1, FP 4 — Province

Field NW Tor — Country North Sea, Norway

FORMATION CHARACTERISTICS

Formation Name	Danian
Date First Well Completed	, 19
Original Reservoir Pressure	PSIG @ Ft.
Original Produced Gas-Liquid Ratio	SCF/Bbl
Production Rate	Bbls/Day
Separator Pressure and Temperature	PSIG ° F.
Liquid Gravity at 60° F.	° API
Datum	Ft. Subsea

WELL CHARACTERISTICS

Elevation	Ft.
Total Depth	Ft.
Producing Interval	10840 - 10900 Ft.
Tubing Size and Depth	In. to Ft.
Open Flow Potential	MMSCF/Day
Last Reservoir Pressure	7015 PSIG @ 10859 Ft.
Date	, 19
Reservoir Temperature	265 ° F. @ 10859 Ft.
Status of Well	
Pressure Gauge	

SAMPLING CONDITIONS

Flowing Tubing Pressure		PSIG
Flowing Bottom Hole Pressure		PSIG
Primary Separator Pressure	295	PSIG
Primary Separator Temperature	118	° F.
Secondary Separator Pressure		PSIG
Secondary Separator Temperature		° F.
Field Stock Tank Liquid Gravity	38.0	° API @ 60° F.
Primary Separator Gas Production Rate	0*	MSCF/Day
Pressure Base	14.65 PSIA	
Temperature Base	60 ° F.	
Compressibility Factor (F_{pv})		
Gas Gravity (Laboratory)	0.699	
Gas Gravity Factor (F_g)		
Stock Tank Liquid Production Rate @ 60° F.	844	Bbls/Day
Primary Separator Gas/ Stock Tank Liquid Ratio	0	SCF/Bbl
or		Bbls/MMSCF
Core Laboratories, Inc., Engineer		

REMARKS:

*Gas flow rate was insufficient for measurement.

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File RFL 74056

Company Phillips Petroleum Company Norway Formation Danian

Well 2/4-10, DST 1, FP 4 Province

Field NW Tor Country North Sea, Norway

HYDROCARBON ANALYSIS OF Separator GAS SAMPLE

COMPONENT	MOL PER CENT	G P M
Hydrogen	0.56	
Hydrogen Sulfide	Nil	
Carbon Dioxide	6.84	
Nitrogen	4.43	
Methane	82.02	
Ethane	3.19	0.801
Propane	1.06	0.290
iso-Butane	0.32	0.104
n-Butane	0.47	0.147
iso-Pentane	0.26	0.095
n-Pentane	0.29	0.105
Hexanes	0.26	0.106
Heptanes plus	0.30	0.136
	100.00	1.784

Calculated gas gravity (air = 1.000) = 0.699

Calculated gross heating value = 987 BTU
per cubic foot of dry gas at 14.65 psia at 60° F.

Collected at 295 psig and 118 °F.

Company Phillips Petroleum Company Norway Formation Danian

Well 2/4-10, DST 1, FP 4 Province

Field NW Tor Country North Sea, Norway

HYDROCARBON ANALYSIS OF Separator Liquid SAMPLE *

COMPONENT	MOL PER CENT	WEIGHT PER CENT	DENSITY @ 60° F. GRAMS PER CUBIC CENTIMETER	° API @ 60° F.	MOLECULAR WEIGHT
Hydrogen Sulfide	Nil	Nil			
Carbon Dioxide	0.54	0.13			
Nitrogen	0.11	0.02			
Methane	7.20	0.61			
Ethane	1.34	0.21			
Propane	1.24	0.29			
iso-Butane	0.74	0.23			
n-Butane	1.51	0.47			
iso-Pentane	1.85	0.71			
n-Pentane	2.25	0.86			
Hexanes	5.89	2.68			
Heptanes plus	77.33	93.79	0.8462	35.5	229
	100.00	100.00			

Collected at 295 psig and 118°F.

*Due to a field gas-oil ratio of zero, the separator liquid sample was assumed to represent the reservoir fluid and was used in the performance of the study.

