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SPECIAL CORE ANALYSIS STUDY

FOR

STATOIL

WELL: 34/10-4

87-0222-1-BA

- 5 MARS 1987

REGISTRERT

OLJEDIREKTORATET

CORE LABORATORIES UK LTD.

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LONDON E1 1EJ

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Statoil
Forus
Postboks 300
N-4001
Stavanger
Norway

September 1981

Attention: Karl Arland

Subject: Special Core Analysis
Well: 34/10-4
File: UKSCAL 7964

Gentlemen,

In a letter dated 21st November 1979, ref KSA/Bri from Mr Karl Arland of Statoil, Core Laboratories UK Limited were requested to perform a series of special core analysis measurements on samples from the subject well.

The results of these measurements are presented herein and serve to confirm those previously submitted in preliminary form.

Five full diameter core pieces were received for use in this study. Four one and a half inch diameter samples were drilled from each core piece using synthetic formation brine as the bit lubricant. Due to the friable nature of the core some of the samples were ultimately mounted in thin metal sleeves to maintain their coherence. All samples are described with respect to depth and lithology on page 1 of this report.

It has been a pleasure working with Statoil on this study. Should you have any questions please do not hesitate to contact us.

Yours faithfully,
CORE LABORATORIES UK LIMITED

Jon Roberts
Laboratory Manager

REGISTERED IN ENGLAND NO. 1331818 VAT NUMBER 219 8700 49

Registered Office:– 75 Greenfield Road, London, E1 1EJ.

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Discussion of Laboratory Procedures

Five of the core plug samples were placed under synthetic formation brine prior to fresh state analysis. The remaining samples were cleaned in cool solvents and dried in an humidity controlled oven. Air permeability and helium injection porosity were then measured.

Air-Brine Capillary Pressure Data (Page 2)

Five samples were scheduled to undergo this analysis but sample A1 fractured and could not undergo further measurements.

The clean, dry samples were evacuated and pressure saturated with simulated formation brine consisting of approximately 43,500 mg/l total dissolved solids and was synthesised according to information furnished for use in this study.

The samples were placed in a porous plate cell and humidified nitrogen introduced at increasing incremental pressures up to 13.6 bars. Equilibrium saturations were determined gravimetrically with the samples removed from the cell. The results are presented in tabular form on page 2 and in graphical form on pages 3 through 6.

Formation Factor and Resistivity Index Data (Page 7)

Prior to air-brine capillary pressure measurements, the electrical resistivity of the fully saturated samples and saturant brine were measured on consecutive days until results stabilised indicating ionic equilibrium within the core samples. Formation resistivity factor values were calculated and results are presented in tabular form on page 7 and in graphical form on page 8. With an intercept 'a' value of unity the average cementation exponent 'm' value is 1.72.

During measurement of air-brine capillary pressure, while the samples were removed from the cell, their resistivity was measured at each equilibrium saturation.

Resistivity indices were calculated and results are presented in tabular form on page 7 and in graphical form on pages 9 through 13. The saturation exponent 'n' values vary from 1.88 to 2.02 with an average of 1.97.

The above results are comparable with those obtained for well 34/10-3 ref UKSCAL 7932 where the average cementation exponent 'm' value is 1.75 with an intercept 'a' value of unity, and the average saturation exponent 'n' value is 1.95.

Air Permeability at Differential Pressures (Page 14)

The same suite of samples that underwent air-brine capillary pressure and electrical resistivity measurements were also scheduled to undergo this analysis.

The samples were leached in cool methanol and dried in an humidity controlled oven.

Cont'd......

The samples were then each mounted in an hydraulic core holder. Gas was flowed through each sample, the volume of which was measured using a wet test meter. Upstream and downstream pressures were gauged using liquid manometers. Air permeabilities were measured at four differential pressures and the results are presented in tabular form on page 14.

Gas-Oil Relative Permeability Data (Page 15)

Five samples which had previously undergone wettability analysis were also scheduled to undergo gas-oil relative permeability measurements.

The clean, dry samples were evacuated and pressure saturated with simulated formation brine. Sample A3 fractured and could not undergo further analysis. The remaining samples were placed in an high pressure cell and desaturated to immobile water saturations.

Each sample was then mounted in an hydraulic core holder and held under reservoir confining pressures of approximately 30.4 bars. They were each flushed with a refined mineral oil having a viscosity of approximately 20 centipoise at room conditions to ensure the removal of all gas and mobile water. Effective permeability to the oil was then measured.

Gas-oil relative permeability measurements were performed using humidified nitrogen as the displacing phase. Incremental productions of oil and gas were recorded against time and the floods were terminated at gas-oil relative permeability ratios in excess of 30. Relative permeability data was calculated using a digital computer and the results are presented in tabular form on pages 15 through 18 and in graphical form on pages 19 through 26.

Waterflood Susceptibility Data at Reservoir Conditions (Page 27)

Five samples were scheduled to undergo this analysis.

The clean, dry samples were evacuated and pressure saturated with synthetic formation brine, and then desaturated in an high speed centrifuge, to immobile water saturations. The samples were each mounted in an hydraulic core holder and flushed with treated degassed kerosene at room conditions to displace any trapped gas and mobile water.

The samples were then removed and each placed in an hydraulic core holder in a reservoir conditions oven. Internal and external pressures were raised simultaneously to 307 bars and 358 bars, respectively. When the pressure had stabilised the temperature was increased slowly, until the reservoir temperature of 162°F was attained. When conditions had stabilised once more, crude oil was

Cont'd......

flushed through and effective permeability to this crude was then measured. The samples were then allowed to age for a period of weeks, at reservoir pressure and temperature, in this live crude. After ageing, a few pore volumes of crude oil were again flushed through and effective permeability to this crude oil remeasured.

Waterfloods were performed using synthetic formation brine as the displacing phase. Incremental volumes of oil and water produced were recorded against time and the floods were terminated at watercuts in excess of 99.99%.

Results are summarised on page 27 and are presented in tabular form on pages 28 through 31 and in graphical form on pages 32 through 35. Sample A5 failed during this analysis and no data is available.

Water-Oil Relative Permeability Data (Page 36)

Water-oil relative permeability data was calculated from the waterflood susceptibility results. The data is presented in tabular form on pages 36 through 39 and in graphical form on pages 40 through 47.

Water Permeability Data (Page 48)

Four samples were scheduled to undergo this analysis.

The clean, dry samples were evacuated and pressure saturated with synthetic formation brine. Each sample was mounted in an hydraulic core holder with an effective overburden pressure of 13.6 bars, they were then flushed with the brine to ensure the removal of any trapped gas, permeability to the brine was then measured.

The effective overburden pressure was then increased to approximately 51.0 bars, the samples were flushed with the brine until conditions stabilised and permeability to the brine was then measured.

The samples were then placed in a reservoir conditions oven, mounted in an hydraulic coreholder and the internal and external pressures were raised simultaneously to 307 bars and 358 bars respectively. Brine was flowed through each sample until a stable water permeability was reached.

With the samples still under these conditions the temperature was increased until the reservoir temperature of 162°F was reached, brine was flowed through each sample until conditions stabilised and permeability to the brine was again measured. Results are presented in tabular form on page 48.

Wettability Determinations by Imbibition and Dynamic Displacement (Page 49)

Five fresh state samples were scheduled to undergo this analysis.

The samples were each mounted in an hydraulic core holder and flushed with synthetic formation brine to ensure the removal of any trapped gas. Effective permeability to this brine was then measured.

Cont'd......

They were then immersed in treated, degassed kerosene for a period of weeks until static imbibition of the kerosene ceased. The volume of oil imbibed, indicated by the volume of brine displaced, was recorded. The plugs were then flushed with kerosene and the volume of brine displaced indicating the volume of kerosene imbibed recorded. Effective permeability to the kerosene was then measured.

The procedure was repeated using synthetic formation brine as the imbibing fluid. Wettability indices were calculated using the volumes of fluid statically and dynamically imbibed.

The samples were then cleaned in Dean-Stark type distillation apparatus, leached in methanol and dried in an humidity controlled oven.

Air permeability and helium injection porosity were measured and fluid saturations calculated using material balance equations.

Results are presented in tabular form on page 49. The samples show a tendency to be wet by water except for sample E3 which shows a tendency to be wet by oil.

Rock Compressibility Data (Page 50)

Five samples were scheduled to undergo these measurements but sample A2 was unsuitable for this analysis.

The remaining clean, dry samples were mounted in heat shrinkable tubing, placed in an hydraulic core holder, then saturated with a brine consisting of approximately 30,000 mg/l sodium chloride. The external sleeve pressure and internal pore pressure were raised simultaneously to approximately 361 bars and 347 bars respectively. Having reached pressure stabilisation, the internal pore pressure was reduced incrementally to simulate reservoir depletion and corresponding pore volume reductions recorded.

Compressibilities were calculated from a plot of pore volume versus effective overburden pressure and, from the curve, the instantaneous change in pore volume per unit overburden pressure was determined. The resulting compressibilities were corrected for uniaxial loading as per Teeuw [1]. The results are presented in tabular form on pages 50 through 53.

[1] Uniaxial loading conditions, transformed from hydrostatic data as per Teeuw, Dirk: "Prediction of Formation Compaction from Laboratory Compressibility Data", Trans AIME (1971) 251, 263-271.

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CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
LONDON—ABERDEEN

File UKSCAL 7964

COMPANY: STATOIL | FORMATION:
WELL: 34/10-4 | COUNTRY: NORTH SEA
FIELD: | NORWAY

IDENTIFICATION AND DESCRIPTION OF FULL DIAMETER SAMPLES

Sample Number	Depth Feet	Lithological Description
A3	1836.09	Sst, lt brn, med gr wsrt, pcmt, fri, mic
B1	1867.12	As Above
B2 Rannoch	1867.19	As Above
B3	1867.25	As Above
B5	1867.33	As Above
C1	1869.11	As Above
C2 Rannoch	1869.15	As Above
C3 Rannoch	1869.20	As Above
C5 Rann	1869.32	As Above
D1 Rann	1879.76	As Above
D2 Rannoch	1879.80	As Above Rock compressibility.
D3	1879.85	As Above
D5	1879.97	As Above
E1	1889.28	As Above
E2 Rannoch	1889.35	As Above
E3	1889.40	As Above
E5	1889.48	As Above

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AIR-BRINE CAPILLARY PRESSURE DATA

Sample Number	Permeability Millidarcys	Porosity Per Cent	Brine Saturation, Per Cent Pore Space						
		Pressure, Bars	.07	.14	.27	.54	1.0	2.0	13.6
B1	1496	37.9	89.8	46.2	27.5	21.3	17.5	16.9	16.4
C1	1286	37.2	92.0	46.3	29.4	21.4	15.3	12.7	12.6
D1	1275	38.4	91.2	47.5	26.8	21.1	18.1	16.8	16.7
E1	639	36.6	93.9	73.9	40.5	30.1	24.5	22.1	20.7

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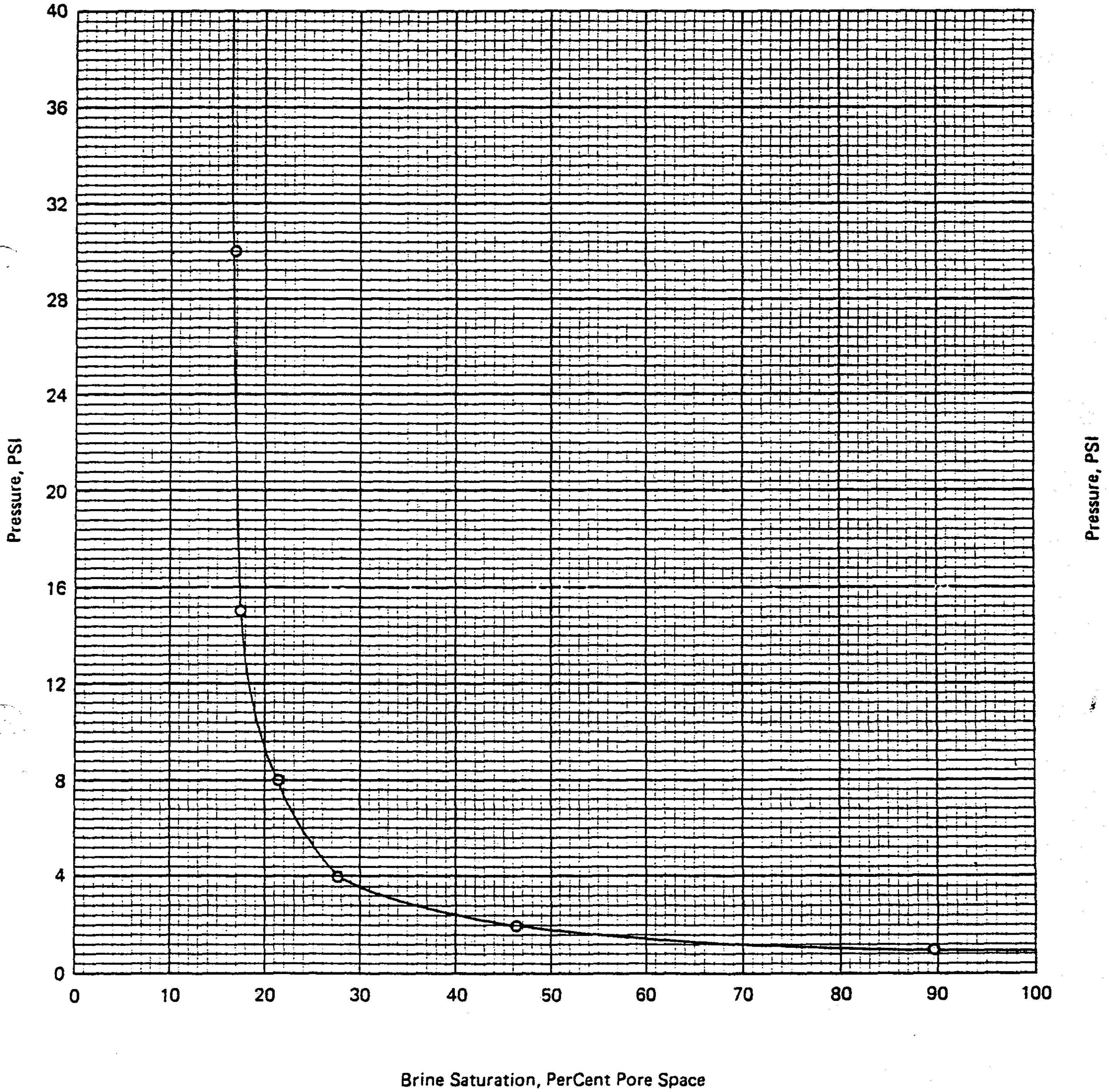
Company STATOIL
Well 34/10-4
Field
Formation
Country NORTH SEA NORWAY

SAMPLE NUMBER: B1
AIR PERMEABILITY, MD: 1496



Company STATOIL
Well 34/10-4
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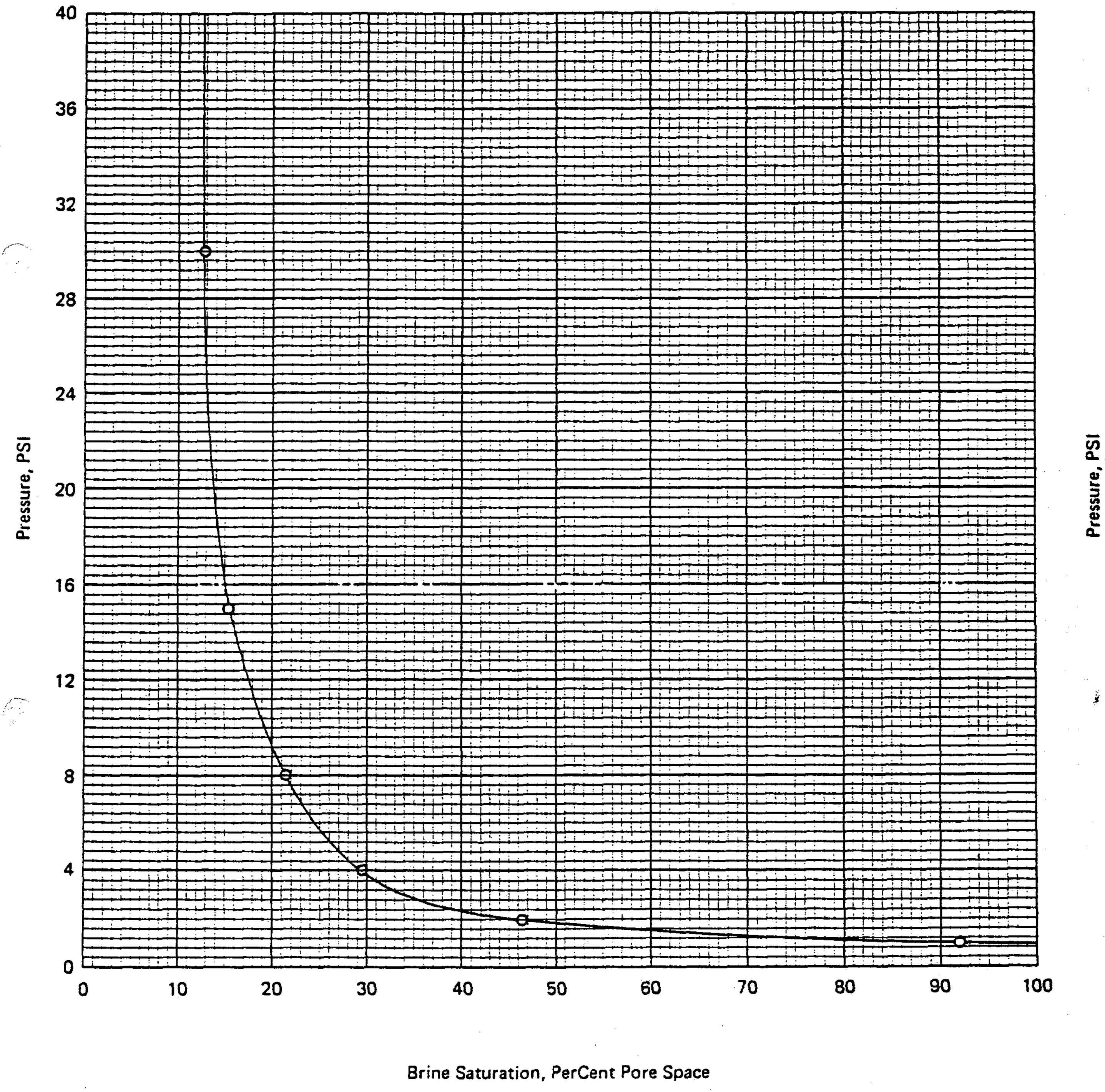
Formation
Country NORTH SEA NORWAY

