RESERVOIR FLUID STUDY

for

A/S Norske Shell Exploration & Production

Well: 31/2-6

North Sea, Norway.

CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
ABERDEEN, SCOTLAND

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13th August 1982

A/S Shell Exploration & Production
Gamle Forusvei 43
P.O. Box 10
N-4033 Forus
NORWAY

Subject: Reservoir Fluid Study
Well: 31/2-6
North Sea, Norway.
Our File: RFLA 820069

Attention: Mr. D. C. Jolly.

Gentlemen,

On the 29th March 1982 samples of separator oil and gas from the subject well were received in our Aberdeen laboratory for use in a reservoir fluid study. the results of these analyses are presented in the following report.

On receipt in the laboratory the hydrocarbon composition of the separator gas was determined by chromatography. This composition may be found on page two.

The hydrocarbon composition of the separator liquid through heptanes was determined by the use of low temperature fractional distillation. This composition in terms of both mol and weight percent may be found on page three.

The separator liquid was placed in a high pressure visual cell at 150°F and separator gas added in increments until a saturation pressure of 2280 psig at 150°F was obtained. This fluid was then utilised for the remainder of the study.

The hydrocarbon composition of this recombined fluid was determined by the use of low temperature fractional distillation. This composition in terms of both mol and weight percent may be found on page four.

A portion of reservoir fluid was placed in a high pressure visual cell and thermally expanded to the reported reservoir temperature of 150°F. During a constant composition expansion at this temperature, a saturation pressure of 2280 psig was observed. The results of the pressure-volume relations may be found on page six. the associated compressibility data for the undersaturated fluid are presented on page five.

A large portion of reservoir fluid was subjected to differential vaporisation at 150°F, resulting in the liberation of a total of 333 standard cubic feet of gas per barrel of residual oil with an associated relative oil volume of 1.175 barrels of saturated oil ber barrel of residual oil. At several pressure levels below the observed saturation pressure, oil density, gas gravity and gas formation volume factor were monitored. These data are tabulated on page seven and graphically represented on pages eight and nine.

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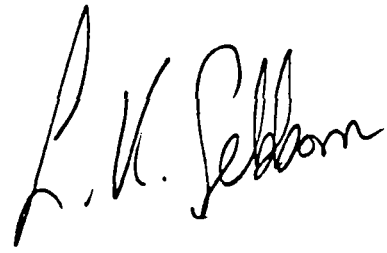
Whilst maintaining the operating temperature of 150°F the viscosity of the fluid was measured over a wide range of pressure from above saturation pressure to atmospheric pressure. The minimum viscosity determined at saturation pressure was 1.83 centipoise. These data are tabulated on page nine and graphically represented on page ten.

Due to a seal failure on the viscosimeter the initial volume charged was lost. After repeating the test to give the data required the volume of sample remaining was found to be insufficient for any further analysis.

It has been a pleasure to be of service to A/S Norske Shell Exploration & Production. Should any questions arise concerning data presented in this report, or if we can be of any further assistance, please do not hesitate to contact us.

Very truly yours

Core Laboratories UK Limited
Reservoir Fluid Analysis



LKS/stb
10cc/Addressee

Les. K. Sebborn
Laboratory Manager

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Petroleum Reservoir Engineering
ABERDEEN, SCOTLAND

File RFLA 820069

Company A/S Norske Shell Expl. & Prod. Date Sampled 25th September 1981

Well 31/2-6 County North Sea

Field Block 31/2 State Norway

FORMATION CHARACTERISTICS

Formation Name	Oil Zone
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	25 M.
Total Depth	Ft.
Producing Interval	1576 to 1579 M.
Tubing Size and Depth	5 and 3½ In. to 1571.45 M.
Open Flow Potential	MMSCF/Day
Last Reservoir Pressure	2288 PSIG @ 1568 M.
Date	, 19
Reservoir Temperature	150* °F. @ Ft.
Status of Well	Static
Pressure Gauge	