VOLUMETRIC DATA OF Reservoir Fluid SAMPLE

1. Saturation pressure (bubble-point pressure) 401 PSIG @ 265 °F.
2. Thermal expansion of saturated oil @ 2000 PSI $= \frac{V \text{ @ } 265 \text{ °F}}{V \text{ @ } 77 \text{ °F}} =$ 1.09709
3. Compressibility of saturated oil @ reservoir temperature: Vol/Vol/PSI:

   From 7500 PSI to 5000 PSI = 6.72×10^{-6}

   From 5000 PSI to 2500 PSI = 8.30×10^{-6}

   From 2500 PSI to 401 PSI = 10.43×10^{-6}
4. Specific volume at saturation pressure: ft ^{3}/lb 0.02170 @ 265 °F.

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DALLAS, TEXAS 75207

File RFL 74056
Well 2/4-10, DST 1, FP 4

Reservoir Fluid SAMPLE TABULAR DATA

PRESSURE PSI GAUGE	PRESSURE-VOLUME RELATION @ 265 °F.. RELATIVE VOLUME OF OIL AND GAS, V/VSAT.	VISCOSITY OF OIL @ 265 °F.. CENTIPOISES	DIFFERENTIAL LIBERATION @ 265 °F.		
			GAS/OIL RATIO LIBERATED PER BARREL OF RESIDUAL OIL	GAS/OIL RATIO IN SOLUTION PER BARREL OF RESIDUAL OIL	RELATIVE OIL VOLUME, V/VR
7500	0.9417	1.499			1.144
7000	0.9446				1.147
6500	0.9477	1.399			1.151
6000	0.9509				1.155
5500	0.9543	1.300			1.159
5000	0.9578				1.163
4500	0.9614	1.201			1.168
4000	0.9653				1.172
3500	0.9694	1.102			1.177
3000	0.9736	1.053			1.183
2500	0.9781	1.004			1.188
2000	0.9829	0.955			1.194
1500	0.9877	0.906			1.200
1000	0.9931	0.857			1.206
700	0.9965				1.210
600	0.9976	0.817			1.212
500	0.9988				1.213
401	1.0000	0.798	0	132	1.215
399	1.0022				
397	1.0044				
393	1.0089				
388	1.0147				
380	1.0244				
368	1.0400				
347		0.822	9	123	1.211
345	1.0736				
313	1.1307				
279	1.2088				
275		0.856	21	111	1.205
243	1.3214				

V = Volume at given pressure
VSAT. = Volume at saturation pressure and the specified temperature.
VR = Residual oil volume at 14.65 PSI absolute and 60° F.

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Petroleum Reservoir Engineering
DALLAS, TEXAS 75207

File RFL 74056

Well 2/4-10, DST 1, FP 4

Reservoir Fluid SAMPLE TABULAR DATA

PRESSURE PSI GAUGE	PRESSURE-VOLUME RELATION @ 265 °F., RELATIVE VOLUME OF OIL AND GAS, V/VSAT.	VISCOSITY OF OIL @ 265°F., CENTIPOISES	DIFFERENTIAL LIBERATION @ 265 °F.		
			GAS/OIL RATIO LIBERATED PER BARREL OF RESIDUAL OIL	GAS/OIL RATIO IN SOLUTION PER BARREL OF RESIDUAL OIL	RELATIVE OIL VOLUME, V/VR
208	1.4717				
200		0.899	36	96	1.196
169	1.7301				
135	2.0903				
125		0.950	53	79	1.184
104	2.6492				
77	3.5749				
67			69	63	1.171
0		1.129	132	0	1.100
				@ 60°F.	= 1.000

Gravity of residual oil = 36.4° API @ 60°F.

V = Volume at given pressure
VSAT. = Volume at saturation pressure and the specified temperature.
VR = Residual oil volume at 14.65 PSI absolute and 60° F.

Differential Pressure Depletion at 265°F.