SAMPLE NUMBER: C1

AIR PERMEABILITY, MD: 1286



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Company STATOIL
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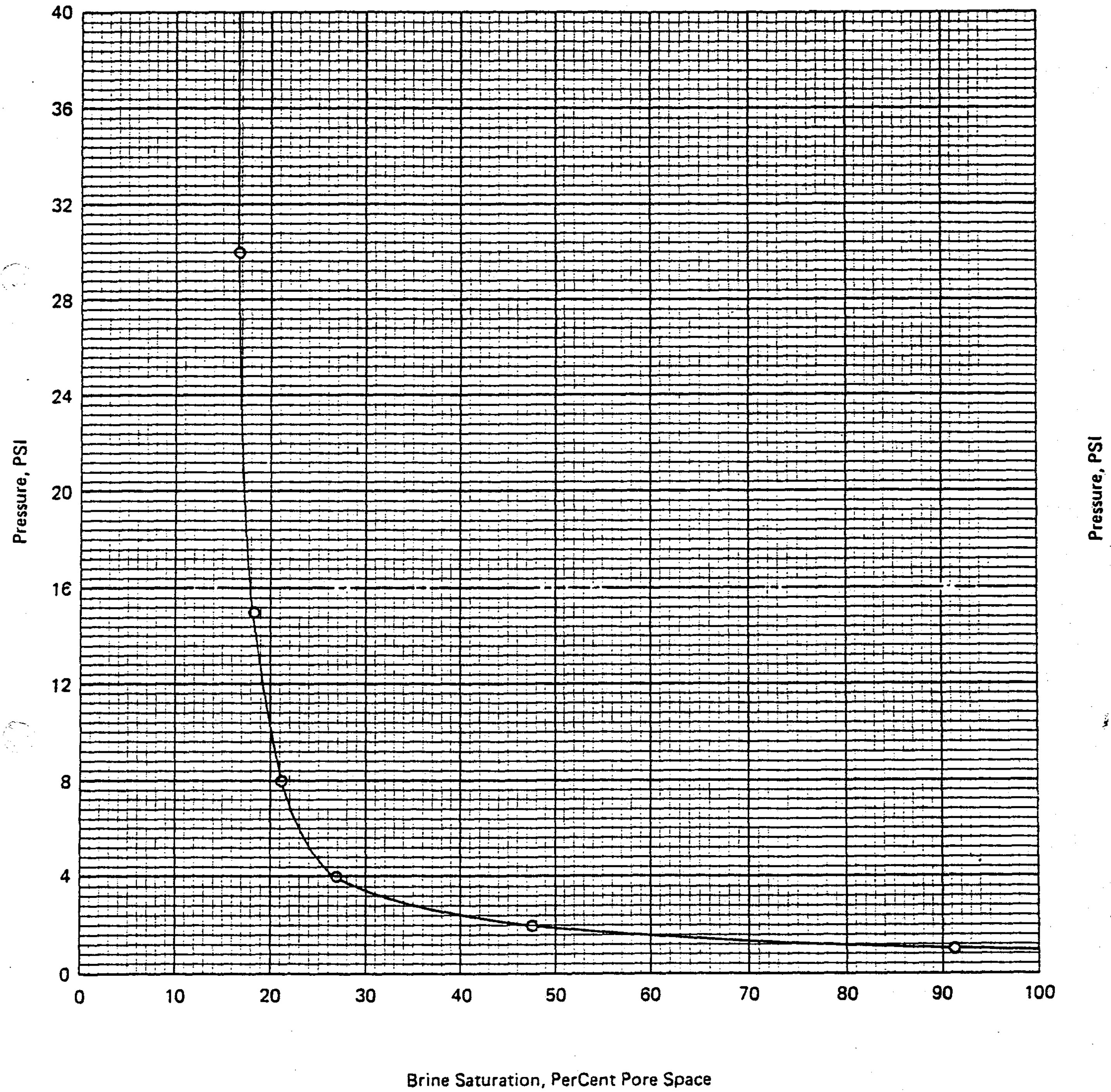
SAMPLE NUMBER: D1

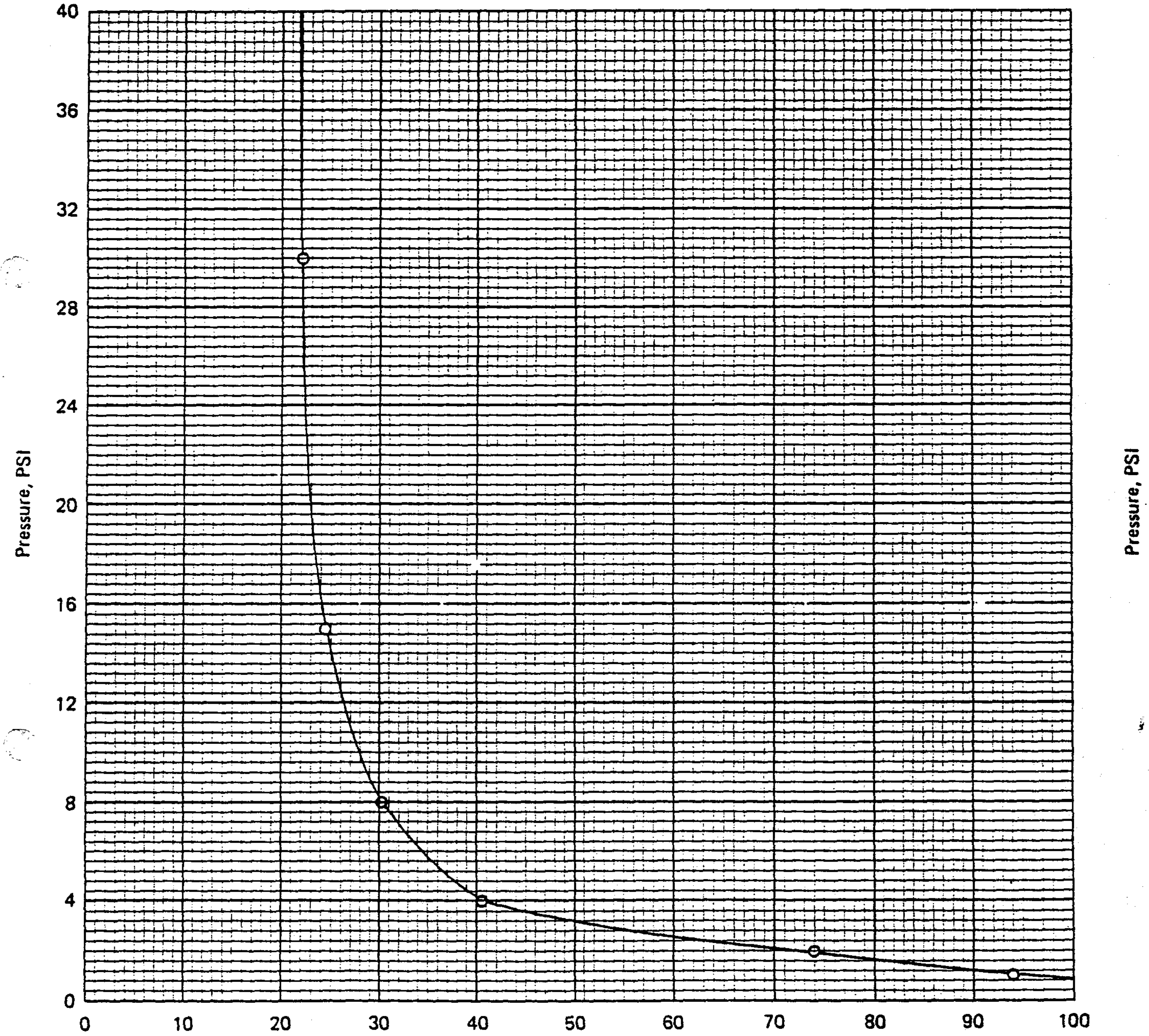
AIR PERMEABILITY, MD: 1275



Company STATOIL
Well 34/10-4
Field
Formation
Country NORTH SEA
NORWAY

SAMPLE NUMBER: E1

AIR PERMEABILITY, MD: 639



Brine Saturation, PerCent Pore Space

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FORMATION FACTOR AND RESISTIVITY INDEX DATA

Resistivity of Saturating Brine, Ohm-Meters: .195 @ 60°

Sample Number	Air Permeability Millidarcys	Porosity Per Cent	Formation Factor	Brine Saturation Per Cent Pore Space	Resistivity Index
D1	1275	38.4	5.2	100	1.00
				89.8	1.22
				46.2	4.20
				27.5	15.0
				21.3	33.0
B1	1496	37.9	5.3	100	1.00
				92.0	1.16
				29.4	11.1
				15.3	45.0
				12.6	79.4
C1	1286	37.2	5.5	100	1.00
				91.2	1.17
				26.8	9.88
				21.1	19.1
				18.1	40.0
E1	639	36.6	6.0	100	1.00
				73.9	1.82
				40.5	5.84
				24.5	17.5
				20.7	28.5

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Well: 34/10-4
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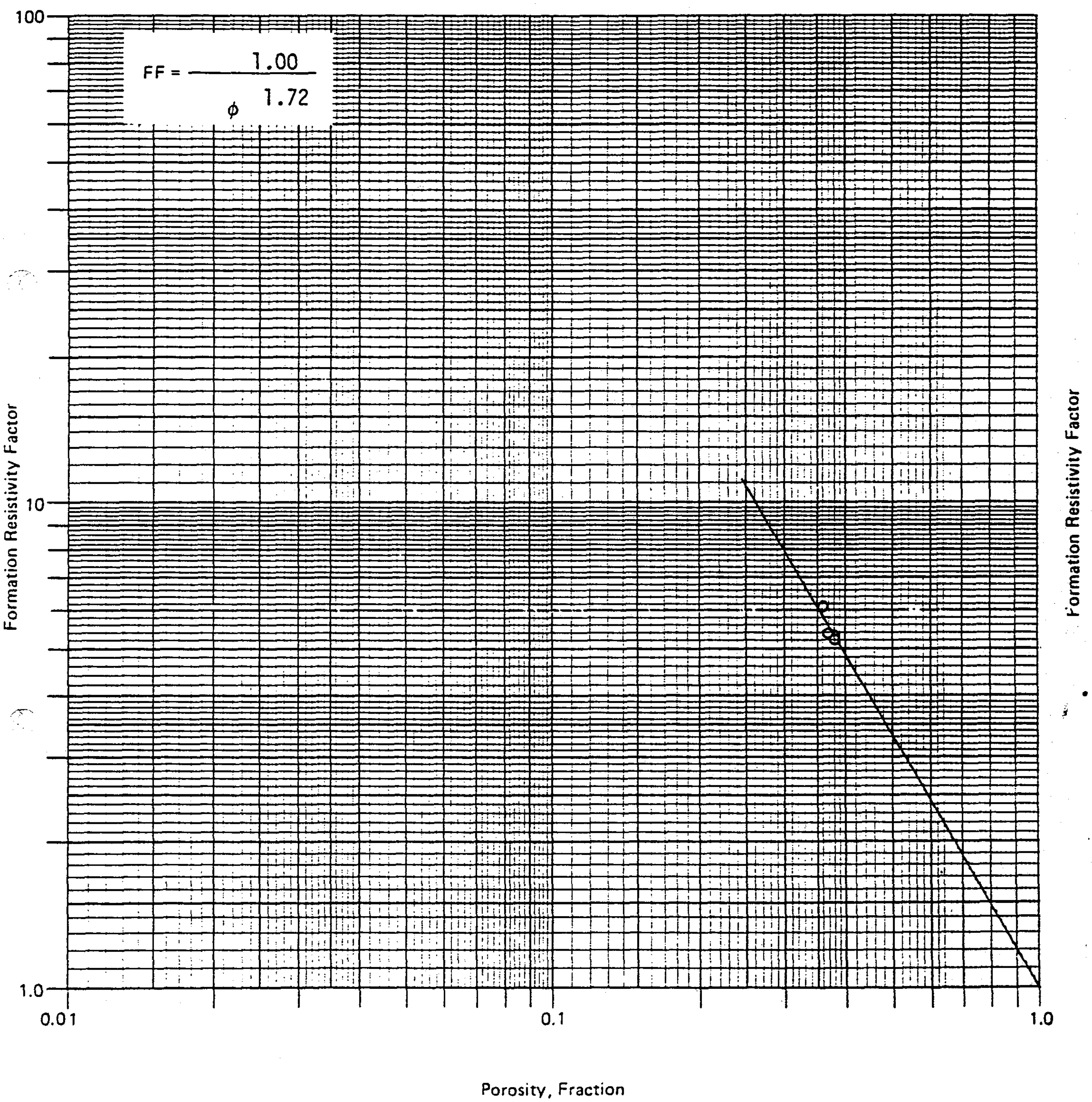
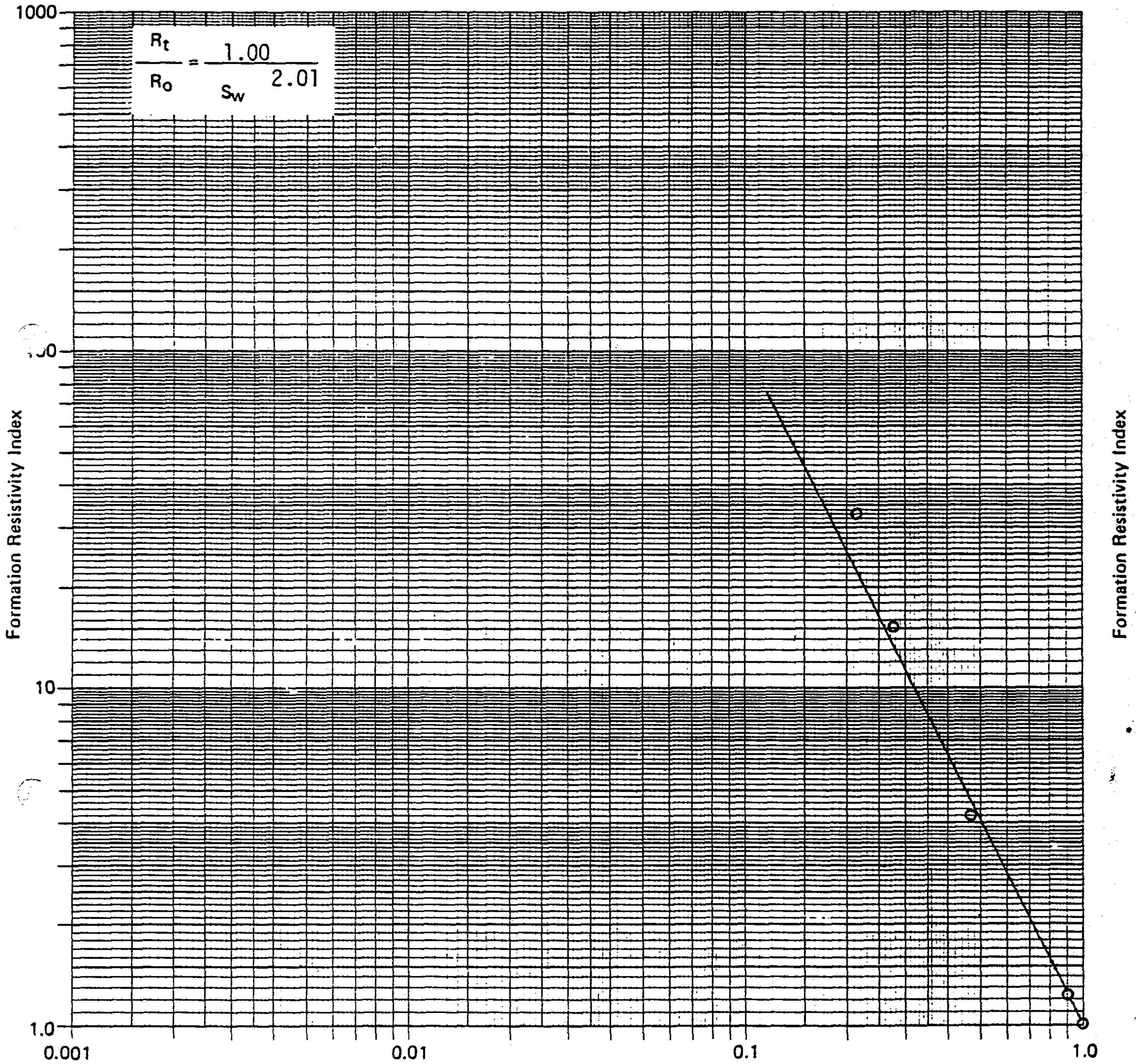
Formation:
Country: NORTH SEA
NORWAY