SAMPLING CONDITIONS

Flowing Tubing Pressure	635 PSIG
Flowing Bottom Hole Pressure	PSIG
Primary Separator Pressure	85 PSIG
Primary Separator Temperature	52 °F.
Secondary Separator Pressure	PSIG
Secondary Separator Temperature	°F.
Field Stock Tank Liquid Gravity	°API @ 60°F.
Primary Separator Gas Production Rate	MSCF/Day
Pressure Base	14.73 PSIA
Temperature Base	60 °F.
Compressibility Factor (F_{pv})	1.0071
Gas Gravity (Laboratory)	0.615
Gas Gravity Factor (F_g)	1.2752
Liquid Production Rate @ °F.	Bbls/Day
Primary Separator Gas/ Liquid Ratio	SCF/Bbl
or	Bbls/MMSCF
Sampled by	Flopetrol

REMARKS: * Data supplied by A/S Norske Shell Exploration & Production.

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Company A/S Norske Shell Expl. & Prod. Formation Oil Zone

Well 31/2-6 County North Sea

Field Block 31/2 State Norway

HYDROCARBON ANALYSIS OF SEPARATOR GAS SAMPLE

COMPONENT	MOL PERCENT	GPM
Hydrogen Sulfide	NIL	
Carbon Dioxide	1.21	
Nitrogen	0.75	
Methane	90.77	
Ethane	6.11	
Propane	0.48	0.132
iso-Butane	0.48	0.157
n-Butane	0.03	0.010
iso-Pentane	0.02	0.007
n-Pentane	TRACE	TRACE
Hexanes	0.11	0.045
Methylcyclopentane	0.01	)
Benzene	TRACE	)
Cyclohexane	0.01	)
Heptanes	0.01	) 0.018
Methylcyclohexane	0.01	)
Toluene	TRACE	)
Octanes plus	TRACE	)
	100.00	0.369

Calculated gas gravity (air = 1.000) = 0.615

Calculated gross heating value = 1065 BTU per cubic foot of dry gas at 14.73 psia and 60°F.

Collected at 85 psig and 52°F.

Company A/S Norske Shell Expl. & Prod. Formation Oil Zone

Well 31/2-6 County North Sea

Field Block 31/2 State Norway

HYDROCARBON ANALYSIS OF SEPARATOR LIQUID SAMPLE*

COMPONENT	MOL PERCENT	WEIGHT PERCENT	DENSITY	API	MOL WEIGHT
Hydrogen Sulfide	NIL	NIL			
Carbon Dioxide	0.11	0.02			
Nitrogen	0.01	TRACE			
Methane	3.59	0.25			
Ethane	1.87	0.24			
Propane	0.51	0.10			
iso-Butane	1.02	0.26			
n-Butane	0.10	0.03			
iso-Pentane	0.16	0.05			
n-Pentane	0.04	0.01			
Hexanes	1.19	0.44			
Heptanes plus	91.40	98.60	0.8974	26.0	249
	100.00	100.00			

* Cylinder Number: 130-111-68.

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Company A/S Norske Shell Expl. & Prod. Formation Oil Zone

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Field Block 31/2 State Norway

HYDROCARBON ANALYSIS OF RECOMBINED RESERVOIR FLUID SAMPLE

COMPONENT	MOL PERCENT	WEIGHT PERCENT	DENSITY	API	MOL WEIGHT
Hydrogen Sulfide	NIL	NIL			
Carbon Dioxide	0.53	0.16			
Nitrogen	0.29	0.05			
Methane	37.46	4.06			
Ethane	3.07	0.62			
Propane	0.41	0.12			
iso-Butane	1.08	0.42			
n-Butane	0.12	0.05			
iso-Pentane	0.30	0.15			
n-Pentane	0.08	0.04			
Hexanes	0.91	0.53			
Heptanes plus	55.75	93.80	0.8971	26.1	249
	100.00	100.00			

