

**RESERVOIR FLUID STUDY**  
**FOR**  
**PHILLIPS PETROLEUM COMPANY - NORWAY**  
**2/4-4AX WELL**  
**(3000 FEET)**  
**EKOFISK FIELD**  
**NORTH SEA, NORWAY**



**CORE LABORATORIES, INC.**

*Petroleum Reservoir Engineering*

**DALLAS, TEXAS 75207**

December 14, 1970

**RESERVOIR FLUID ANALYSIS**

Phillips Petroleum Company - Norway  
P. O. Box 72  
Stavanger, Norway

Attention: Mr. P. W. Reynolds

Subject: Reservoir Fluid Study  
2/4-4AX Well  
(3000 Feet)  
Ekofisk Field  
Offshore, Norway  
Our File Number: RFL 6655

Gentlemen:

A subsurface fluid sample was collected from the subject well at a depth of 3000 feet on August 10, 1970. The sample was forwarded to our laboratory in Dallas for use in a reservoir fluid study, and the results of this study are presented on the following pages.

At the analysis temperature of 266° F. the fluid exhibited a bubble point pressure of 5545 psig. During the differential pressure depletion the fluid liberated a total of 1942 cubic feet of gas at 14.696 psia and 60° F. per barrel of residual oil at 60° F. The corresponding formation volume factor was 2.174 barrels of saturated fluid per barrel of residual oil. The oil density, gas gravity and gas deviation factors were measured at each point on the differential pressure depletion, and these data are presented on page five of the report. The viscosity test was performed under conditions similar to those of the differential pressure depletion and the viscosity of the fluid varied from a minimum of 0.229 centipoise at the saturation pressure to a maximum of 1.285 centipoises at atmospheric pressure.

A multi-stage separator test was performed at specified conditions and the data from this test, including gas-oil ratios, stock tank oil gravity and

Phillips Petroleum Company - Norway  
2/4-4AX Well (3000 Feet)

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formation volume factor are presented on page six of the report. In addition, the primary separator gas from the multi-stage separator test was collected and analyzed for hydrocarbons. The results of this analysis may be found on page seven. The hydrocarbon composition of the reservoir fluid sample was measured by means of low temperature, fractional distillation and is presented on page eight.

As always, it has been a pleasure to be of service to Phillips Petroleum Company - Norway. If we may answer any questions or be of further assistance in any manner, please feel free to contact us.

Very truly yours,

Core Laboratories, Inc.  
Reservoir Fluid Analysis

*P. L. Moses* (JF)

P. L. Moses  
Manager

PLM:JF:dl

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Phillips Petroleum  
 Company Company - Norway Date Sampled August 10, 1970\*  
 Well 2/4-4AX (3000 Feet) Province Offshore  
 Field Ekofisk Country Norway

## FORMATION CHARACTERISTICS

Formation Name Danian  
 Date First Well Completed \_\_\_\_\_, 19\_\_\_\_  
 Original Reservoir Pressure \_\_\_\_\_ PSIG @ \_\_\_\_\_ Ft.  
 Original Produced Gas-Oil Ratio \_\_\_\_\_ SCF/Bbl  
 Production Rate \_\_\_\_\_ Bbl/Day  
 Separator Pressure and Temperature 570 PSIG, 74 °F.  
 Oil Gravity at 60° F. \_\_\_\_\_ °API  
 Datum \_\_\_\_\_ Ft. Subsea  
 Original Gas Cap \_\_\_\_\_

## WELL CHARACTERISTICS

Elevation 322\*\* Ft.  
 Total Depth 10894 Ft.  
 Producing Interval 10380-10510 Ft.  
 Tubing Size and Depth 3-1/2 In. to 10319 Ft.  
 Productivity Index \_\_\_\_\_ Bbl/D/PSI @ \_\_\_\_\_ Bbl/Day  
 Last Reservoir Pressure \_\_\_\_\_ PSIG @ \_\_\_\_\_ Ft.  
 Date \_\_\_\_\_, 19\_\_\_\_  
 Reservoir Temperature 266 °F. @ 10445 Ft.  
 Status of Well Flowing  
 Pressure Gauge \_\_\_\_\_  
 Normal Production Rate 744 Bbl/Day  
 Gas-Oil Ratio 1206 SCF/Bbl  
 Separator Pressure and Temperature 570 PSIG, 74 °F.  
 Base Pressure \_\_\_\_\_ PSIA  
 Well Making Water None % Cut