Company STATOIL
Well 34/10-4
Field
Formation
Country NORTH SEA
NORWAY

SAMPLE NUMBER: D1



Brine, Saturation, Fraction

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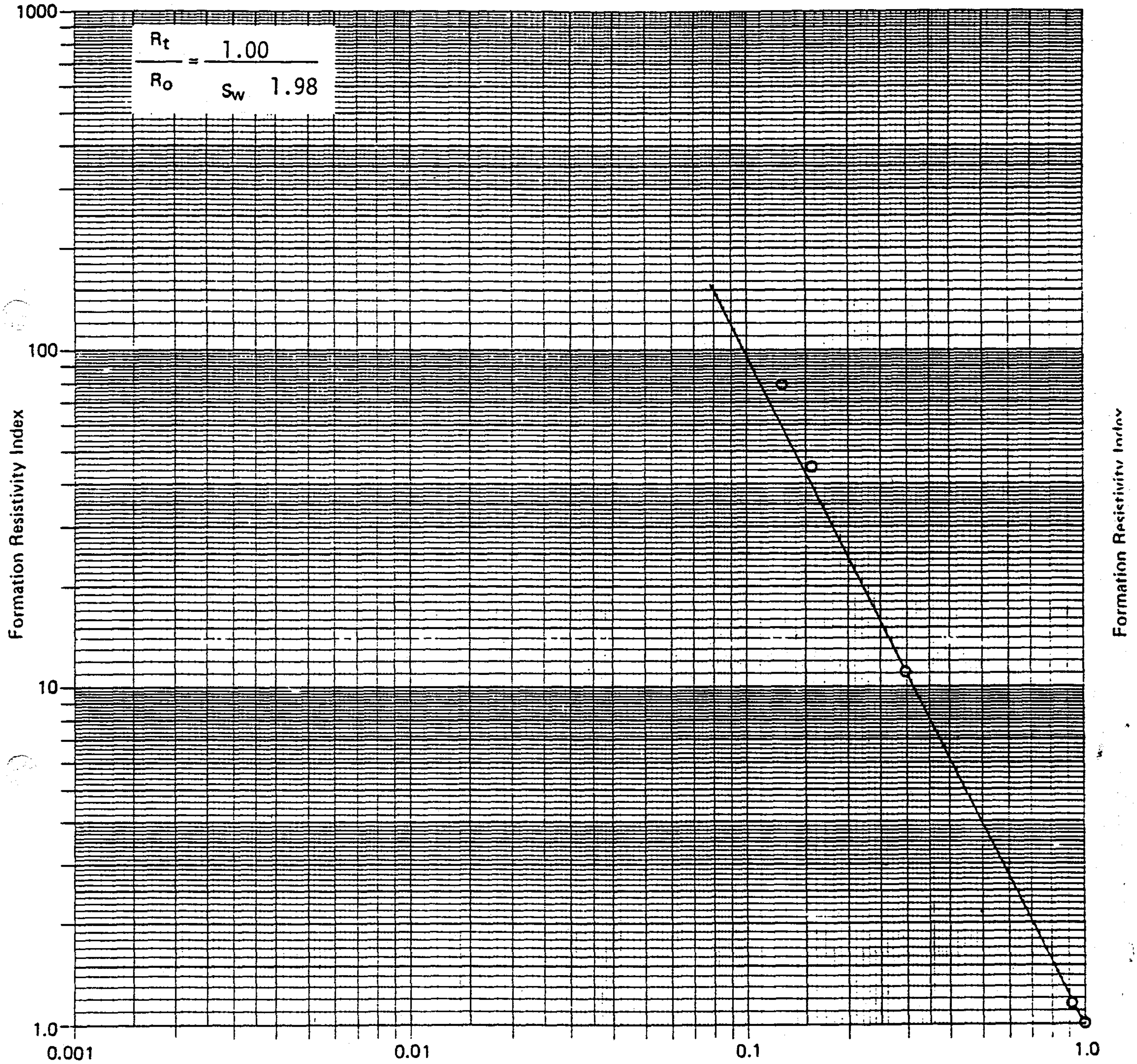
LONDON · ABERDEEN

Company	STATOIL	Formation	
Well	34/10-4	Country	NORTH SEA
Field			NORWAY

SAMPLE NUMBER: B1



Brine, Saturation, Fraction

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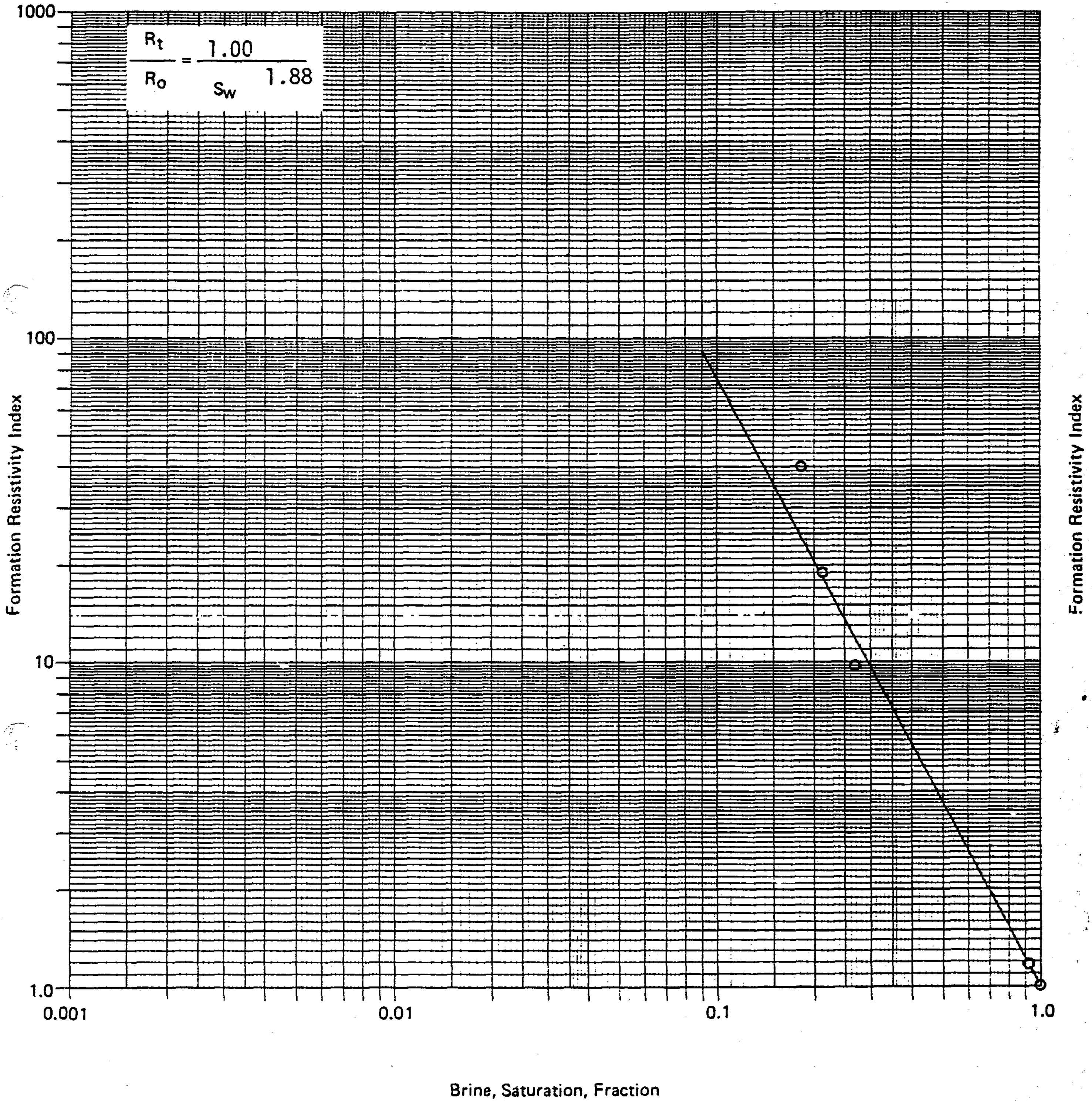
File UKSCAL 7964

Company STATOIL
Well 34/10-4
Field
Formation
Country NORTH SEA
NORWAY

SAMPLE NUMBER: C1



Company STATOIL
Well 34/10-4
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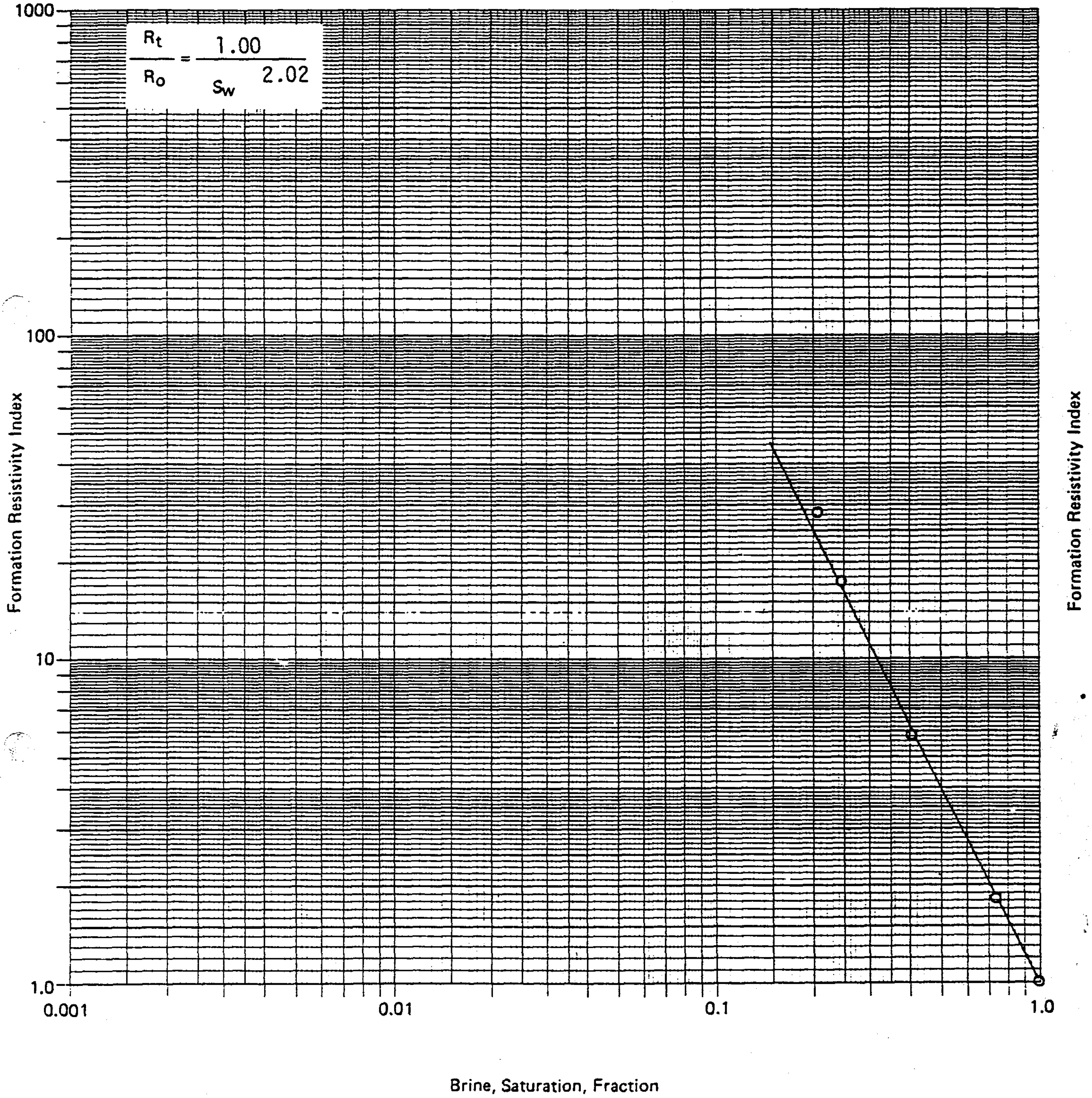
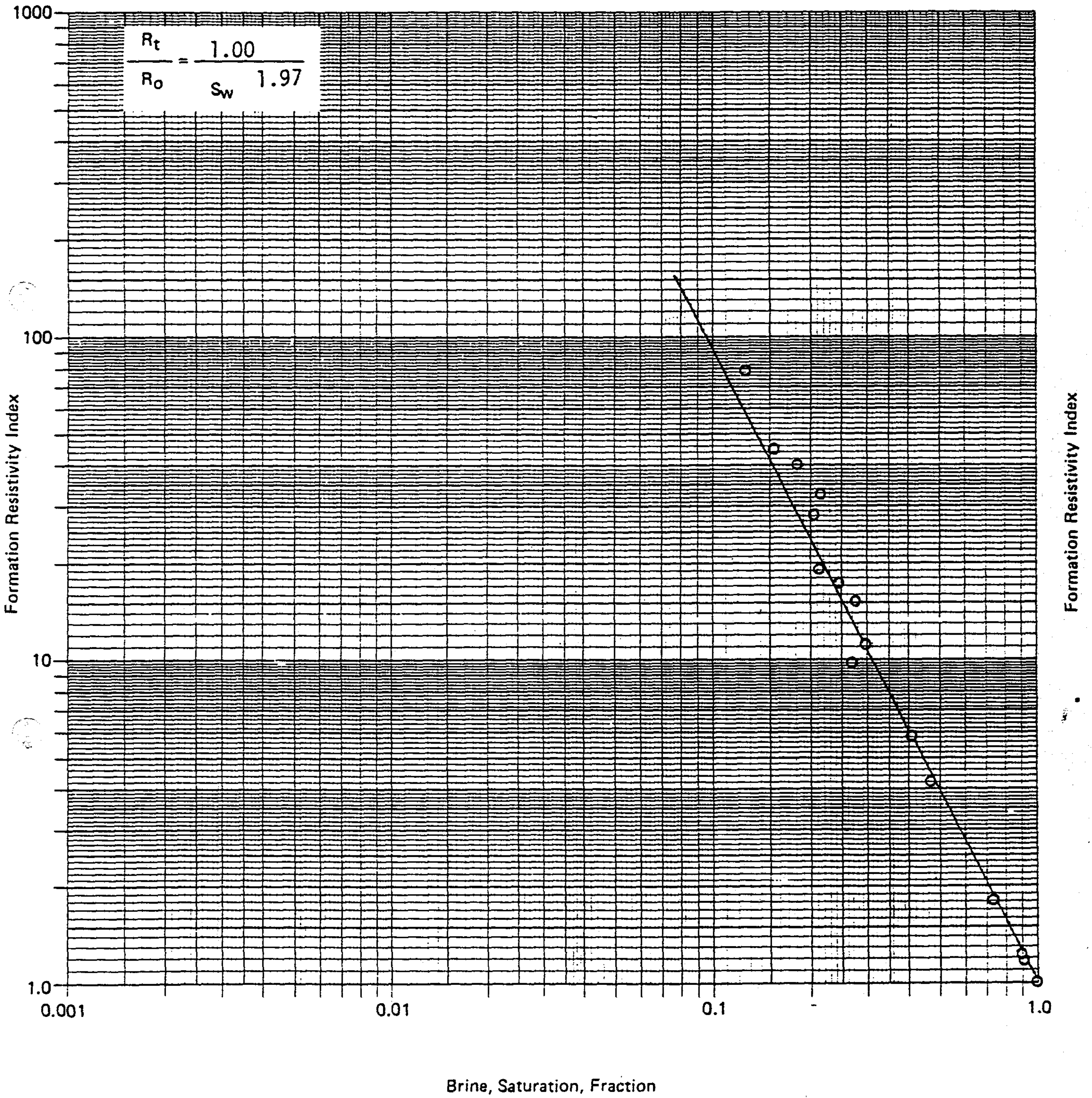
Country NORTH SEA NORWAY

SAMPLE NUMBER: E1



Company STATOIL
Well 34/10-4
Field
Formation
Country NORTH SEA
NORWAY

COMPOSITE



AIR PERMEABILITY DATA

Sample Number	Mean Differential Pressure (Bars)	Air Permeability MD
B1	1.11	1040
	1.17	970
	1.24	920
	1.31	880
C1	1.09	760
	1.16	700
	1.23	670
	1.30	620
D1	1.08	670
	1.15	610
	1.23	520
	1.30	480
E1	1.08	620
	1.15	570
	1.22	540
	1.30	520

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GAS-OIL RELATIVE PERMEABILITY DATA

Sample Number: C3

Air Permeability, Md: 1500

Oil Permeability with Initial Water Present, Md: 1170

Initial Water Saturation Per Cent Pore Space: 11.3

Porosity, Per Cent: 37.1

Liquid Saturation Per Cent Pore Space	Gas-Oil Relative Permeability Ratio	Relative Permeability To Gas*, Fraction	Relative Permeability To Oil*, Fraction
100.0	.000	.000	1.000
90.4	.012	.0067	.550
87.2	.031	.014	.452
84.1	.063	.023	.364
80.9	.110	.032	.288
77.9	.171	.041	.240
72.8	.388	.062	.160
68.2	.884	.091	.103
66.1	1.25	.109	.087
61.2	2.89	.133	.046
58.5	5.17	.160	.031
55.7	9.14	.192	.021
51.7	20.3	.242	.012
48.2	43.2	.289	.0067

* Relative to Oil Permability

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GAS-OIL RELATIVE PERMEABILITY DATA

Sample Number: B3

Air Permeability, Md: 1830

Oil Permeability with Initial Water Present, Md: 996

Initial Water Saturation Per Cent Pore Space: 13.3

Porosity, Per Cent: 39.2

Liquid Saturation Per Cent Pore Space	Gas-Oil Relative Permeability Ratio	Relative Permeability To Gas*, Fraction	Relative Permeability To Oil*, Fraction
100.0	.000	.000	1.000
93.1	.014	.0098	.702
89.2	.036	.020	.560
86.0	.069	.031	.449
83.3	.112	.042	.377
76.9	.307	.075	.243
73.5	.522	.095	.182
67.3	1.49	.151	.101
63.2	3.23	.200	.062
60.1	5.43	.239	.044
57.7	8.75	.280	.032
52.9	23.8	.380	.016
50.3	41.5	.447	.011

*Relative to Oil Permeability

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GAS-OIL RELATIVE PERMEABILITY DATA

Sample Number: D3

Air Permeability, Md: 1430

Oil Permeability with Initial Water Present, Md: 902

Initial Water Saturation Per Cent Pore Space: 12.3

Porosity, Per Cent: 38.8

Liquid Saturation Per Cent Pore Space	Gas-Oil Relative Permeability Ratio	Relative Permeability To Gas*, Fraction	Relative Permeability To Oil*, Fraction
100.0	.000	.000	1.000
89.7	.021	.011	.520
85.2	.055	.021	.380
83.0	.080	.026	.320
79.0	.151	.036	.238
76.0	.244	.047	.191
73.8	.341	.056	.164
70.1	.599	.072	.120
66.0	1.18	.097	.082
60.4	2.74	.131	.048
56.2	5.62	.159	.028
52.5	10.9	.189	.017
48.2	24.4	.220	.0090
44.2	57.5	.247	.0043

* Relative to Oil Permeability.