Pressure, PSIG	Oil Density, Gms/Cc	Gas Gravity	Deviation Factor Z
	API		
401	0.7380 60.23		
347	0.7387	0.856	0.962
275	0.7408	0.904	0.968
200	0.7436	1.003	0.975
125	0.7469	1.253	0.982
67	0.7503	1.655	0.990
0	0.7653	2.694	

File RFL 74056

Well 2/4-10, DST 1, FP 4

SEPARATOR TESTS OF Reservoir Fluid SAMPLE

SEPARATOR PRESSURE, PSI GAUGE	SEPARATOR TEMPERATURE, ° F.	SEPARATOR GAS/OIL RATIO See Foot Note (1)	STOCK TANK GAS/OIL RATIO See Foot Note (1)	STOCK TANK GRAVITY, ° API @ 60° F.	SHRINKAGE FACTOR, $V_R/V_{SAT.}$ See Foot Note (2)	FORMATION VOLUME FACTOR, $V_{SAT.}/V_R$ See Foot Note (3)	SPECIFIC GRAVITY OF FLASHED GAS
0	118	71	71	38.4	0.8643	1.157	1.029
20	118	56 +	8 64	38.6	0.8696	1.150	
40	118	48 +	14 62	38.7	0.8711	1.148	
80	118	40 +	23 63	38.6	0.8703	1.149	
		215	45 260				

Core Laboratories, Inc.
Reservoir Fluid Analysis

P. L. Moses (JF)

P. L. Moses
Manager

(1) Separator and Stock Tank Gas/Oil Ratio in cubic feet of gas @ 60° F. and 14.65 PSI absolute per barrel of stock tank oil @ 60°F.

(2) Shrinkage Factor; $V_R/V_{SAT.}$ is barrels of stock tank oil @ 60° F. per barrel of saturated oil @ 401 PSI gauge and 265 ° F.

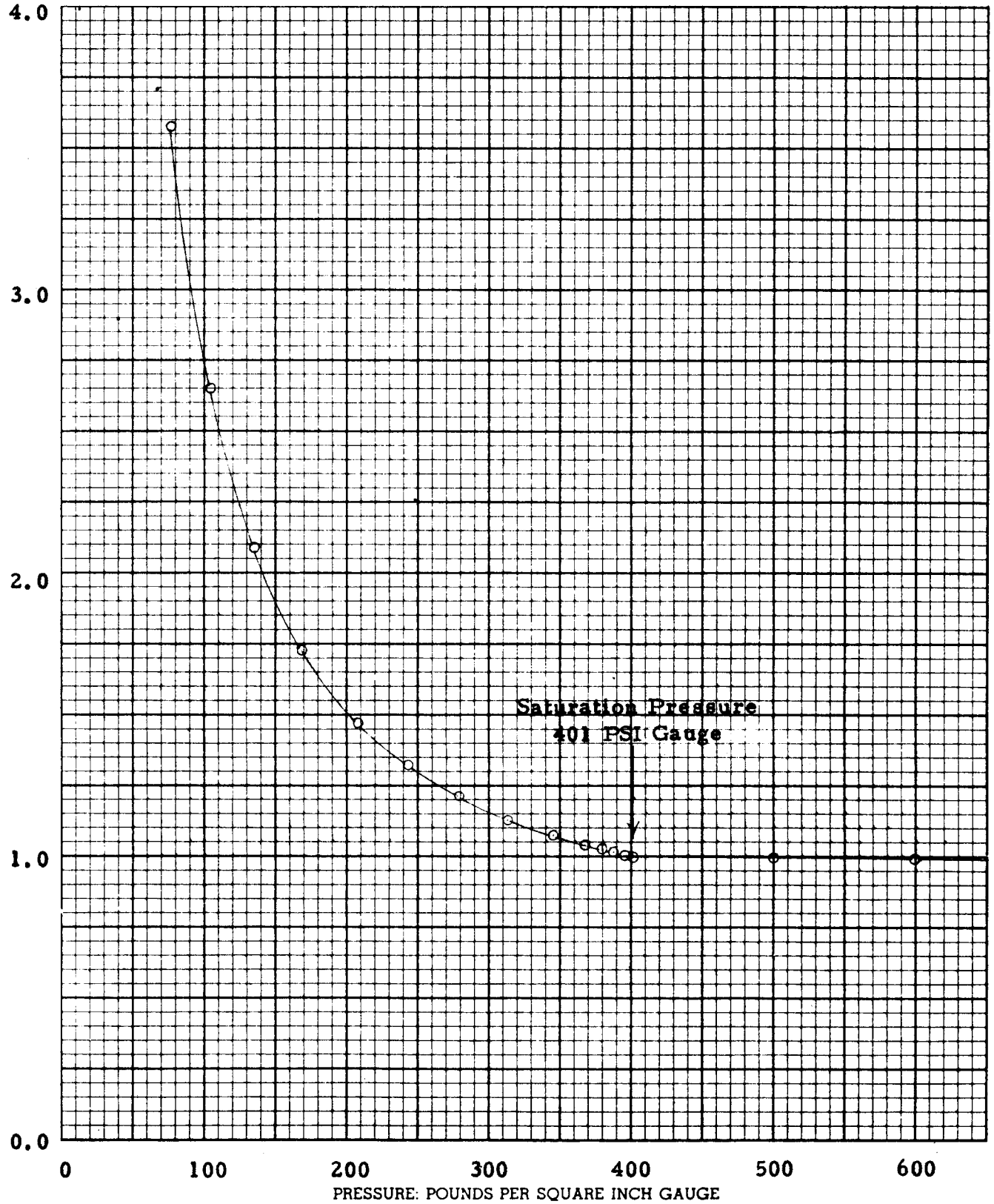
(3) Formation Volume Factor: $V_{SAT.}/V_R$ is barrels of saturated oil @ 401 PSI gauge and 265 ° F. per barrel of stock tank oil @ 60° F.