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Well 31/2-6

VOLUMETRIC DATA OF RESERVOIR FLUID SAMPLE

1. Saturation pressure (bubble-point pressure) 2280 PSIG @ 150 °F.
2. Specific volume at saturation pressure: ft ^{3}/lb 0.02007 @ 150 °F.
3. Thermal expansion of saturated oil @ 5000 PSIG = $\frac{V \text{ @ } 150 \text{ °F.}}{V \text{ @ } 64 \text{ °F.}}$ = 1.04025
4. Compressibility of saturated oil @ reservoir temperature: Vol/Vol/PSI:

   From 5000 PSIG to 4000 PSIG = 5.69 x 10-6

   From 4000 PSIG to 3000 PSIG = 6.82 x 10-6

   From 3000 PSIG to 2281 PSIG = 7.29 x 10-6

PRESSURE-VOLUME RELATIONS AT 150°F.

Pressure PSIG		Relative Volume(1)	Y Function(2)
5000		0.9823	
4000		0.9880	
3000		0.9948	
2700		0.9970	
2600		0.9977	
2500		0.9984	
2400		0.9991	
2300		0.9998	
2280	Saturation Pressure	1.0000	
2233		1.0047	4.528
2138		1.0150	4.425
1979		1.0355	4.264
1782		1.0674	4.119
1554		1.1184	3.912
1359		1.1810	3.707
1207		1.2438	3.606
1092		1.3066	3.503
1002		1.3696	3.403
852		1.4956	3.326
721		1.6638	3.193
606		1.8763	3.078
463		2.2836	2.963
342		2.9190	2.830
233		3.9638	2.786

(1) Relative Volume: V/Vsat is barrels at indicated pressure per barrel at saturation pressure.

(2) Y Function = $\frac{(Psat-P)}{(Pabs)\ (V/Vsat-1)}$

DIFFERENTIAL VAPORISATION AT 150°F.