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GAS-OIL RELATIVE PERMEABILITY DATA

Sample Number: E3

Air Permeability, Md: 498

Oil Permeability with Initial Water Present, Md: 344

Initial Water Saturation Per Cent Pore Space: 20.7

Porosity, Per Cent: 36.5

Liquid Saturation Per Cent Pore Space	Gas-Oil Relative Permeability Ratio	Relative Permeability To Gas*, Fraction	Relative Permeability To Oil*, Fraction
100.0	.000	.000	1.000
93.8	.019	.011	.593
90.2	.048	.021	.440
87.4	.091	.032	.350
84.1	.183	.048	.262
79.7	.387	.072	.187
76.7	.667	.094	.141
73.0	1.23	.117	.096
70.1	2.01	.146	.072
66.4	4.01	.183	.046
63.1	7.77	.228	.029
58.7	19.6	.282	.014
55.8	37.2	.320	.0086
53.0	82.3	.374	.0046

* Relative to Oil Permeability.

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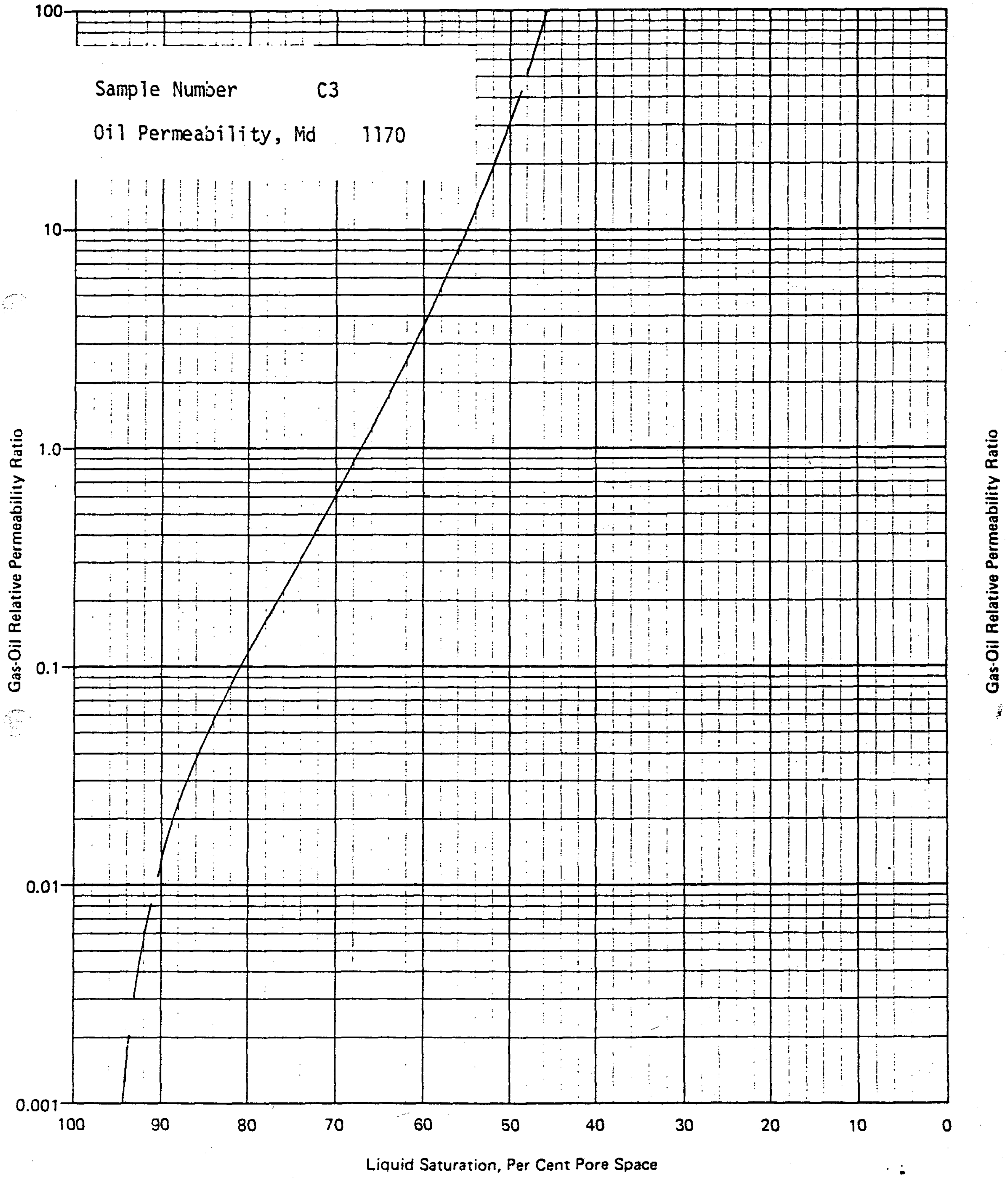
Petroleum Reservoir Engineering
LONDON · ABERDEEN

Company: Statoil
Well: 34/10-4
Field:
Formation:
Country: North Sea
Norway



CORE LABORATORIES, UK LTD
Petroleum Reservoir Engineering
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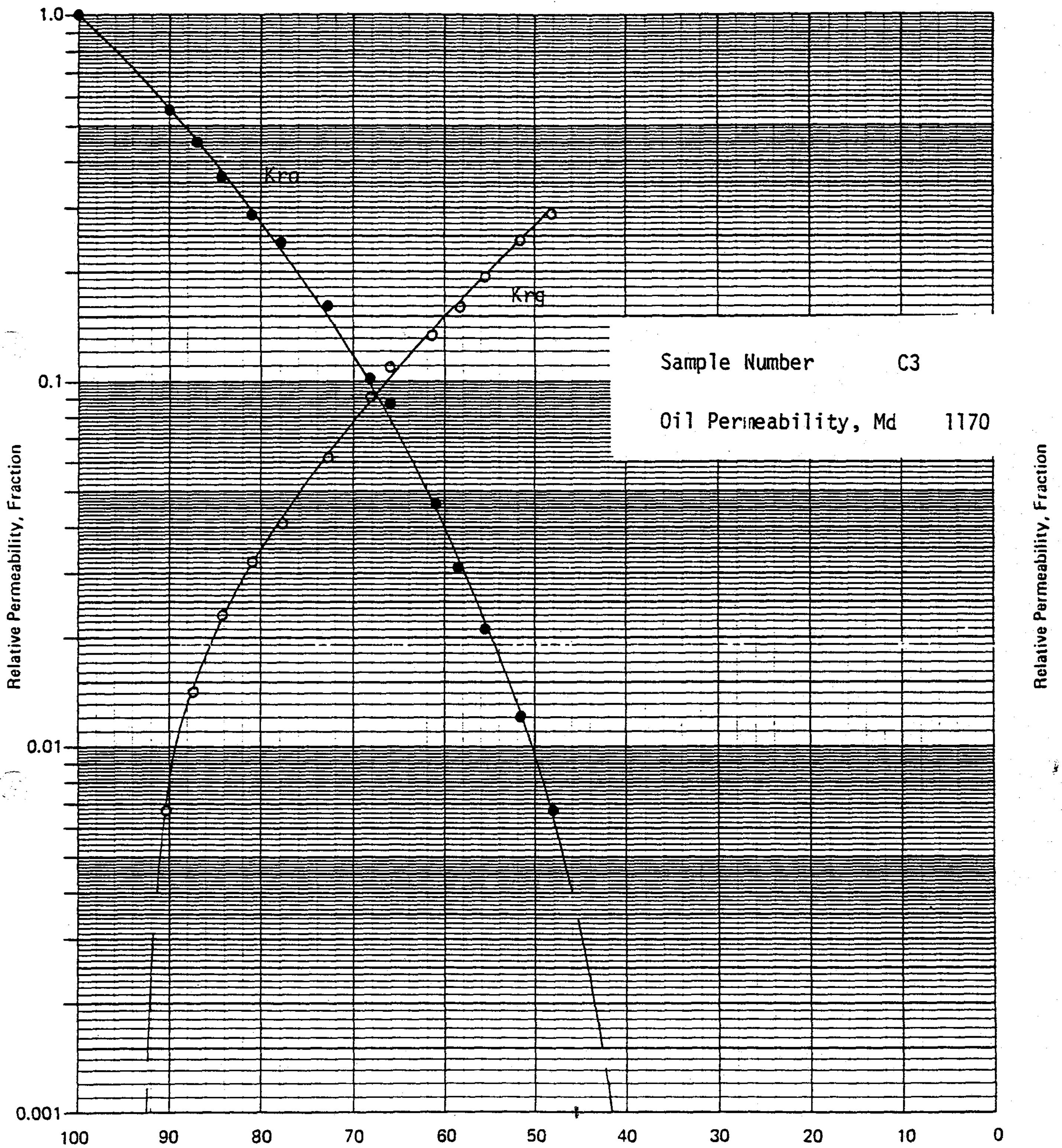
File: UKSCAL 7964

Company: Statoil
Well: 34/10-4
Field:
Formation:
Country: North Sea
Norway



$S_{wc} = 20.7\%$
$S_{org} = 21.3\%$

CORE LABORATORIES UK LTD
Petroleum Reservoir Engineering
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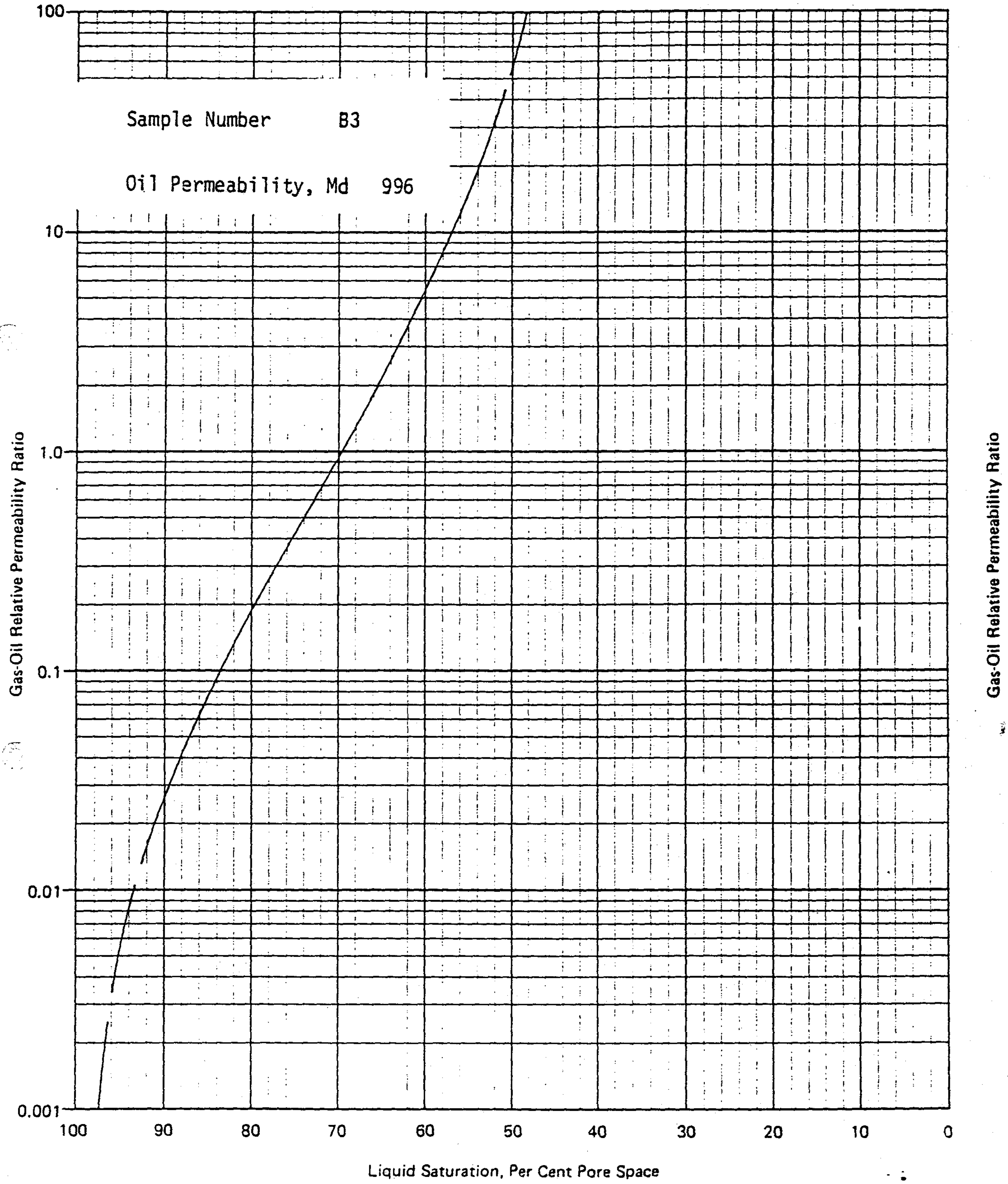
File: UKSCAL 7964

Company Statoil
Well 34/10-4
Field

Formation
Country North Sea
Norway



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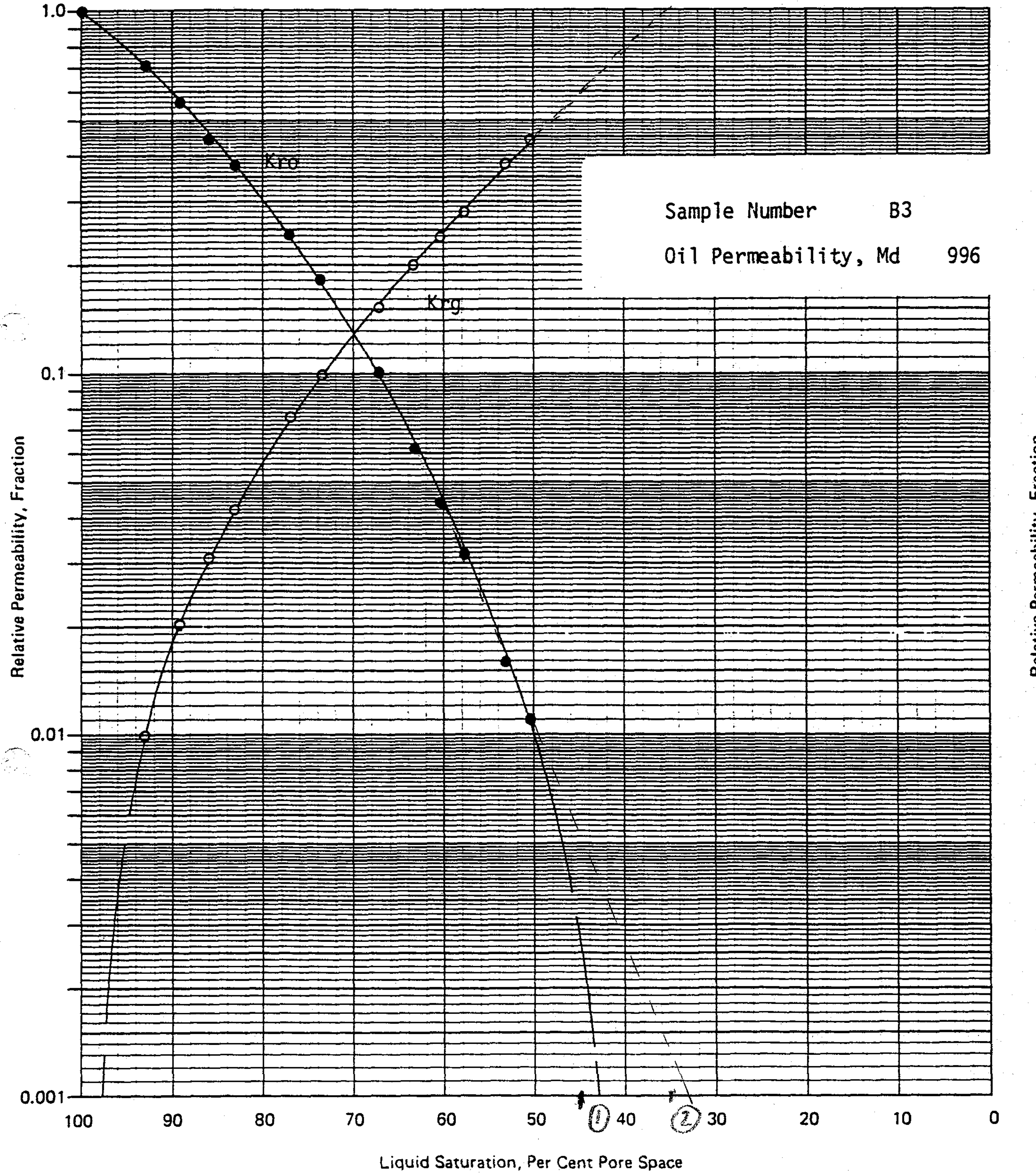
File: UKSCAL 7964