## SAMPLING CONDITIONS

Sampled at 3000 Ft.  
 Status of Well Flowing  
 Gas-Oil Ratio 1206 SCF/Bbl  
 Separator Pressure and Temperature 570 PSIG, 74 °F.  
 Tubing Pressure 4120 PSIG  
 Casing Pressure \_\_\_\_\_ PSIG  
 Core Laboratories Engineer RFB  
 Type Sampler Wofford

## REMARKS:

- \* Sample taken at 7:00 A.M.
- \*\* From RKB to sea bed.

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Well 2/4-4AX (3000 Feet)

VOLUMETRIC DATA OF Reservoir Fluid SAMPLE

1. Saturation pressure (bubble-point pressure) 5545 PSIG @ 266 °F.
2. Thermal expansion of saturated oil @ 7000 PSI =  $\frac{V @ 266 \text{ } ^\circ\text{F}}{V @ 72 \text{ } ^\circ\text{F}}$  = 1.14326
3. Compressibility of saturated oil @ reservoir temperature: Vol/Vol/PSI:  
From 7000 PSI to 6500 PSI =  $18.81 \times 10^{-6}$   
From 6500 PSI to 6000 PSI =  $21.59 \times 10^{-6}$   
From 6000 PSI to 5545 PSI =  $25.19 \times 10^{-6}$
4. Specific volume at saturation pressure: ft<sup>3</sup>/lb 0.02759 @ 266 °F.

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Reservoir Fluid **SAMPLE TABULAR DATA**

PRESSURE PSI GAUGE	PRESSURE-VOLUME RELATION @ 266 °F., RELATIVE VOLUME OF OIL AND GAS, V/V <sub>SAT</sub> .	VISCOSITY OF OIL @ 266 °F., CENTIPOISES	DIFFERENTIAL LIBERATION @ 266 °F.		
			GAS/OIL RATIO LIBERATED PER BARREL OF RESIDUAL OIL	GAS/OIL RATIO IN SOLUTION PER BARREL OF RESIDUAL OIL	RELATIVE OIL VOLUME, V/V <sub>R</sub>
7000	0.9687	0.251			2.105
6700		0.247			
6500	0.9779				2.125
6400		0.242			
6100		0.238			
6000	0.9885				2.149
5900	0.9911				2.154
5800	0.9935	0.233			2.160
5700	0.9959				2.165
5600	0.9986				2.170
5545	1.0000	0.229	0	1942	2.174
5497	1.0024				
5457	1.0045				
5362	1.0095				
5300		0.245	206	1736	2.052
5117	1.0238				
4900		0.272	471	1471	1.904
4813	1.0443				
4435	1.0752				
4400		0.304	717	1225	1.774
4038	1.1169				
3900		0.342	914	1028	1.670
3587	1.1800				
3400		0.380	1072	870	1.589
3143	1.2645				
2900		0.421	1210	732	1.521
2719	1.3814				
2400		0.468	1334	608	1.460
2167	1.6163				
1900		0.522	1448	494	1.406
1635	2.0217				
1400		0.589	1555	387	1.354

V = Volume at given pressure

V<sub>SAT</sub> = Volume at saturation pressure and the specified temperature.

V<sub>R</sub> = Residual oil volume at 14.7 PSI absolute and 60° F.

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Well 2/4-4AX (3000 Feet)

Reservoir Fluid **SAMPLE TABULAR DATA**

PRESSURE PSI GAUGE	PRESSURE-VOLUME RELATION @ 266 °F. RELATIVE VOLUME OF OIL AND GAS, V/V <sub>SAT</sub> .	VISCOSITY OF OIL @ 266 °F. CENTIPOISES	DIFFERENTIAL LIBERATION @ 266 °F.		
			GAS/OIL RATIO LIBERATED PER BARREL OF RESIDUAL OIL	GAS/OIL RATIO IN SOLUTION PER BARREL OF RESIDUAL OIL	RELATIVE OIL VOLUME, V/V <sub>R</sub>
1192	2.6655				
900		0.675	1657	285	1.304
831	3.7241				
400		0.825	1764	178	1.247
118			1840	102	1.192
0		1.285	1942	0	1.097
					@ 60° F. = 1.000

Gravity of residual oil = 32.5° API @ 60° F.

v = Volume at given pressure

V<sub>SAT</sub> = Volume at saturation pressure and the specified temperature.