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

File RFL 74056

PRESSURE-VOLUME RELATIONS OF RESERVOIR FLUID

Company Phillips Petroleum Company Norway Formation Danian
Well 2/4-10, DST 1, FP 4 Province
Field NW Tor Country North Sea, Norway



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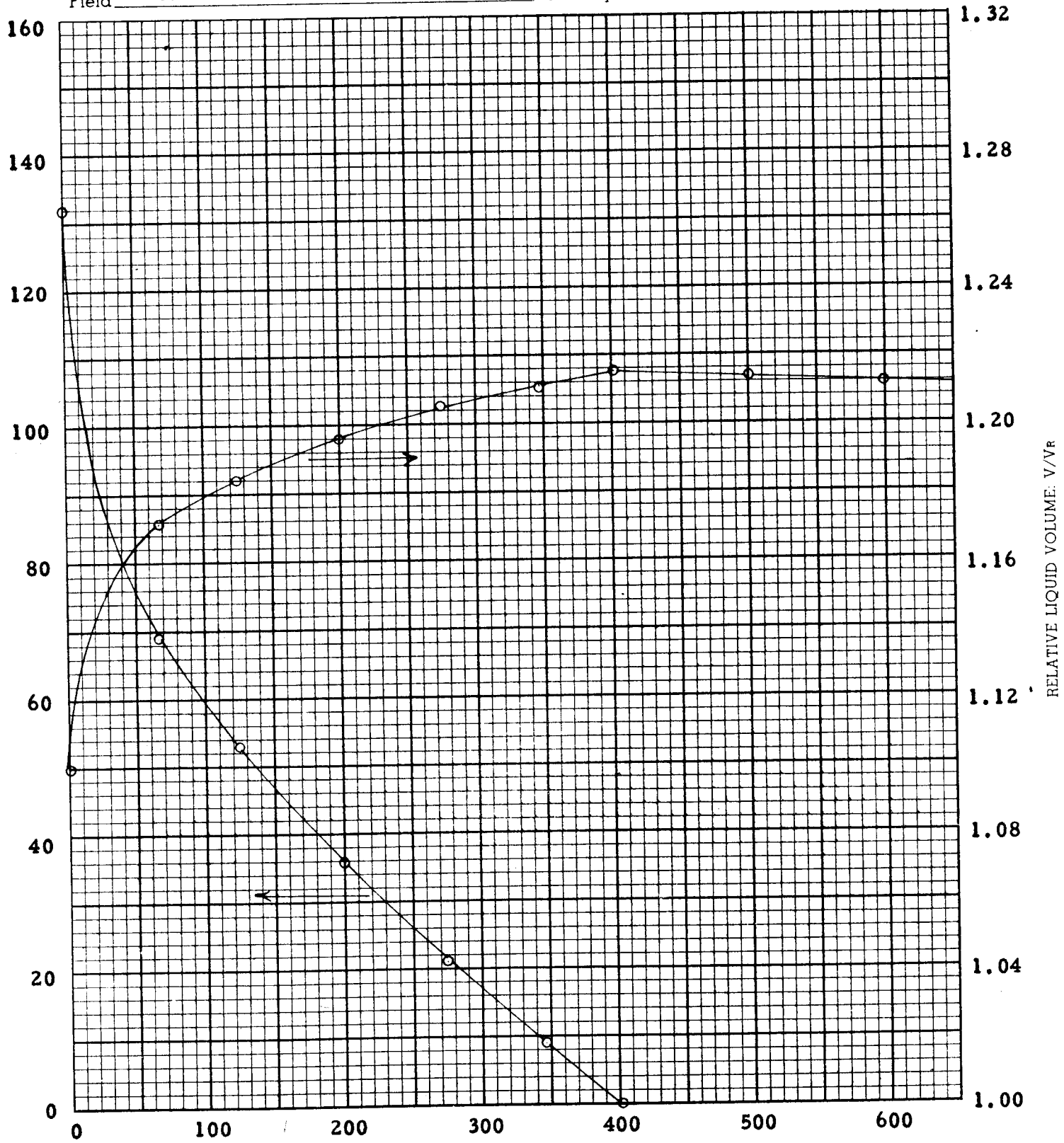
Petroleum Reservoir Engineering
DALLAS, TEXAS