Company: Statoil
Well: 34/10-4
Field:
Formation:
Country: North Sea
Norway



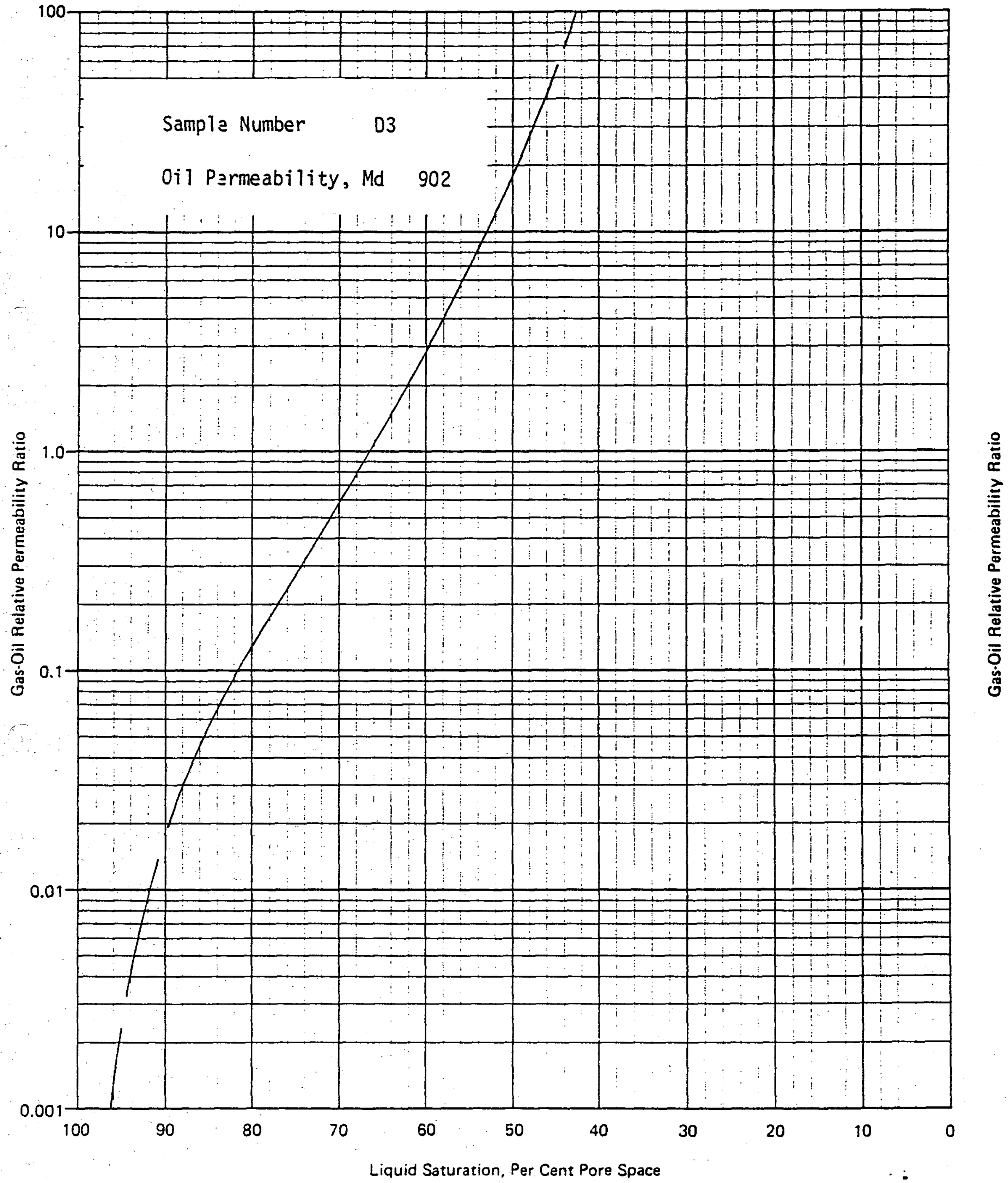
Swc = 13.3 %
Sorg : ① = 29.7 %
② = 19.7 %

CORE LABORATORIES, UK LTD.
Petroleum Reservoir Engineering
LONDON·ABERDEEN

File: UKSCAL 7964

Company Statoil
Well 34/10-4
Field

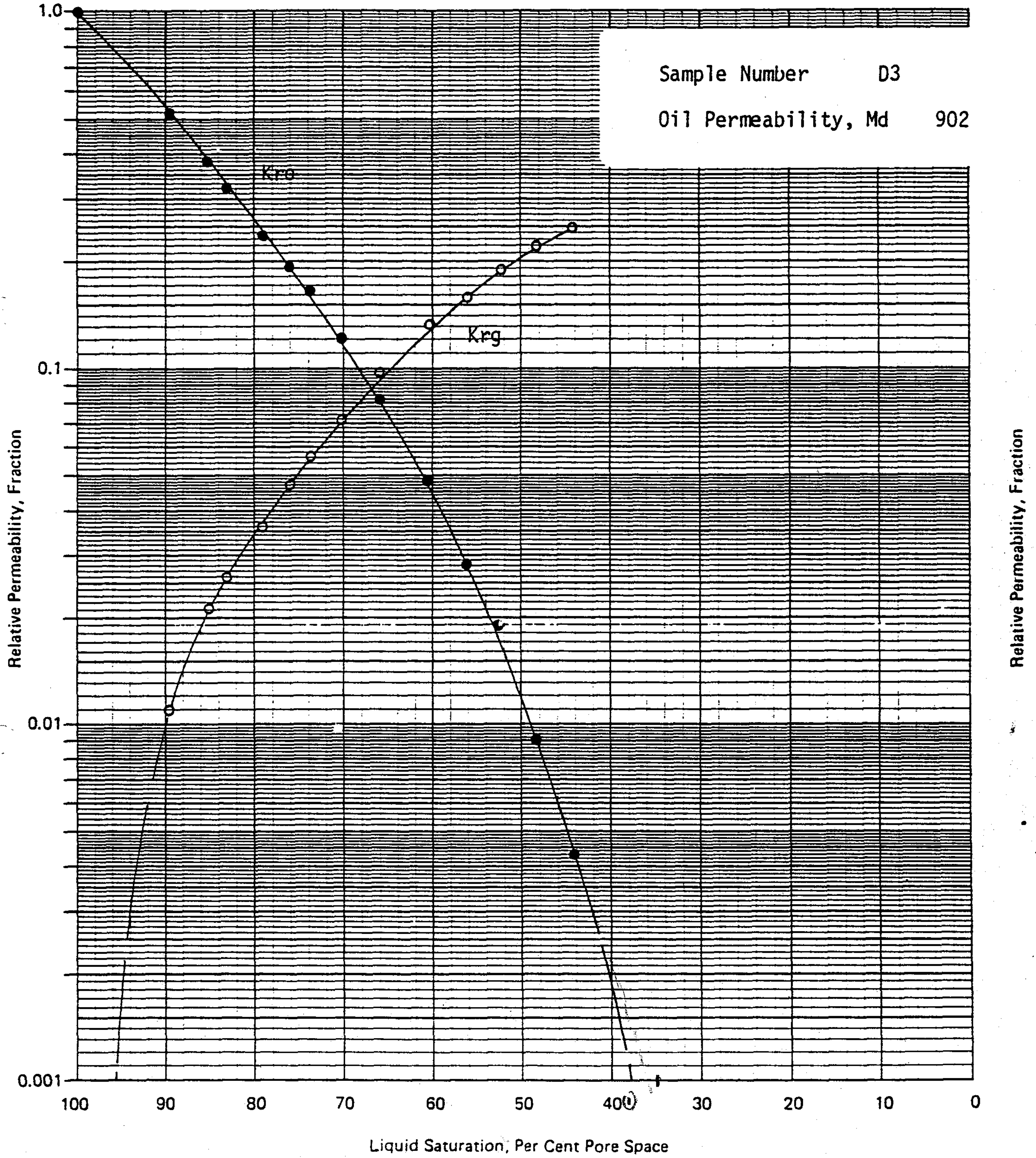
Formation
Country North Sea
Norway



CORE LABORATORIES, UK LTD.
Petroleum Reservoir Engineering
LONDON · ABERDEEN

File: UKSCAL 7964

Company: Statoil
Well: 34/10-4
Field:
Formation:
Country: North Sea Norway



Swc = 12.3 %
Sor = 25.7 % ①

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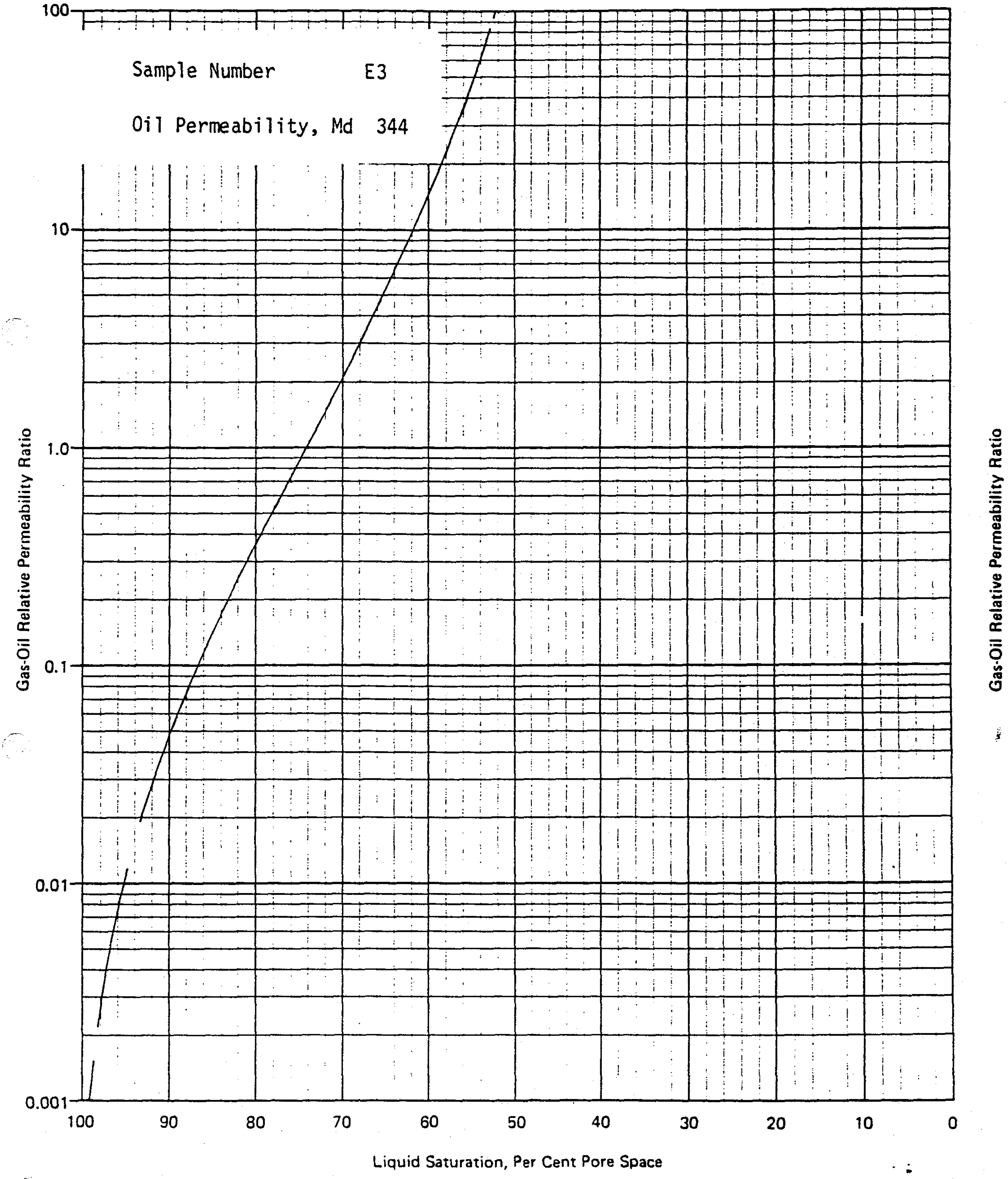
LONDON·ABERDEEN

File: UKSCAL 7964

Company Statoil
Well 34/10-4
Field

Formation
Country North Sea
Norway



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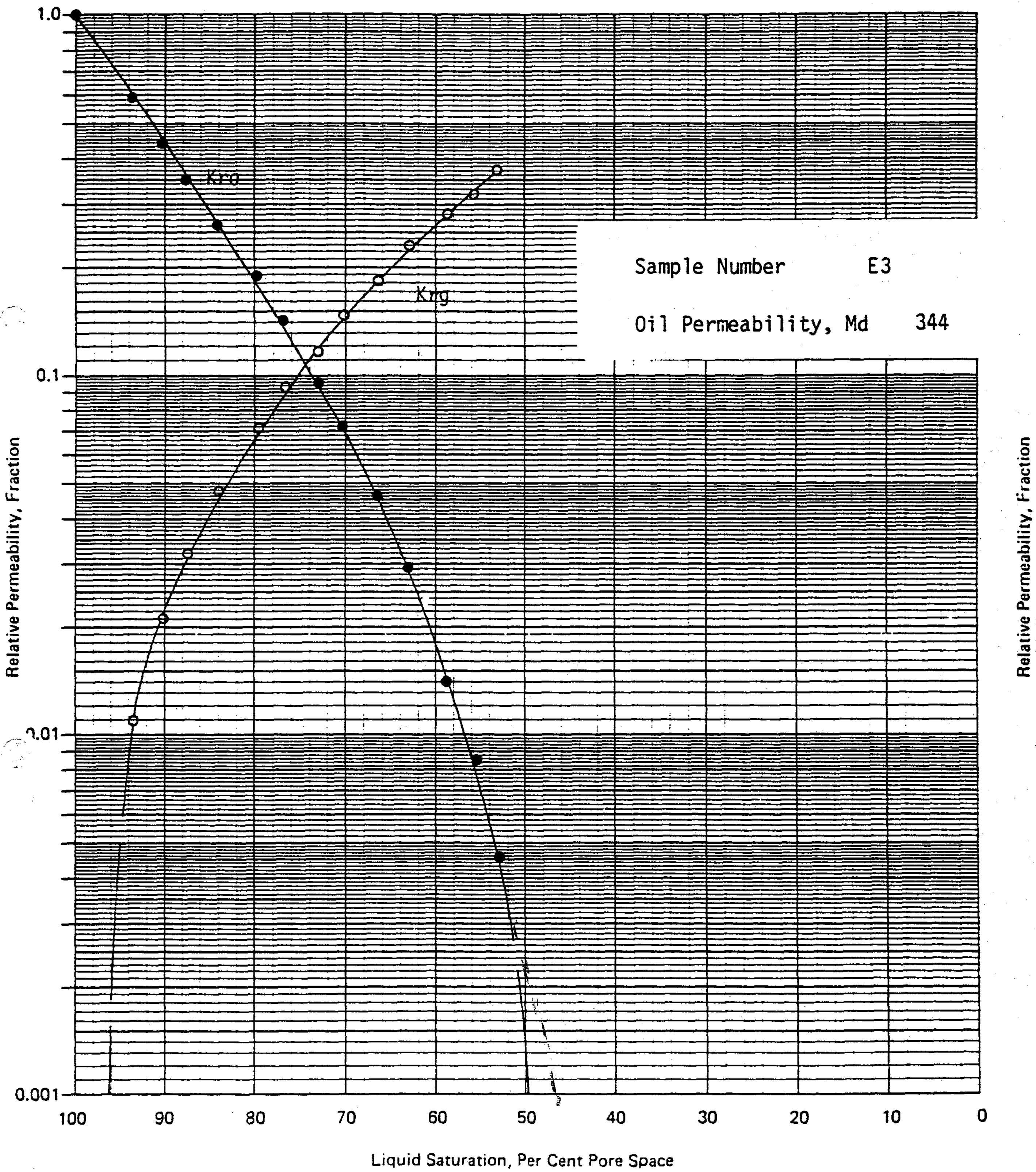
Petroleum Reservoir Engineering
LONDON · ABERDEEN

Company: Statoil
Well: 34/10-4
Field:
Formation:
Country: North Sea
Norway



SUMMARY OF WATERFLOOD TEST RESULTS

RESERVOIR CONDITIONS

Sample Number	Air Permeability Millidarcys	Porosity Per Cent	Initial Conditions: Water Saturation Per Cent Pore Space	Initial Conditions: Oil Permeability Millidarcys	Terminal Conditions: Oil Saturation Per Cent Pore Space	Terminal Conditions: Water Permeability Millidarcys	Oil Recovered: Per Cent Pore Space	Oil Recovered: Per Cent Oil in P
B5	1490	38.4	18.2	187	21.5	120	60.3	73.7
D5	1780	34.5	16.8	179	45.5	112	37.7	45.3
C5	1230	36.5	13.9	16	44.7	11	41.4	48.1
E5	64	27.9	19.3	5.9	35.9	1.5	44.8	55.6

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WATERFLOOD SUSCEPTIBILITY DATA

Sample Number: B5

Reservoir Conditions

Initial Water Per Cent Pore Space: 18.2

Permeability to Air, Md: 1490

Porosity, Per Cent: 38.4

Permeability to Oil with Initial Water Present, Md: before ageing 385, after ageing 187

Water Input Pore Volumes	Cummulative Oil Recovery, Per Cent Pore Space	Average Oil Recovery, *Per Cent Pore Space	Average Water Cut** Per Cent
.466	46.6***	-	-
.862	51.0	48.8	88.41
1.10	51.5	51.3	94.81
2.07	53.0	52.4	98.48
2.82	53.9	53.6	99.23
3.88	55.0	54.4	99.32
5.31	55.9	55.5	99.40
7.94	57.0	56.5	99.60
13.1	59.4	58.2	99.79
18.4	60.5	60.0	99.87
28.8	61.1	60.8	99.94
39.2	61.4	61.3	99.99

* Calculated for mid-point of incremental through-put
** Calculated from incremental through-put volumes
*** Break through recovery

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WATERFLOOD SUSCEPTIBILITY DATA

RESERVOIR CONDITIONS

Sample Number: D5

Permeability to Air, Md: 1780

Permeability to Oil with
Initial Water Present, Md: before ageing 726, after ageing 179

Initial Water
Per Cent Pore Space: 16.8

Porosity, Per Cent: 34.5

Water Input Pore Volumes	Cummulative Oil Recovery, Per Cent Pore Space	Average Oil Recovery, *Per Cent Pore Space	Average Water Cut** Per Cent
.162	16.2***	-	-
.960	22.4	19.3	92.25
2.35	26.0	24.2	97.42
5.39	30.3	28.2	98.59
12.0	32.7	31.5	99.63
24.6	34.8	33.8	99.82
49.1	37.0	35.9	99.91
73.7	37.5	37.3	99.98
122	37.7	37.6	99.99

* Calculated for mid-point of incremental through-put
** Calculated from incremental through-put volumes
*** Break through recovery

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WATERFLOOD SUSCEPTIBILITY DATA

Reservoir Conditions

Sample Number: C5

Permeability to Air, Md: 1280

Permeability to Oil with Initial Water Present, Md: before ageing 165, after ageing 16

Initial Water Per Cent Pore Space: 13.9

Porosity, Per Cent: 36.5

Water Input Pore Volumes	Cummulative Oil Recovery, Per Cent Pore Space	Average Oil Recovery, *Per Cent Pore Space	Average Water Cut** Per Cent
.360	36.0***	-	-
.599	37.6	37.2	97.11
.961	39.2	38.4	98.82
1.22	39.9	39.6	99.08
2.89	41.5	40.7	99.82
5.80	41.8	41.7	99.85
8.73	42.1	42.0	99.89
14.5	42.3	42.2	99.98
20.3	42.7	42.5	99.99