V<sub>R</sub> = Residual oil volume at 14.7 PSI absolute and 60° F.

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Well 2/4-4AX (3000 Feet)

Differential Pressure Depletion at 266° F.

<u>Pressure PSIG</u>	<u>Oil Density Gms/Cc</u>	<u>Gas Gravity</u>	<u>Deviation Factor Z</u>
5545	0.5807		
5300	0.5943	0.950	1.045
4900	0.6123	0.917	0.990
4400	0.6301	0.880	0.955
3900	0.6479	0.844	0.935
3400	0.6632	0.811	0.923
2900	0.6774	0.783	0.914
2400	0.6913	0.766	0.911
1900	0.7047	0.763	0.918
1400	0.7184	0.775	0.932
900	0.7321	0.808	0.954
400	0.7483	0.934	0.978
118	0.7648	1.287	
0	0.7856	2.243	



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**SEPARATOR TESTS OF Reservoir Fluid SAMPLE**

SEPARATOR PRESSURE, PSI GAUGE	SEPARATOR TEMPERATURE, ° F.	GAS/OIL RATIO (1)	GAS/OIL RATIO (2)	STOCK TANK GRAVITY, ° API @ 60° F.	Formation Volume Factor (3)	Separator Volume Factor (4)	SPECIFIC GRAVITY OF FLASHED GAS
1000	150	1041	1216			1.169	0.683
to							
250	80	129	138			1.067	0.709
to							
0	60	124	124	37.7	1.842	1.000	1.091

11.78

- (1) Gas/Oil Ratio in cubic feet of gas @ 60° F. and 14.7 PSI absolute per barrel of oil @ indicated pressure and temperature.
- (2) Gas/Oil Ratio in cubic feet of gas @ 60° F. and 14.7 PSI absolute per barrel of stock tank oil @ 60° F.
- (3) Formation Volume Factor is barrels of saturated oil @ 5545 PSI gauge and 266° F. per barrel of stock tank oil @ 60° F.
- (4) Separator Volume Factor is barrels of oil @ indicated pressure and temperature per barrel of stock tank oil @ 60° F.

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Phillips Petroleum  
 Company Company - Norway Formation Danian  
 Well 2/4-4AX (3000 Feet) Province Offshore  
 Field Ekofisk Country Norway

**HYDROCARBON ANALYSIS OF Separator GAS SAMPLE**

COMPONENT	MOL PER CENT	G P M
Hydrogen Sulfide		
Carbon Dioxide	1.19	
Nitrogen	0.35	
Methane	84.98	
Ethane	7.97	2.008
Propane	2.91	0.799
iso-Butane	0.40	0.130
n-Butane	0.93	0.292
iso-Pentane	0.28	0.102
n-Pentane	0.36	0.130
Hexanes	0.28	0.114
Heptanes plus	0.35	0.158
	100.00	3.733

Calculated gas gravity (air = 1.000) = 0.683

Calculated gross heating value = 1174 BTU  
 per cubic foot of dry gas at 14.696 psia at 60° F.

Collected at 1000 psig and 150 ° F.

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 Company Company - Norway Formation Danian  
 Well 2/4-4AX (3000 Feet) Province Offshore  
 Field Ekofisk Country Norway

**HYDROCARBON ANALYSIS OF Reservoir Fluid SAMPLE**

COMPONENT	MOL PER CENT	WEIGHT PER CENT	DENSITY @ 60° F. GRAMS PER CUBIC CENTIMETER	° API @ 60° F.	MOLECULAR WEIGHT
Hydrogen Sulfide					
Carbon Dioxide	0.95	0.62			
Nitrogen	0.17	0.07			
Methane	58.98	13.95			
Ethane	7.60	3.38			
Propane	4.46	2.91			
iso-Butane	1.14	0.97			
n-Butane	1.80	1.55			
iso-Pentane	0.71	0.75			
n-Pentane	0.92	0.97			
Hexanes	1.94	2.45			
Heptanes plus	21.33	72.38	0.8569	33.5	230
	<u>100.00</u>	<u>100.00</u>			