DIFFERENTIAL VAPORIZATION OF RESERVOIR FLUID

Company Phillips Petroleum Company Norway
Well 2/4-10, DST 1, FP 4
Field NW Tor
Formation Danian
Province
Country North Sea, Norway



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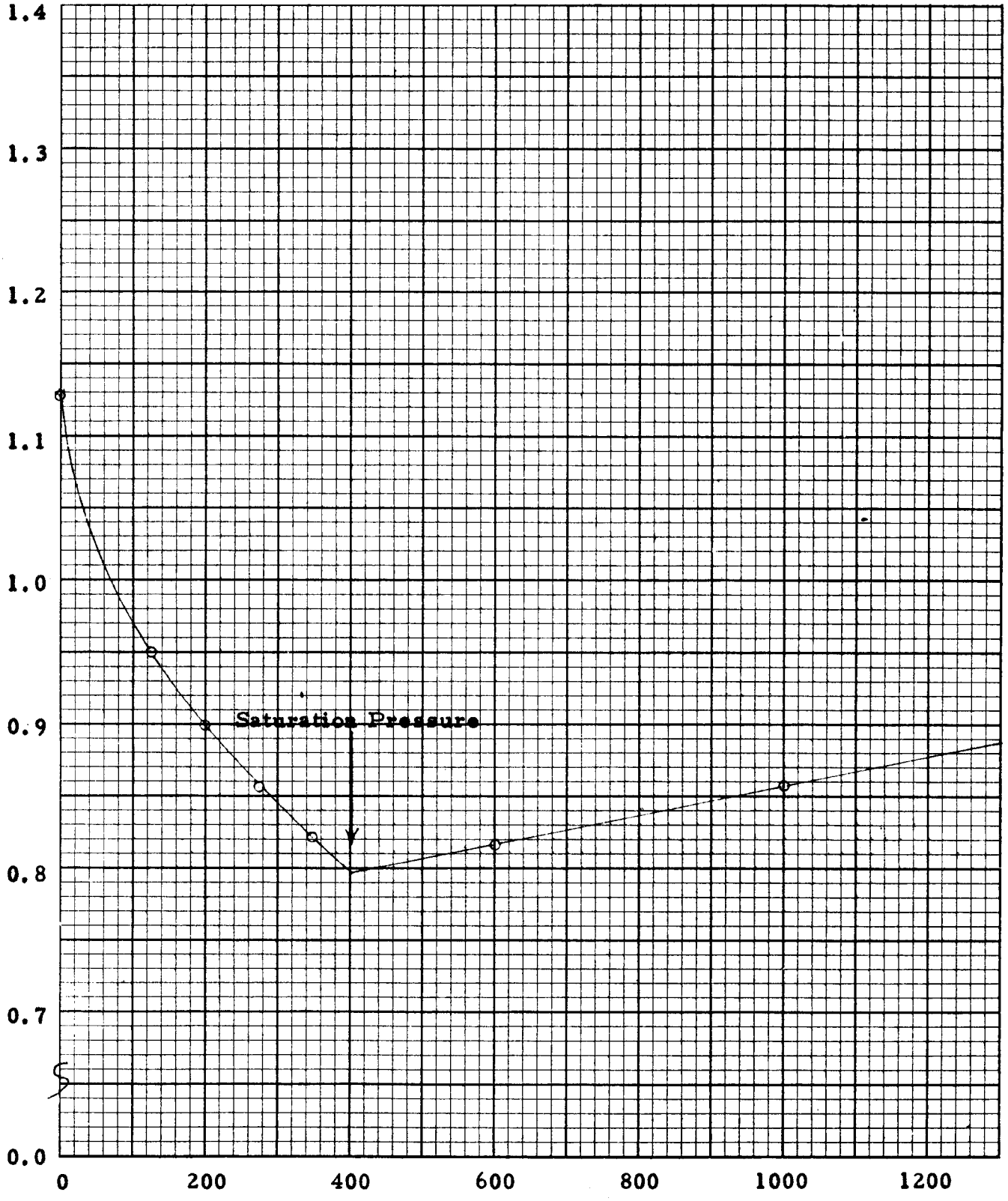
DALLAS, TEXAS