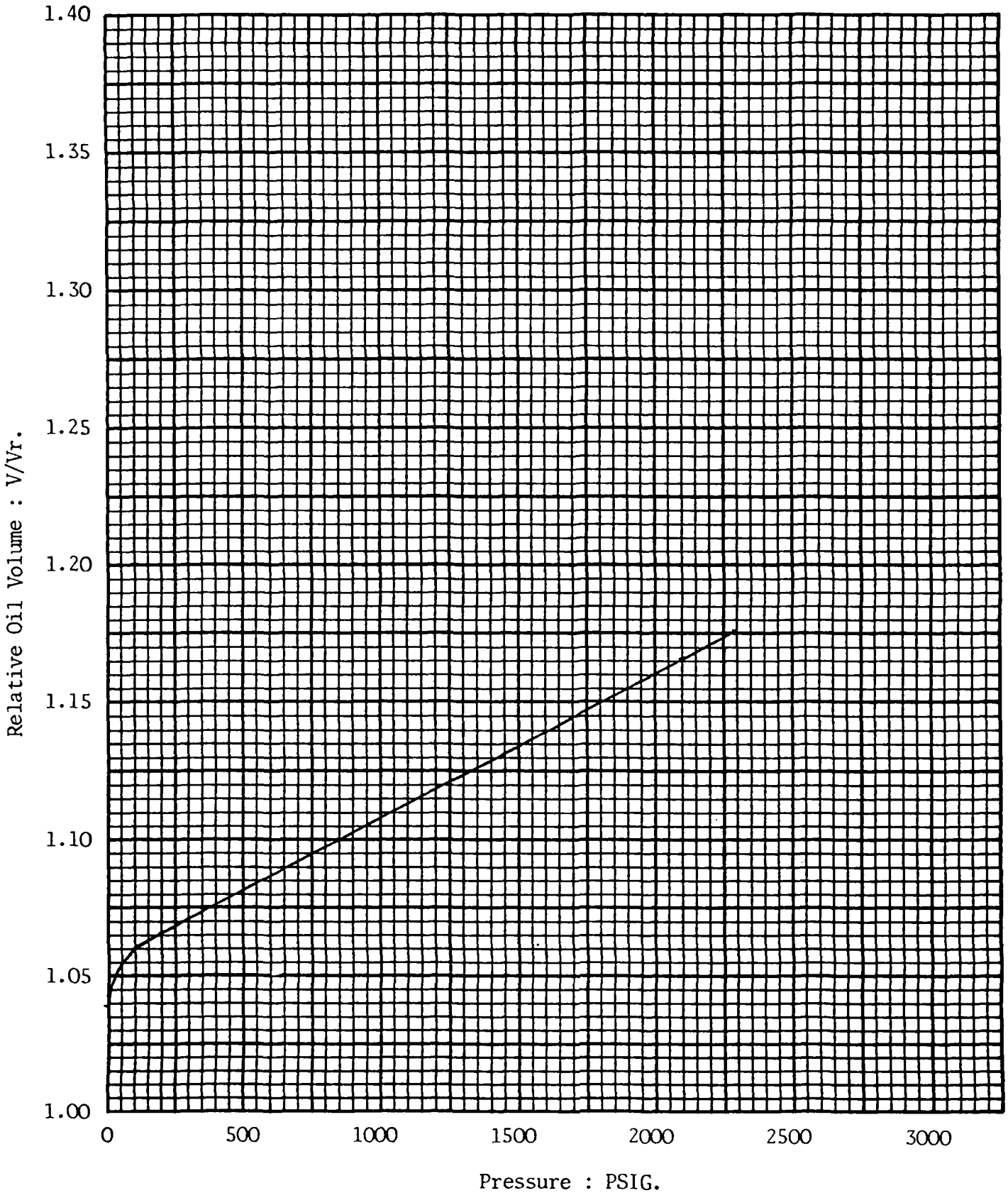
Pressure PSIG	Solution Gas/Oil Ratio(1)	Relative Oil Volume(2)	Relative Total Volume(3)	Oil Density gm/cc	Deviation Factor Z	Gas Formation Volume Factor(4)	Incremental Gas Gravity
2280	333	1.175	1.175	0.7984			
2100	312	1.166	1.193	0.8020	0.888	0.00725	0.693
1700	256	1.144	1.267	0.8108	0.892	0.00899	0.650
1300	198	1.123	1.410	0.8187	0.907	0.01192	0.628
900	142	1.102	1.699	0.8273	0.929	0.01754	0.627
500	83	1.081	2.510	0.8359	0.959	0.03218	0.641
300	55	1.071	3.717	0.8397	0.974	0.05343	0.655
200	39	1.066	5.199	0.8416	0.982	0.07892	0.668
100	22	1.060	9.308	0.8433	0.991	0.14890	0.685
0	0	1.039		0.8560			1.046
	At 60°F = 1.000						

Gravity of Residual Oil = 27.5° API at 60°F.

(1) Cubic feet of gas at 14.73 psia and 60°F. per barrel of residual oil at 60°F.
(2) Barrels of oil at indicated pressure and temperature per barrel of residual oil at 60°F.
(3) Barrels of oil plus liberated gas at indicated pressure and temperature per barrel of residual oil at 60°F.
(4) Cubic feet of gas at indicated pressure and temperature per cubic foot at 14.73 psia and 60°F.

Differential Vaporisation of Reservoir Fluid at 150° F.

Company A/S Norske Shell Expl. & Prod. **Formation** Oil Zone
Well 31/2-6 **County** North Sea
Field Block 31/2-6 **State** Norway



Differential Vaporisation of Reservoir Fluid at 150° F.