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 Reservoir Fluid Analysis

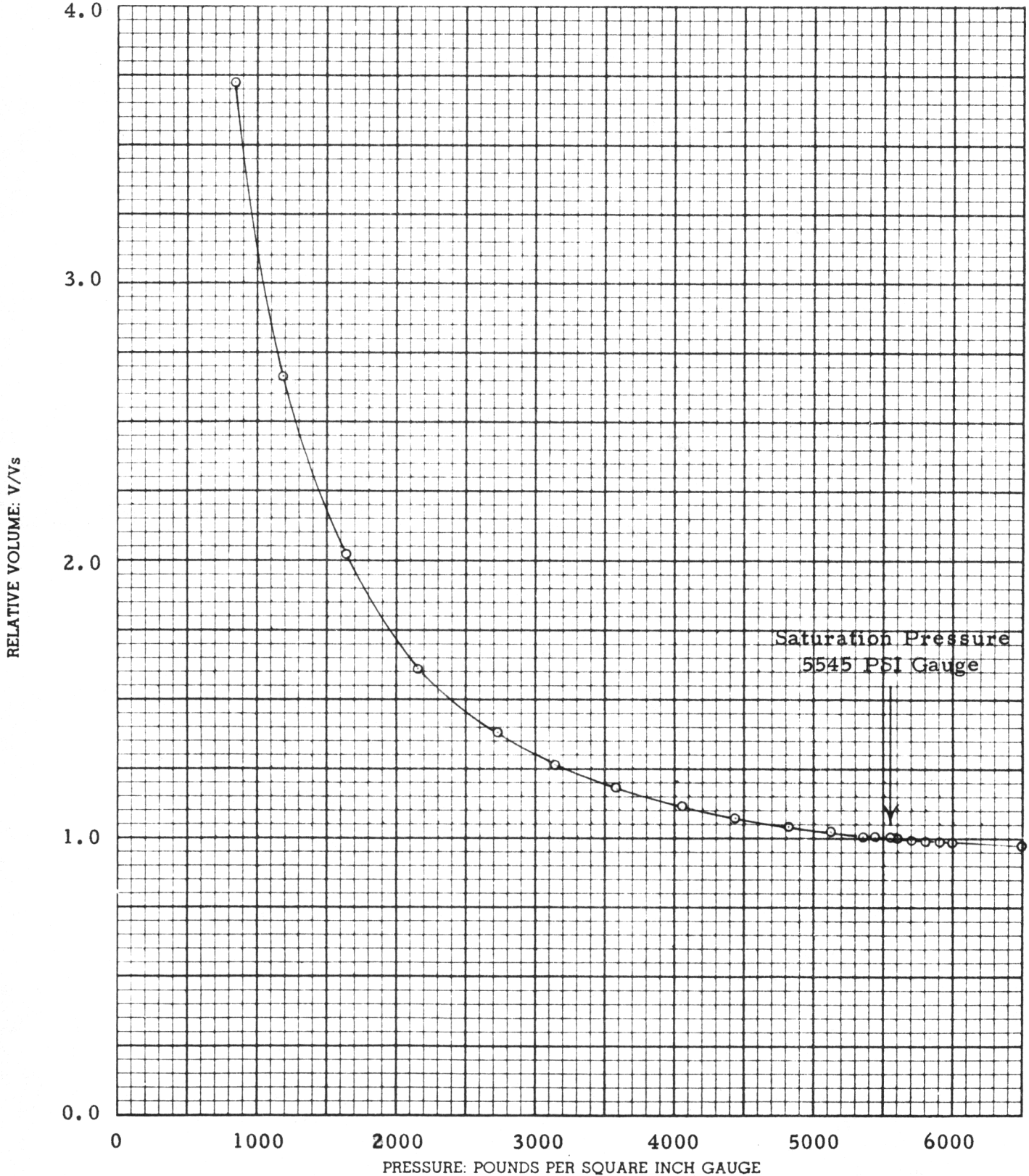
*P. L. Moses* (JA)