* Calculated for mid-point of incremental through-put
** Calculated from incremental through-put volumes
*** Break through recovery

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WATERFLOOD SUSCEPTIBILITY DATA

Reservoir Conditions

Sample Number: E5

Permeability to Air, Md: 64

Permeability to Oil with Initial Water Present, Md: Before Ageing 5.9, After Ageing 5.9

Initial Water Per Cent Pore Space: 19.3

Porosity, Per Cent: 27.9

Water Input Pore Volumes	Cummulative Oil Recovery, Per Cent Pore Space	Average Oil Recovery, *Per Cent Pore Space	Average Water Cut** Per Cent
.296	29.6 ***	-	-
.378	31.8	30.7	64.95
.521	34.5	33.2	80.84
1.01	37.6	36.1	93.70
1.51	39.0	38.3	97.08
2.49	41.2	40.1	98.74
3.43	42.4	41.8	99.31
5.67	43.3	42.9	99.62
10.04	44.5	43.9	99.73
18.68	44.7	44.6	99.97
27.30	44.8	44.8	99.99

* Calculated for mid-point of incremental through-put
** Calculated from incremental through-put volumes
*** Break through recovery

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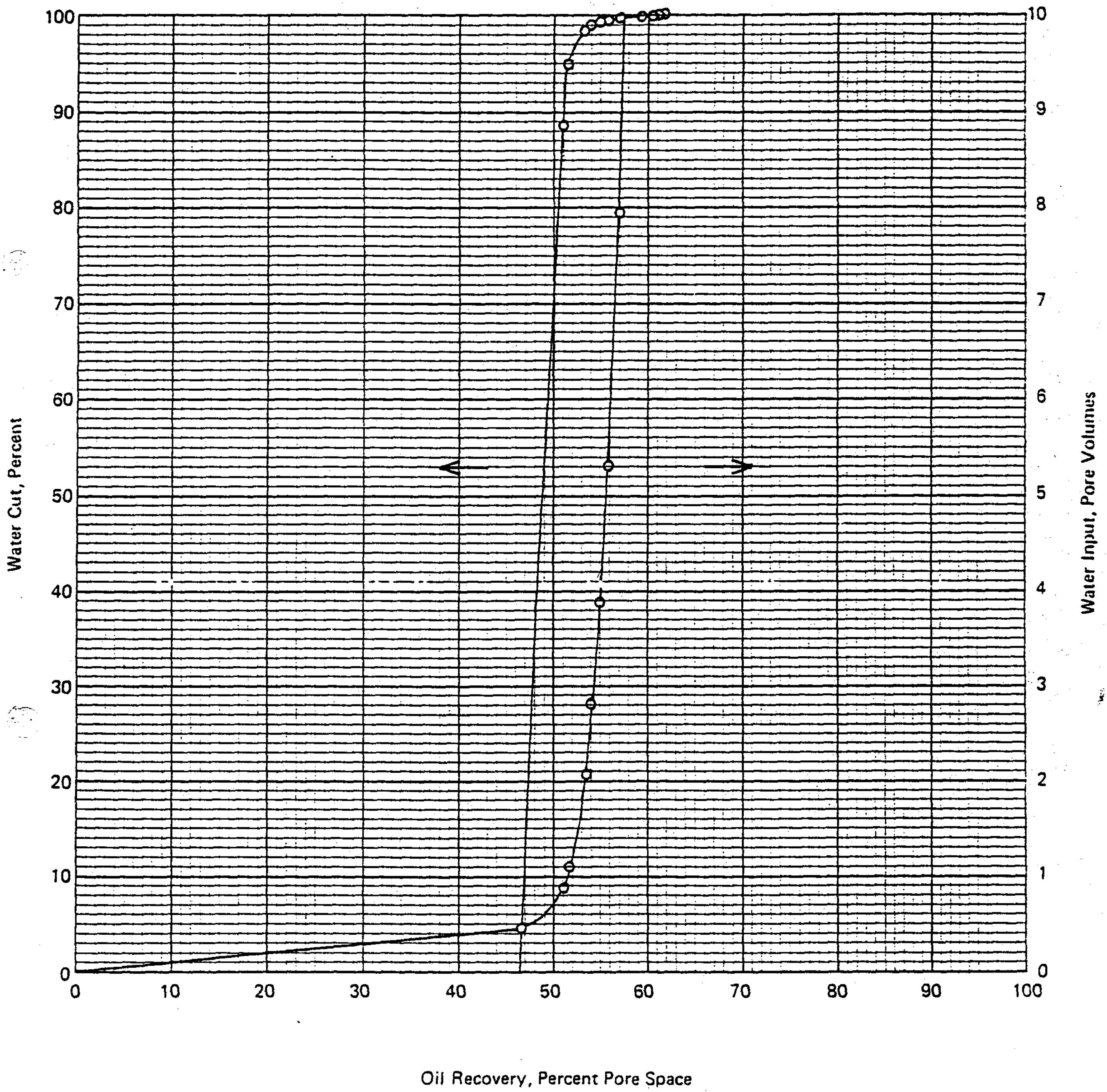
Company STATOIL
Well 34/10-4
Field

Formation
Country NORTH SEA
NORWAY

SAMPLE NUMBER: B5
OIL PERMEABILITY MD: 187



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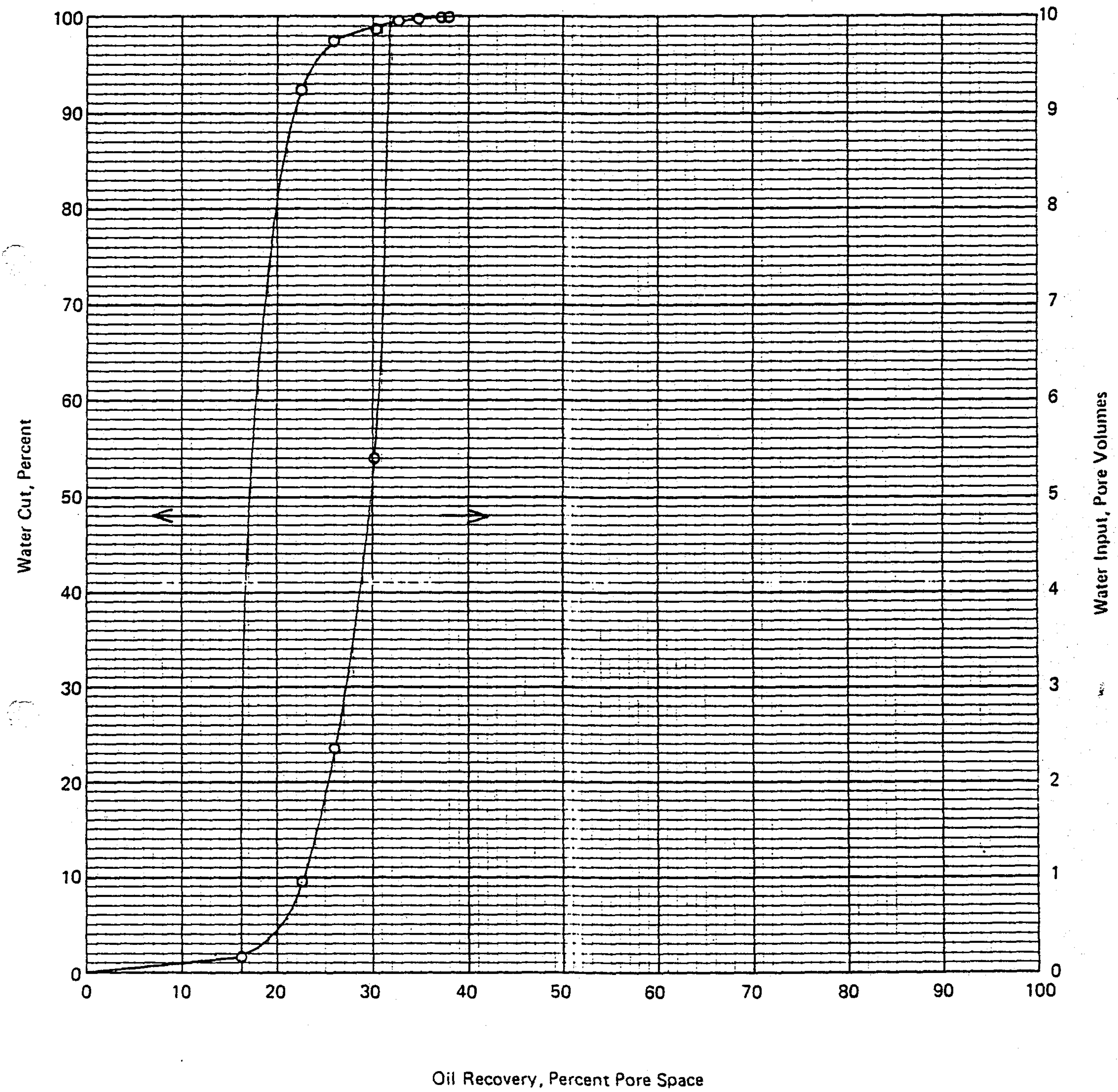
Company STATOIL
Well 34/10-4
Field
Formation
Country NORTH SEA
NORWAY

SAMPLE NUMBER D5

OIL PERMEABILITY, MD 179



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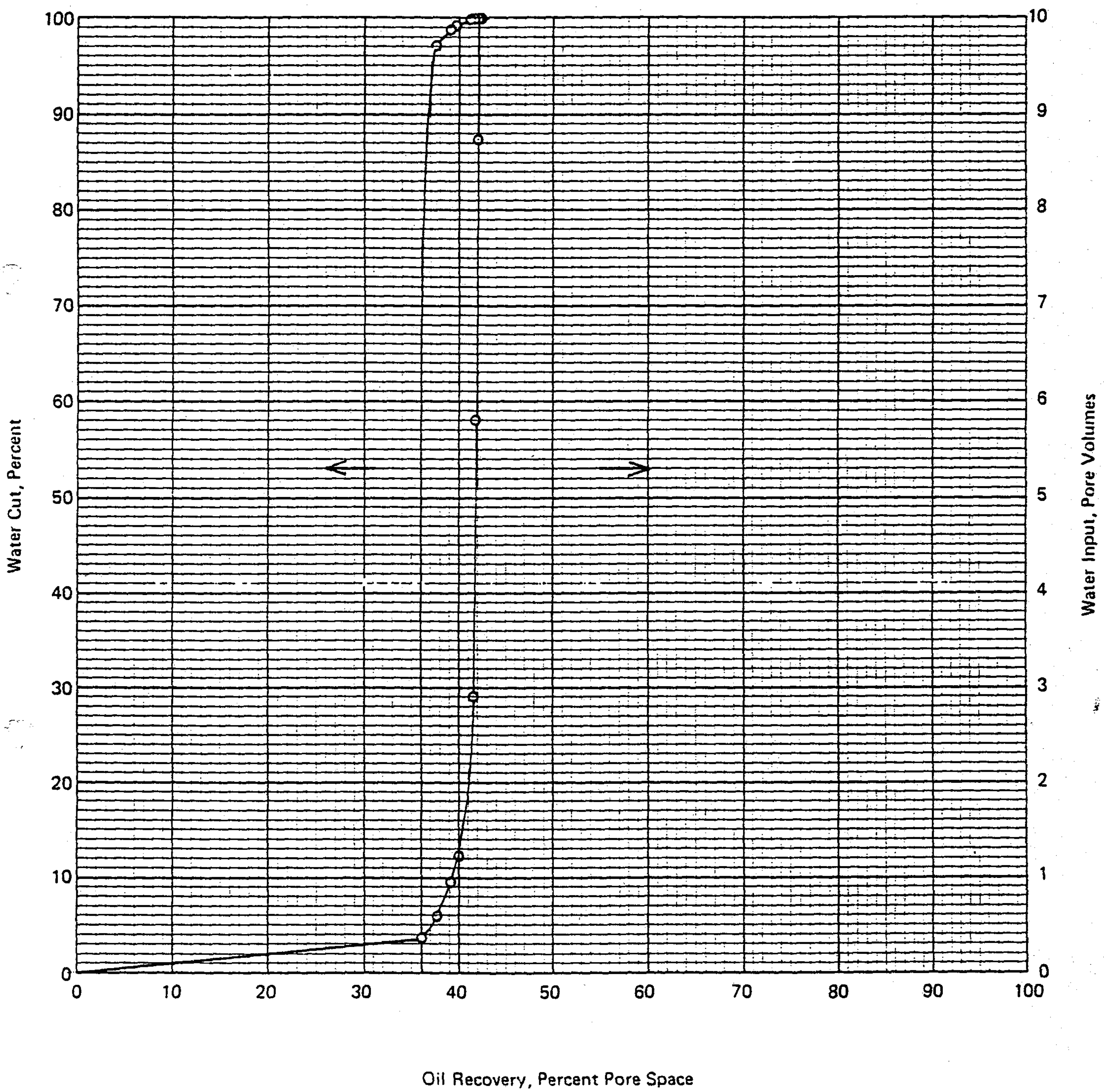
Company STATOIL
Well 34/10-4
Field

Formation
Country NORTH SEA
NORWAY

SAMPLE NUMBER:C5

OIL PERMEABILITY MD: 16

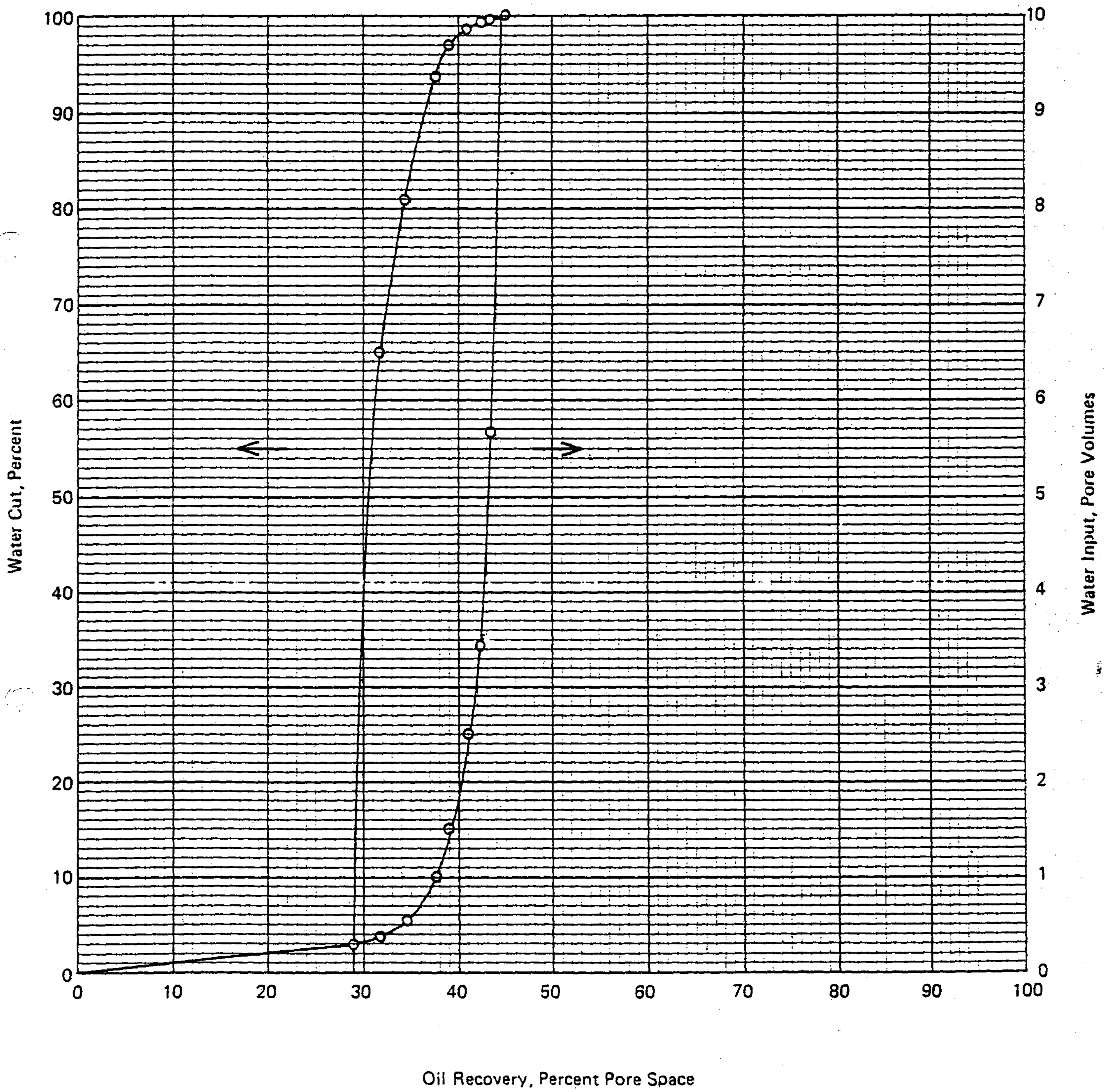


Company STATOIL
Well 34/10-4
Field

Formation
Country NORTH SEA
NORWAY

Sample Number: E5

Oil Permeability, MD: 5.9



WATER-OIL RELATIVE PERMEABILITY DATA

Sample Number: B5

Air Permeability, Md: 1490

Oil Permeability with Initial Water Present, Md: 187

Initial Water Saturation Per Cent Pore Space: 18.2

Porosity, Per Cent: 38.4

Water Saturation Per Cent Pore Space	Water-Oil Relative Permeability Ratio	Relative Permeability To Water*, Fraction	Relative Permeability To Oil*, Fraction
18.2	.000	.000	1.000
56.8	3.92	.243	.062
60.8	8.08	.315	.039
65.1	19.0	.400	.021
68.1	41.8	.460	.011
69.2	55.8	.480	.0086
69.5	61.3	.490	.0080
69.6	64.0	.499	.0078
70.9	96.4	.511	.0053
72.4	162	.552	.0034
73.7	252	.579	.0023
75.2	434	.608	.0014
77.1	1172	.621	.00053
78.5	-	.642	.00000