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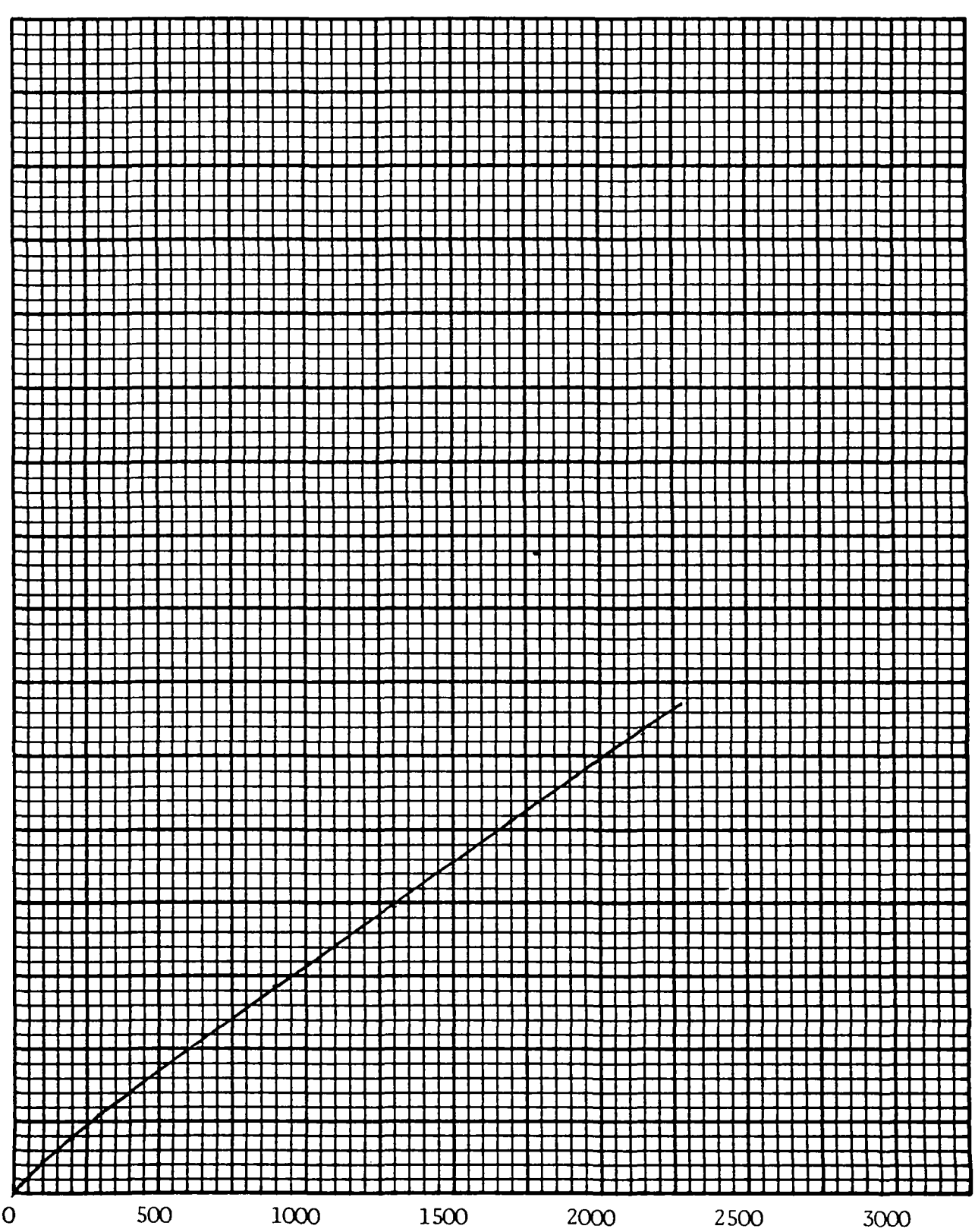

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Well 31/2-6

VISCOSITY DATA AT 150°F.

Pressure PSIG		Oil Viscosity Centipoise	Calculated Gas Viscosity Centipoise	Oil/Gas Viscosity Ratio
5000		2.29		
4000		2.12		
3000		1.95		
2700		1.90		
2400		1.85		
2280	Saturation Pressure	1.83		
2100		1.88	0.0170	110.3
1700		2.04	0.0156	130.4
1300		2.27	0.0146	155.7
900		2.62	0.0137	191.1
500		3.08	0.0130	237.6
300		3.38	0.0126	267.9
200		3.54	0.0124	284.7
100		3.75	0.0122	306.3
0		4.20		

Viscosity of Reservoir Fluid at 150°F.