P. L. Moses  
 Manager

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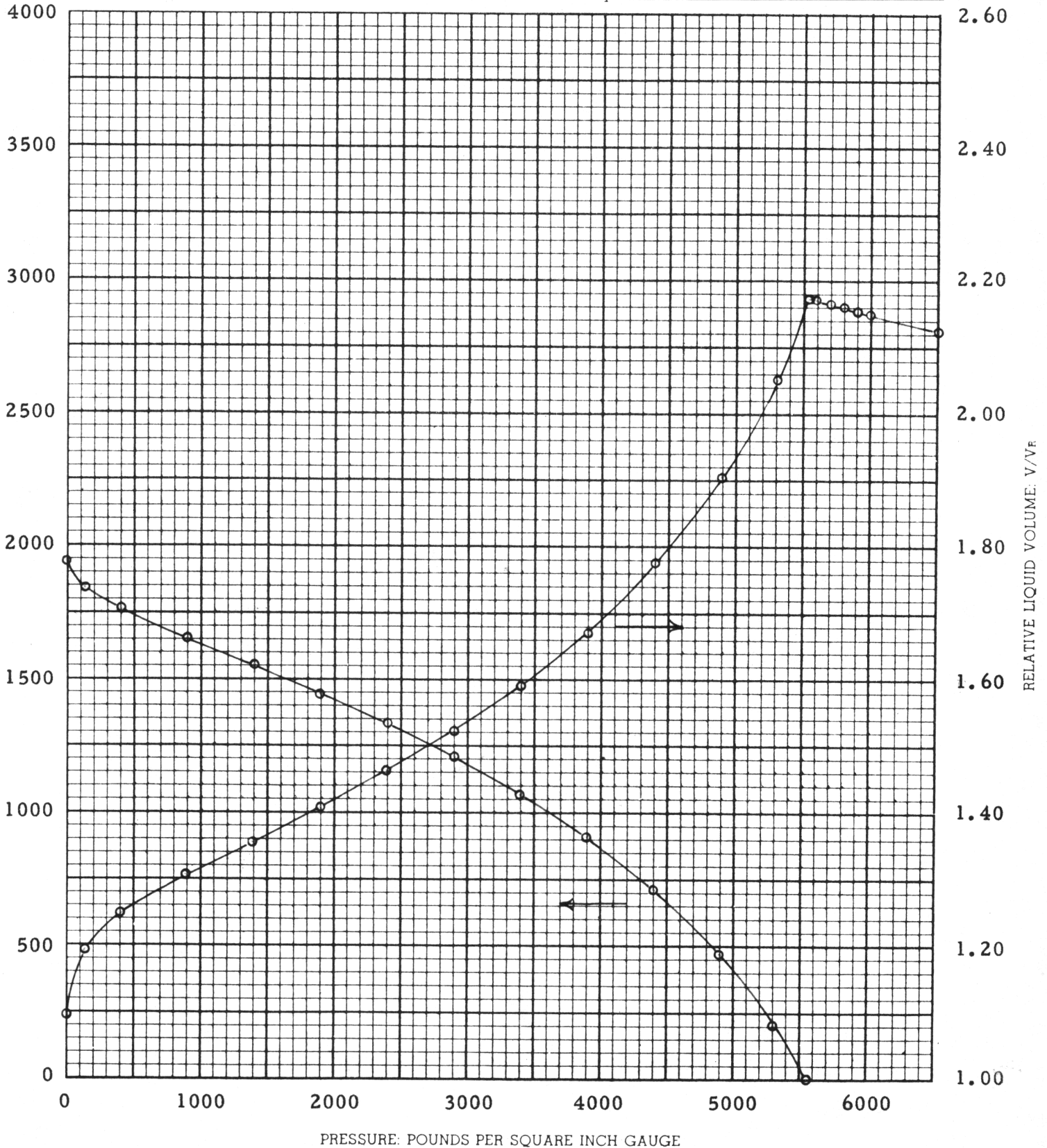
PRESSURE-VOLUME RELATIONS OF RESERVOIR FLUID

Company Phillips Petroleum Company - Norway Formation Danian  
Well 2/4-4AX (3000 Feet) Province Offshore  
Field Ekofisk Country Norway