VISCOSITY OF RESERVOIR FLUID

Company Phillips Petroleum Company Norway Formation Danian
Well 2/4-10, DST 1, FP 4 Province
Field NW Tor Country North Sea, Norway



Well File
2/4-10 No. 11

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS 75207

April 3, 1974

RESERVOIR FLUID DIVISION

Phillips Petroleum Company Norway
P. O. Box 69
4001 Stavanger, Norway

Attention: Mr. B. M. Thompson

Subject: Errata
Reservoir Fluid Study
2/4-10 Well
Drill Stem Test 1, Flow Period 4
NW Tor Field
North Sea, Norway
Our File Number: RFL 74056

Gentlemen:

On March 19, 1974, a report was issued from our Dallas offices covering the results of a reservoir fluid study performed using samples of separator gas and liquid collected from the subject well during Flow Period 4 of Drill Stem Test 1. An error has been discovered in the original report.

On page eight of the report, it was discovered that the separator temperatures listed are all incorrect. The temperatures listed are laboratory temperature at the time each test was performed. The actual separator temperature for each test was 118°F. New copies of page eight are enclosed reflecting this change. Please destroy all old copies of this page.

We apologize for this miscue and hope it has not caused you serious inconvenience. It is always a pleasure to be of service to Phillips Petroleum Company Norway. If we may be of assistance to you at any time in the future, please do not hesitate to call upon us.

Very truly yours,

Core Laboratories, Inc.
Reservoir Fluid Analysis

P. L. Moses (JA)
P. L. Moses
Manager

PLM:JF:vs
7 cc. - Addressee
2 cc. - Mr. B. M. Boyce
Phillips Petroleum Company
Bartlesville, Oklahoma 74004

SEPARATOR TESTS OF Reservoir Fluid SAMPLE

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Reservoir Fluid Analysis

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Manager

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(2) Shrinkage Factor; $V_R/V_{SAT.}$ is barrels of stock tank oil @ 60° F. per barrel of saturated oil @ 401 PSI gauge and 265 ° F.

(3) Formation Volume Factor: $V_{SAT.}/V_R$ is barrels of saturated oil @ 401 PSI gauge and 265 ° F. per barrel of stock tank oil @ 60° F.