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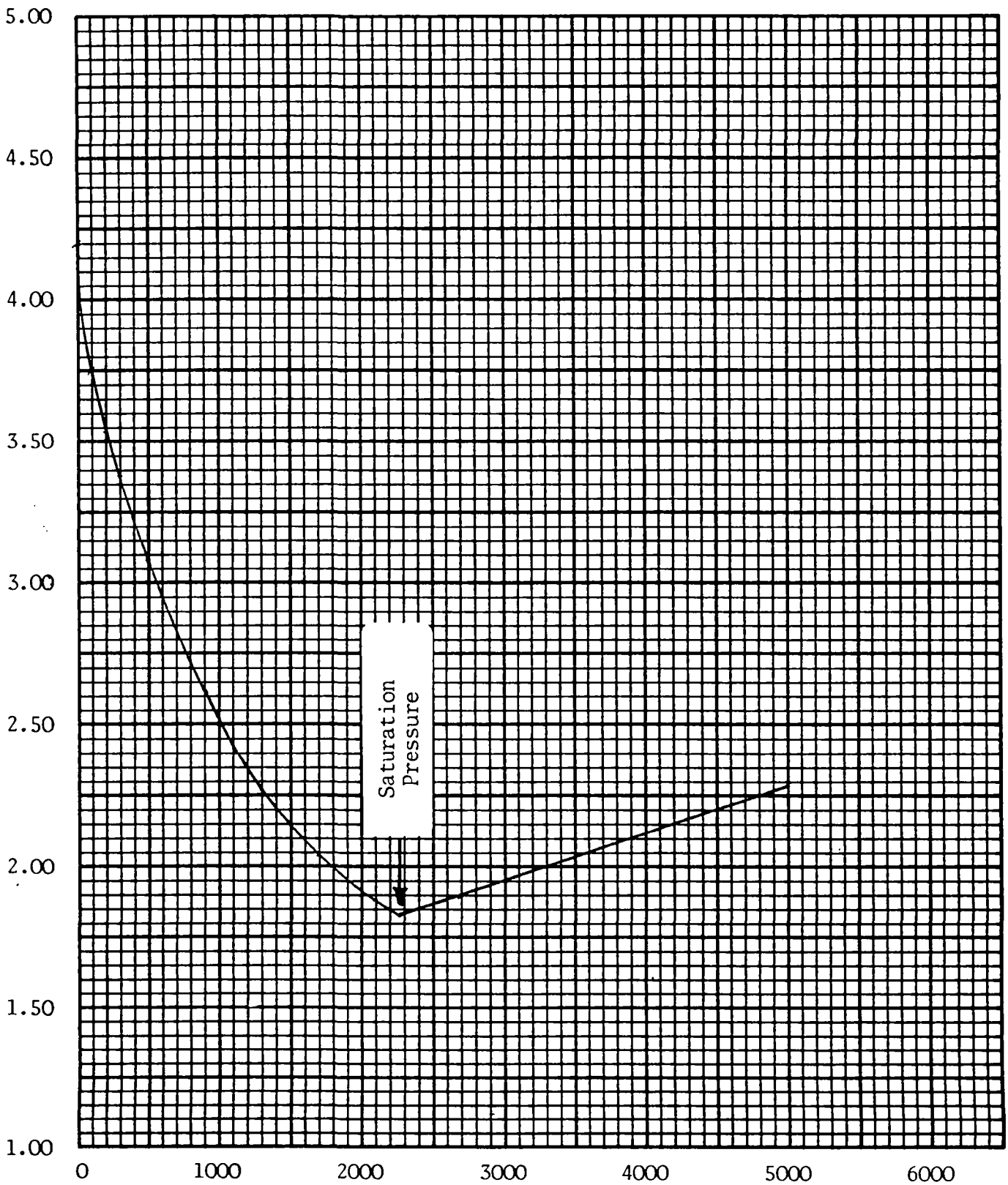

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A/S NORSKE SHELL EXPLORATION & PRODUCTION
Well: 31/2-6

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Reservoir Fluid Analysis

L. K. Sebborn

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