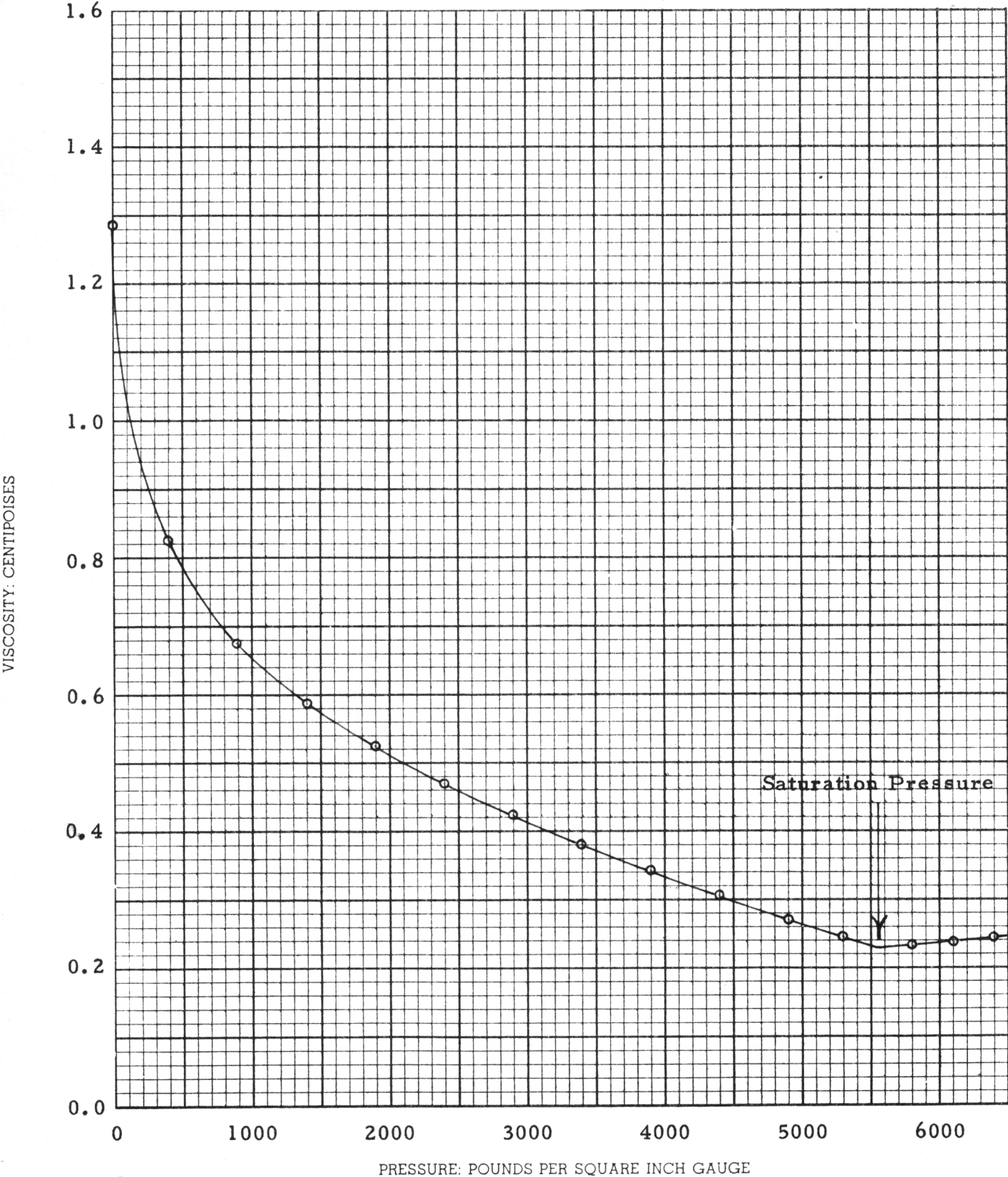
DIFFERENTIAL VAPORIZATION OF RESERVOIR FLUID

Company	<b>Phillips Petroleum Company - Norway</b>	Formation	<b>Danian</b>
Well	<b>2/4-4AX (3000 Feet)</b>	Province	<b>Offshore</b>
Field	<b>Ekofisk</b>	Country	<b>Norway</b>



VISCOSITY OF RESERVOIR FLUID

Phillips Petroleum  
Company Company - Norway Formation Danian  
Well 2/4-4AX (3000 Feet) Province Offshore  
Field Ekofisk Country Norway



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