* Relative to Oil Permeability

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Petroleum Reservoir Engineering

LONDON—ABERDEEN

File: UKSCAL 7964

WATER-OIL RELATIVE PERMEABILITY DATA

Sample Number: D5

Air Permeability, Md: 1780

Oil Permeability with Initial Water Present, Md: 179

Initial Water Saturation Per Cent Pore Space: 16.8

Porosity, Per Cent: 34.5

Water Saturation Per Cent Pore Space	Water-Oil Relative Permeability Ratio	Relative Permeability To Water*, Fraction	Relative Permeability To Oil*, Fraction
16.8	.000	.000	1.000
38.2	3.63	.218	.060
38.3	3.83	.222	.058
41.2	12.5	.301	.024
47.2	137	.465	.0034
49.1	293	.498	.0017
50.5	586	.539	.00092
53.3	3005	.601	.00020
54.4	41200	.618	.000015
54.5	-	.623	.000000

* Relative to Oil Permeability

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Petroleum Reservoir Engineering
LONDON—ABERDEEN

File: UKSCAL 7964

WATER-OIL RELATIVE PERMEABILITY DATA

Sample Number: C5

Air Permeability, Md: 1280

Oil Permeability with Initial Water Present, Md: 16

Initial Water Saturation Per Cent Pore Space: 13.9

Porosity, Per Cent: 36.5

Water Saturation Per Cent Pore Space	Water-Oil Relative Permeability Ratio	Relative Permeability To Water*, Fraction	Relative Permeability To Oil*, Fraction
13.9	.000	.000	1.000
33.8	.437	.066	.151
46.5	10.3	.279	.027
49.7	30.8	.370	.012
50.4	43.2	.397	.0092
51.4	77.6	.450	.0058
52.2	100	.500	.0050
54.2	546	.601	.0011
54.6	849	.603	.00071
55.0	1605	.642	.00040
55.3	-	.660	.00000

* Relative to Oil Permeability

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Petroleum Reservoir Engineering

LONDON—ABERDEEN

File: UKSCAL 7964

WATER-OIL RELATIVE PERMEABILITY DATA

Sample Number: E5

Air Permeability, Md: 64

Oil Permeability with Initial Water Present, Md: 5.9

Initial Water Saturation Per Cent Pore Space: 19.3

Porosity, Per Cent: 27.9

Water Saturation Per Cent Pore Space	Water-Oil Relative Permeability Ratio	Relative Permeability To Water*, Fraction	Relative Permeability To Oil*, Fraction
19.3	.000	.000	1.000
41.8	.887	.055	.062
43.2	1.20	.060	.050
47.3	3.42	.082	.024
52.9	14.3	.126	.0088
55.4	28.3	.150	.0053
57.3	57.9	.168	.0029
57.8	68.8	.172	.0025
58.5	83.2	.183	.0022
60.5	165	.198	.0012
62.7	575	.230	.00040
64.1	-	.250	.00000

* Relative to Oil Permeability

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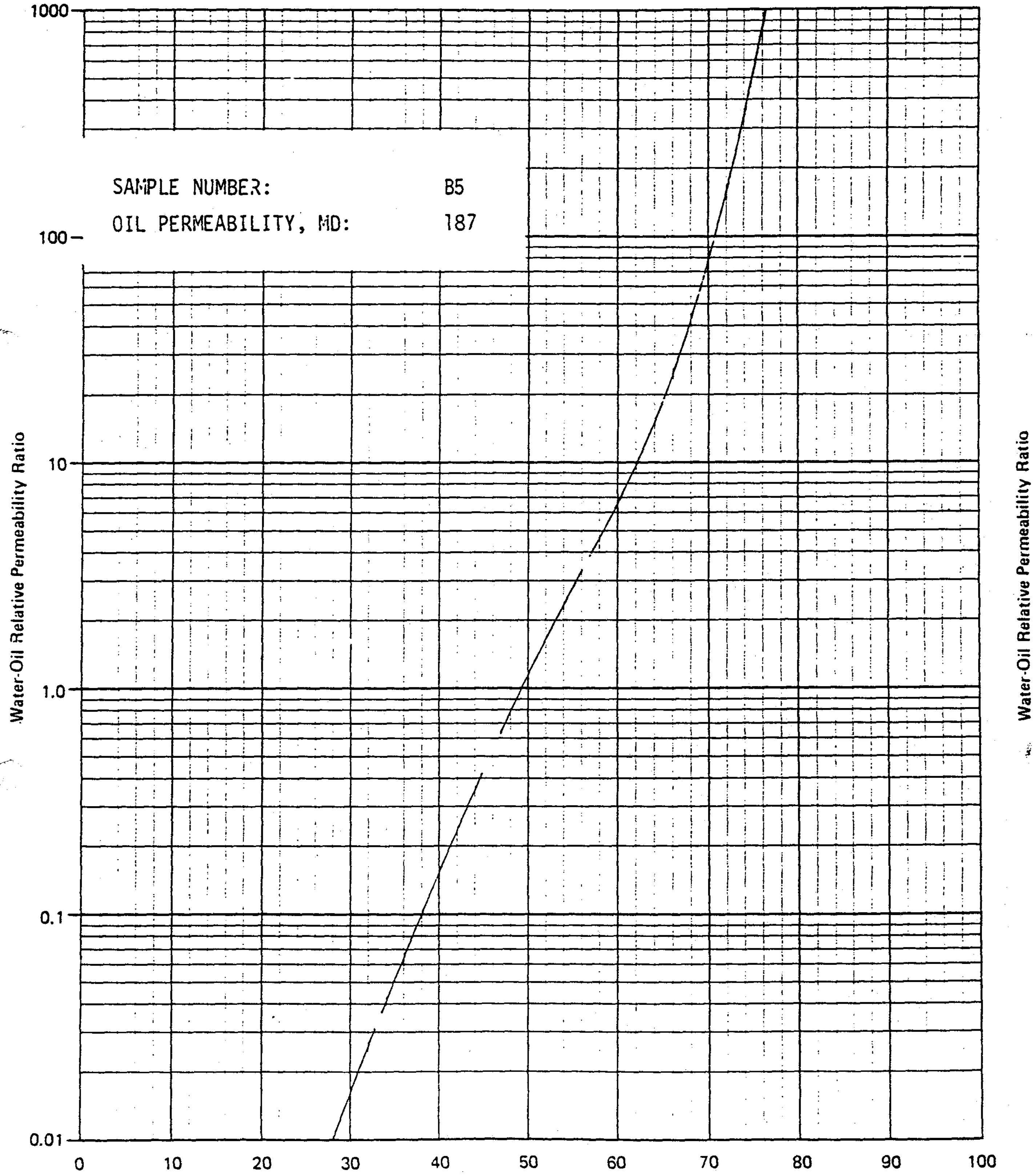
LONDON·ABERDEEN

File UKSCAL 7964

Company STATOIL
Well 34/10-4
Field

Formation
Country NORTH SEA NORWAY

SAMPLE NUMBER: B5
OIL PERMEABILITY, MD: 187



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Petroleum Reservoir Engineering
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Company STATOIL
Well 34/10-4
Field

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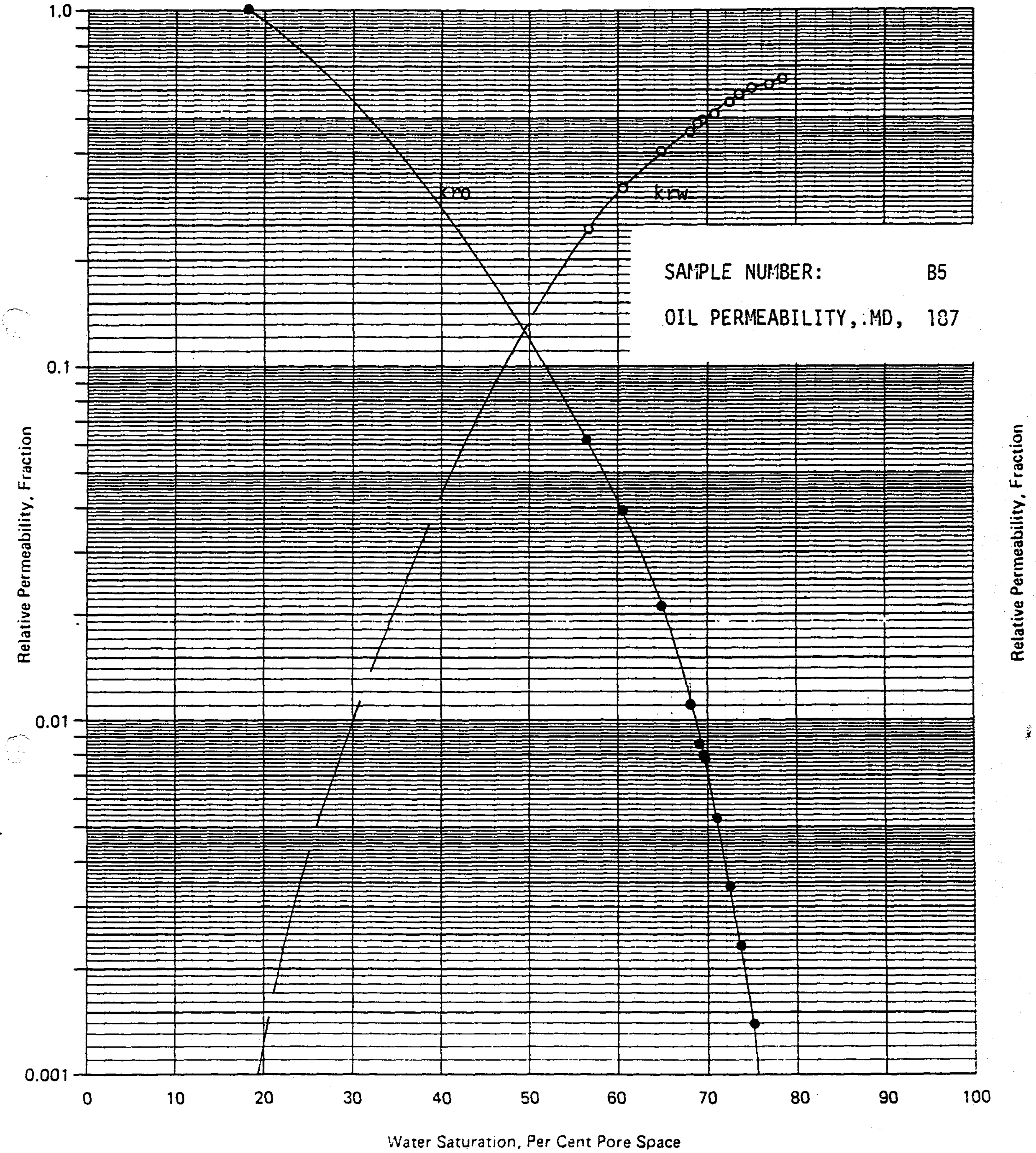
Country NORTH SEA
NORWAY



Company STATOIL
Well 34/10-4
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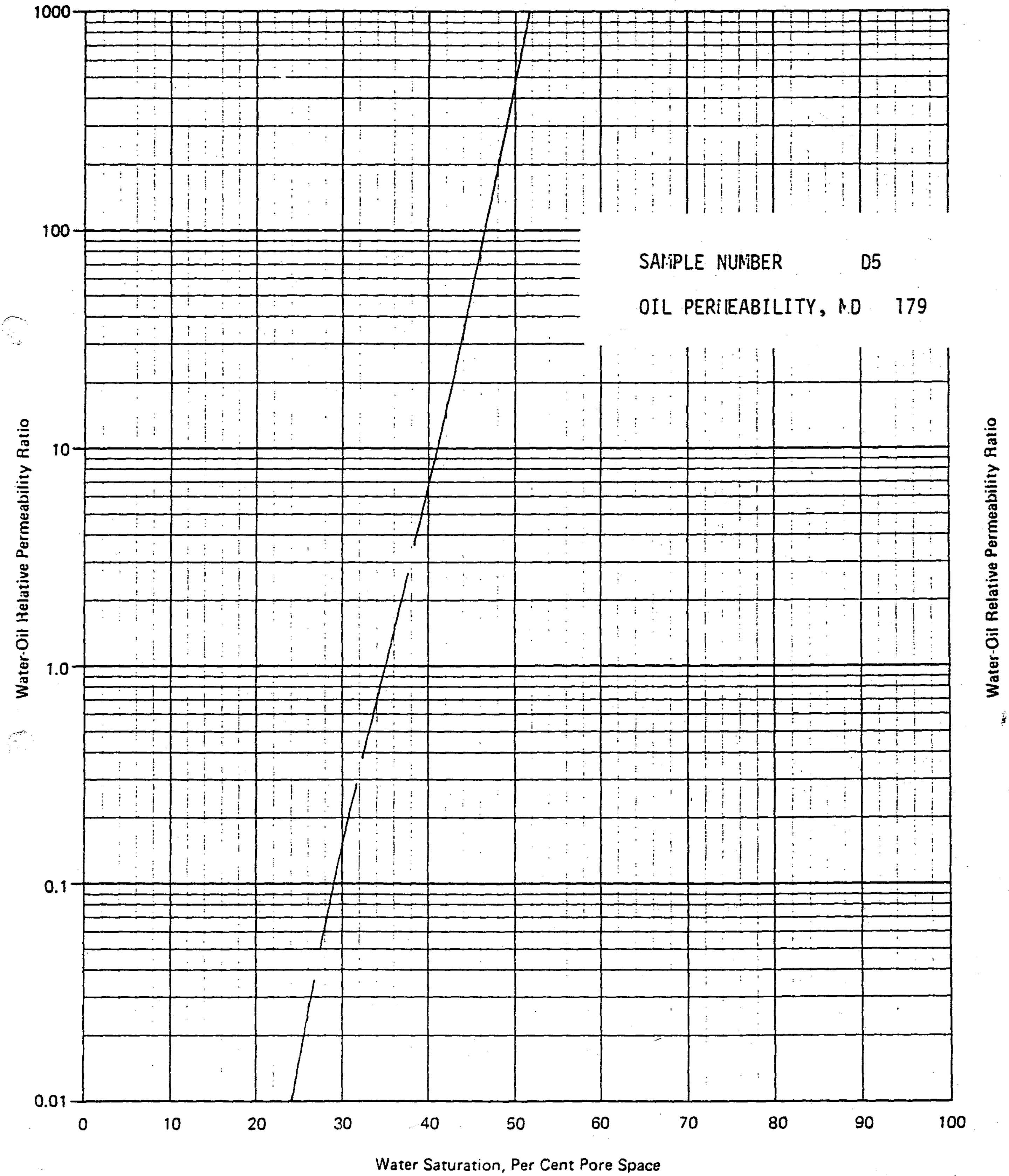
NORWAY



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Well 34/10-4
Field

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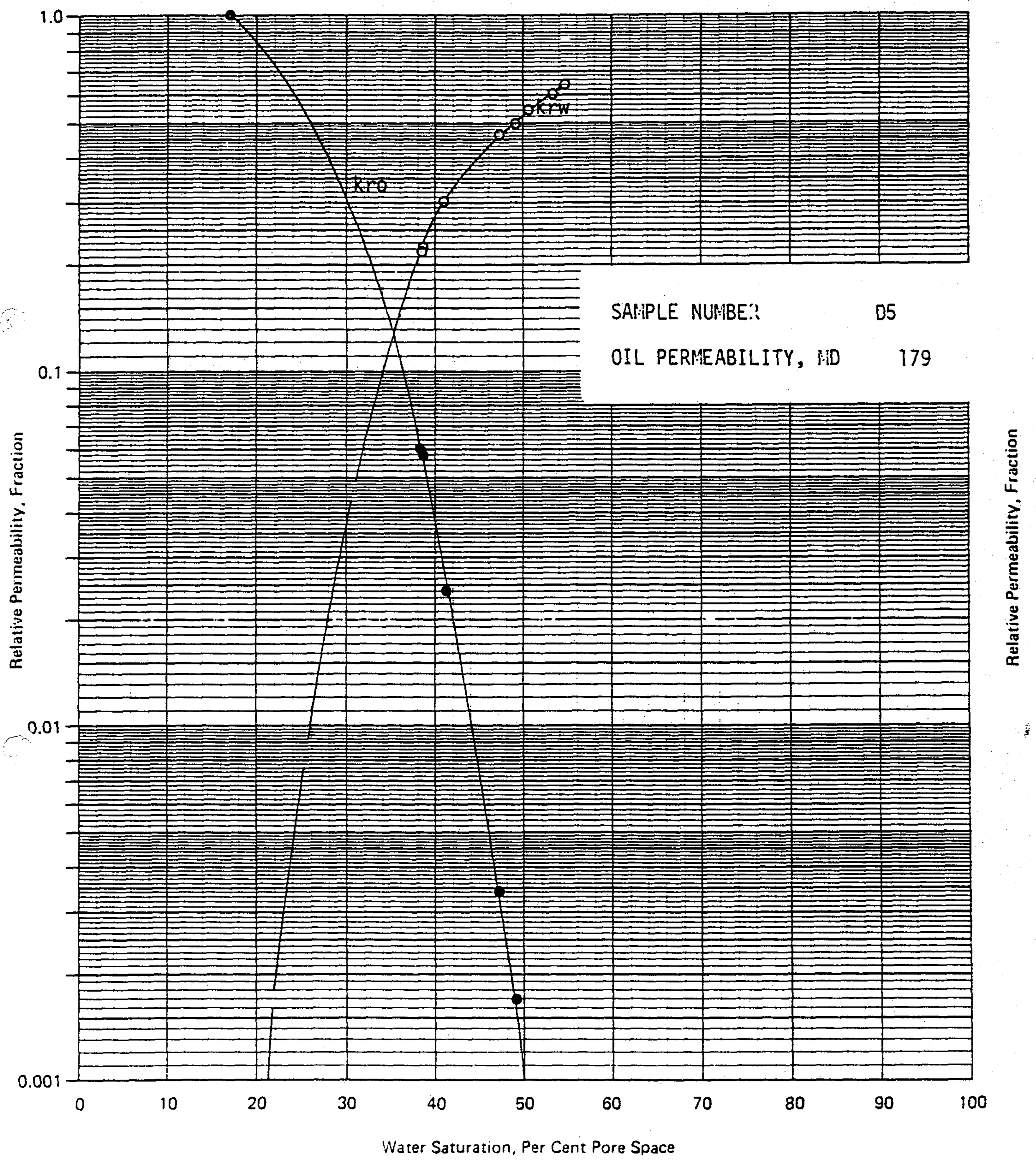

Company STATOIL
Well 34/10-4
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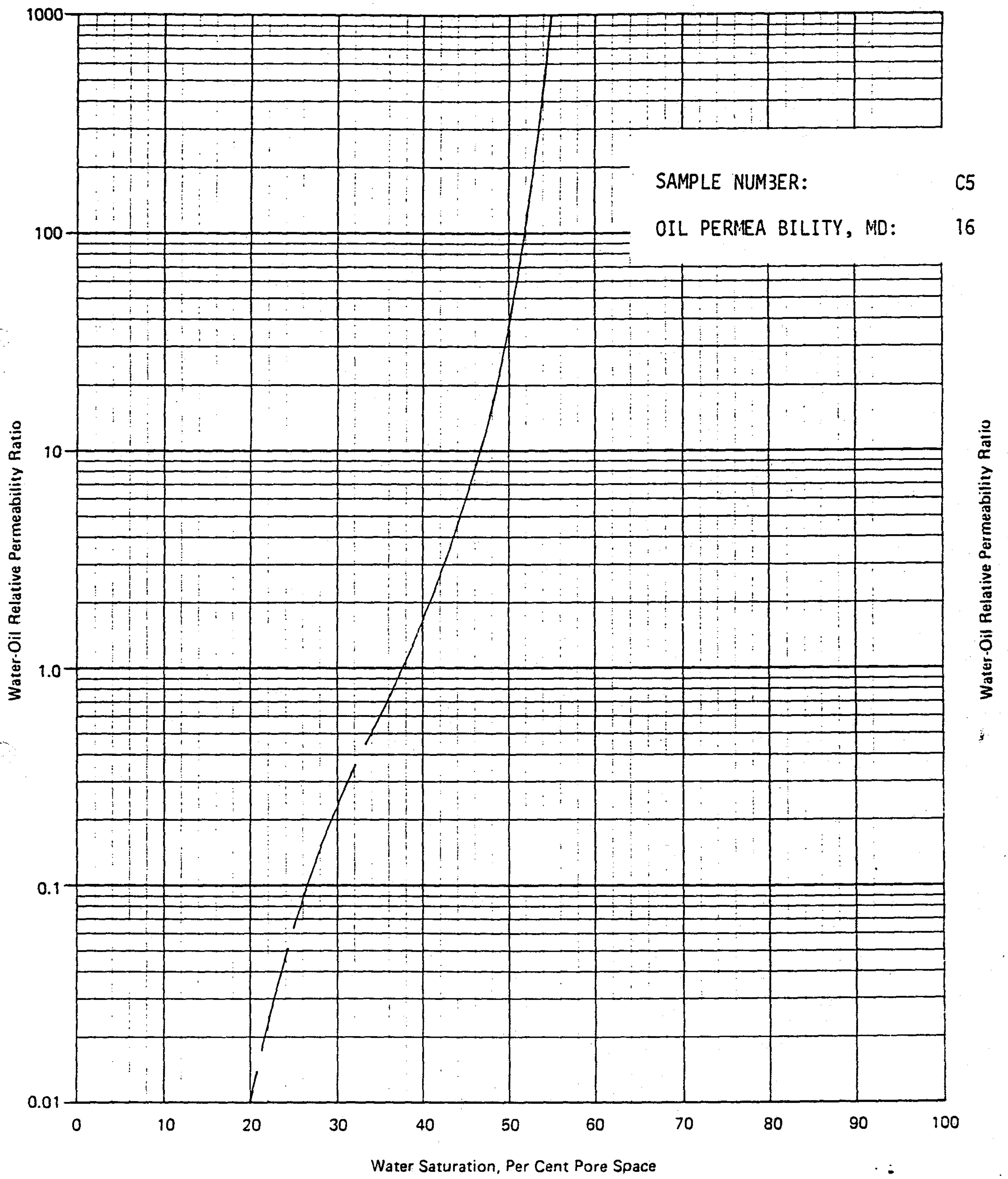
Country NORTH SEA
NORWAY



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Company STATOIL
Well 34/10-4
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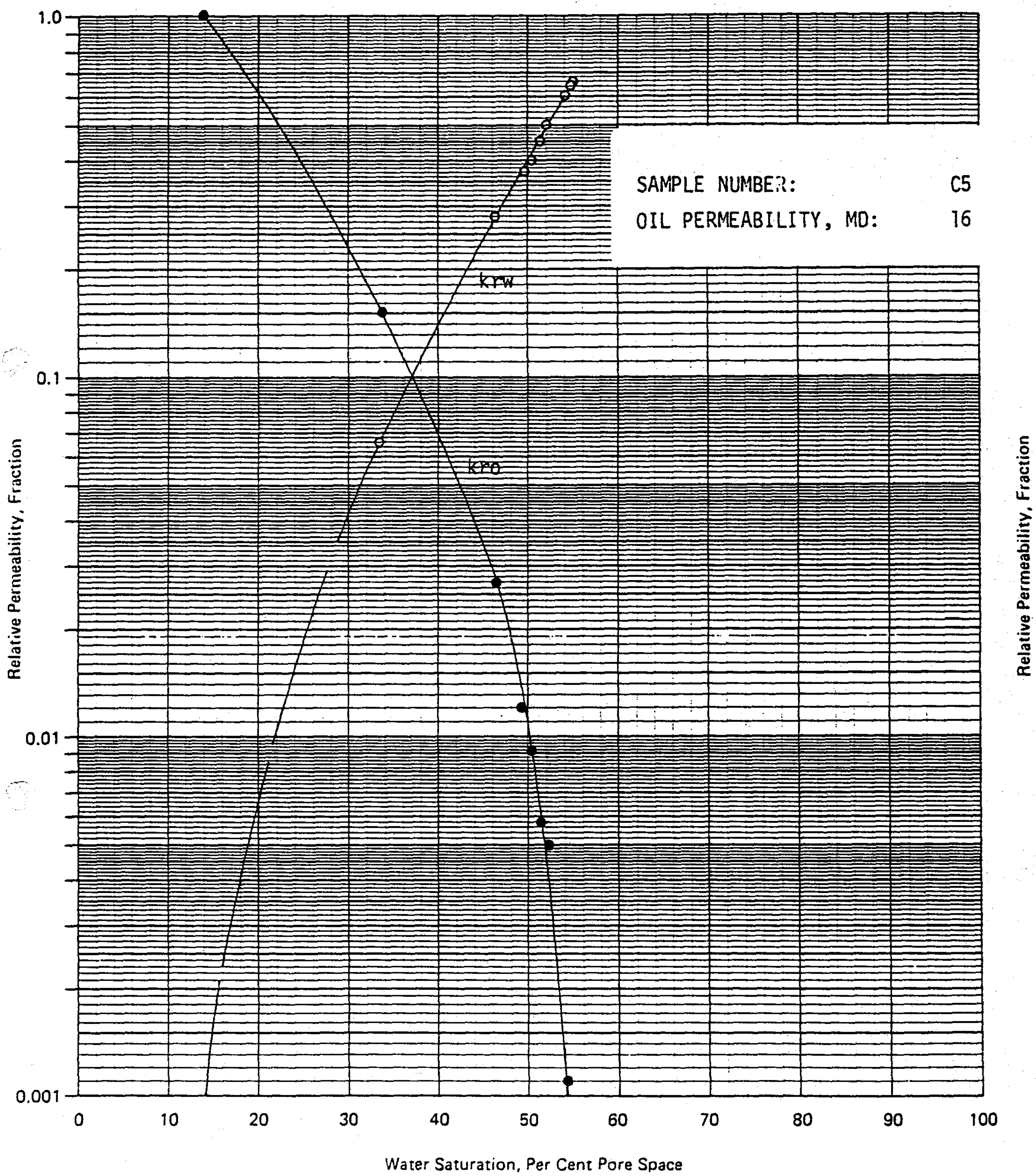

Company STATOIL
Well 34/10-4
Field
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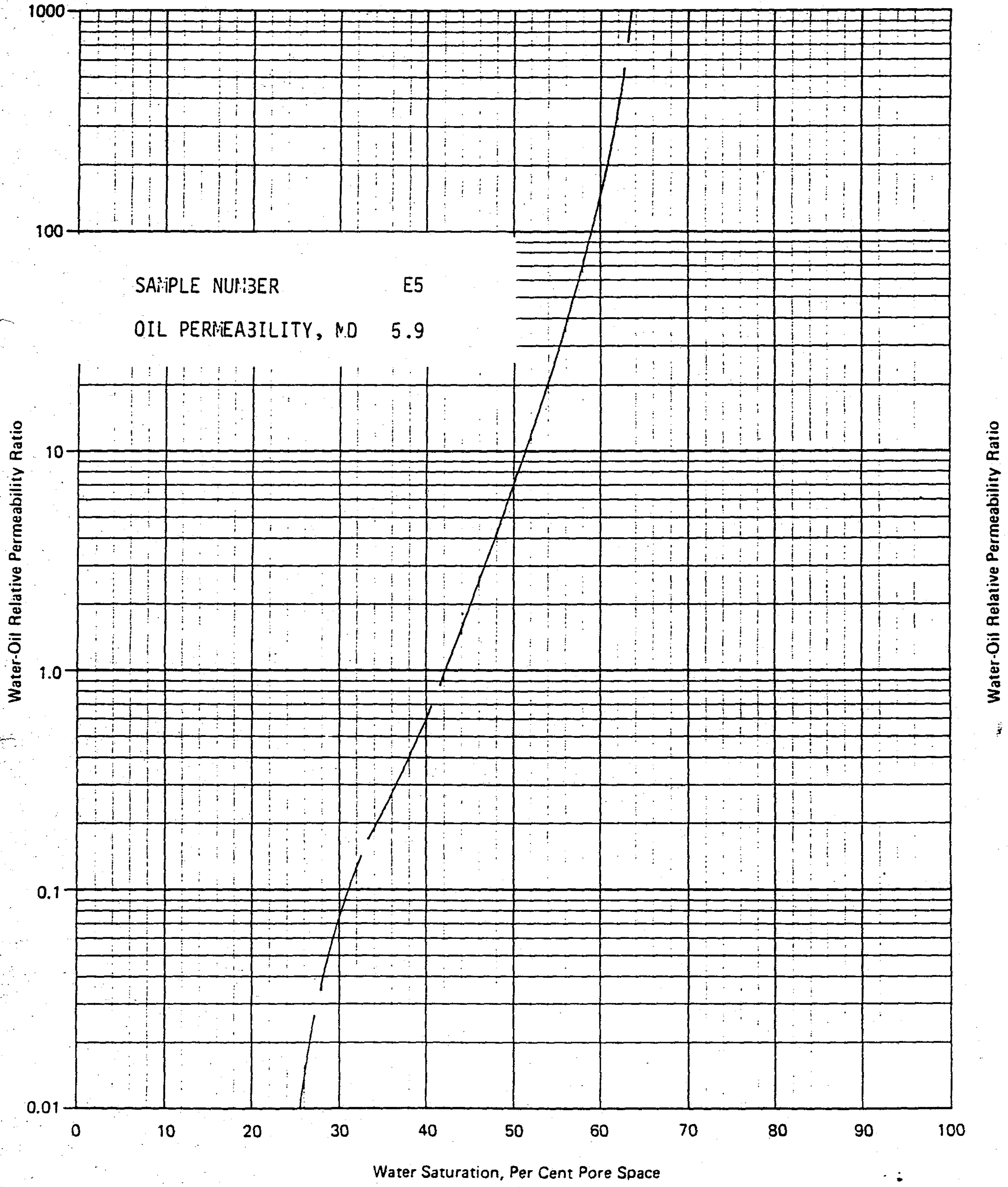

Company STATOIL
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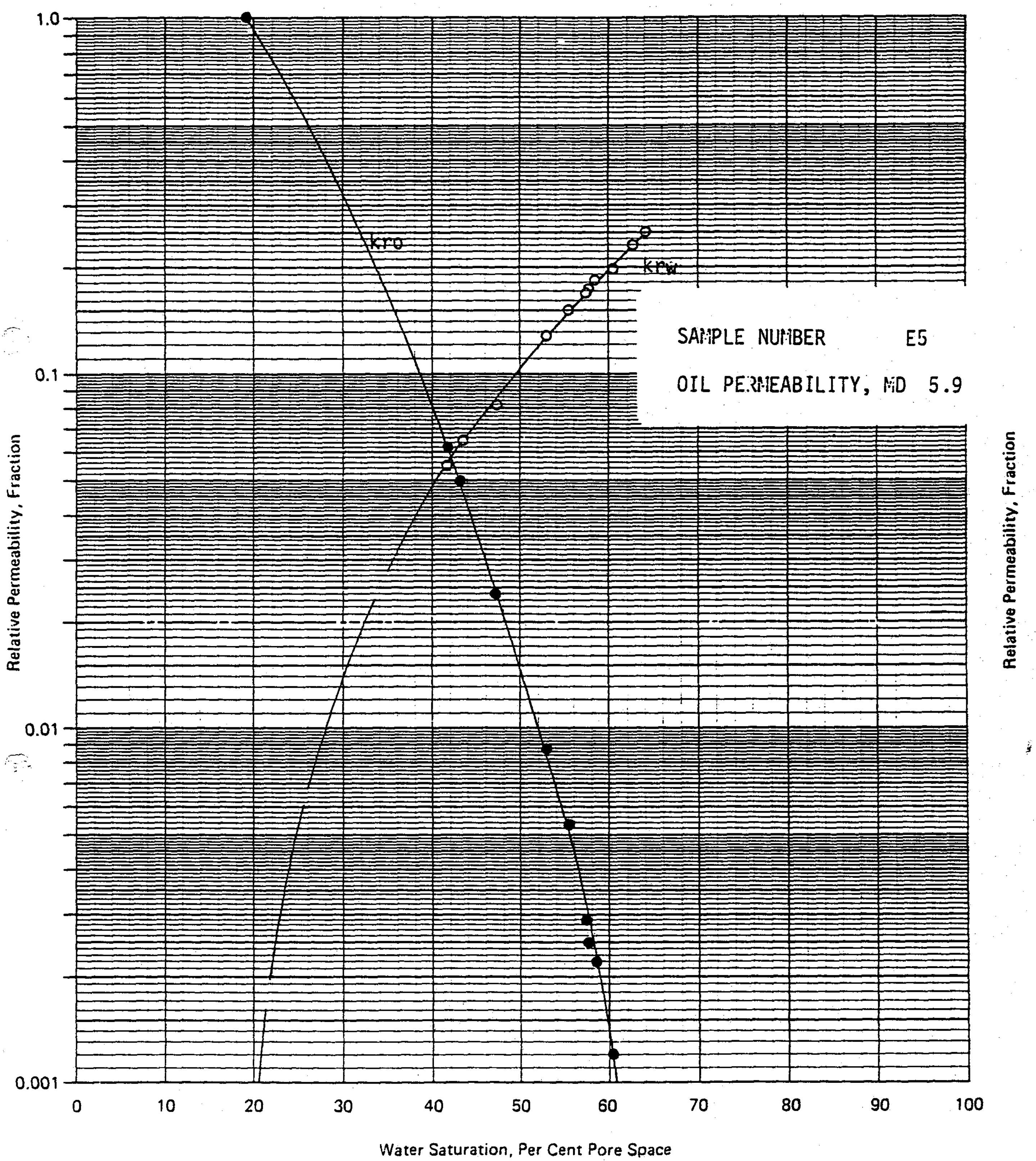

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LONDON—ABERDEEN

File: UKSCAL 7964

Water Permeability Data

Sample Number	Room Conditions		Reservoir Pressure	
	13.6 Bars Overburden	51.0 Bars Pressure	Room Temperature	Reservoir Temperature
B_1	1050	1030	827	455
C_1	850	827	751	729
D_1	849	810	804	345
E_1	460	429	445	275

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SUMMARY OF FRESH-STATE IMBIBITION AND DYNAMIC DISPLACEMENT
(AMOTT METHOD)

Initial Fluid Imbibed is Oil

Sample Number:	A3	B3	C3	D3	E3
Depth, Metres:	1836.09	1867.25	1869.20	1879.85	1889.40
Air Permeability, Md:	2100	1830	1500	1430	498
Porosity, Per Cent:	39.7	39.2	37.1	38.8	36.5
Immobile Water Saturation,* Per Cent Pore Space:	39.0	42.4	48.3	38.0	29.7
Oil Permeability, Md. At Immobile Water Saturation:	882	955	629	689	140
Water Imbibed Statically, Per Cent Pore Space:	18.9	12.9	1.0	14.1	4.8
Water Imbibed Dynamically, Per Cent Pore Space:	34.1	34.7	37.6	38.7	44.1
Total Water Imbibed, Per Cent Pore Space:	53.0	47.6	48.6	52.8	48.9
Immobile Oil Saturation,** Per Cent Pore Space:	11.5	14.8	10.5	14.2	32.6
Water Permeability, Md. At Immobile Oil Saturation:	343	261	202	234	66
Oil Imbibed Statically, Per Cent Pore Space:	3.7	4.0	5.2	4.8	6.2
Oil Imbibed Dynamically, Per Cent Pore Space:	45.9	38.8	36.0	43.0	31.5
Total Oil Imbibed, Per Cent Pore Space:	49.6	42.8	41.2	47.8	37.7
Wettability Index to Water:	0.357	0.271	0.226	0.267	0.098
Wettability Index to Oil:	0.075	0.093	0.126	0.100	0.164

* Water present just prior to water imbibition
** Oil present just prior to oil imbibition

$$\text{Wettability Index} = \frac{\text{Fluid Imbibed Statically}}{\text{Total Fluid Imbibed}}$$

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ROCK COMPRESSIBILITY DATA

Sample Number	Pressure, Bars Initial External	Effective Overburden	Pore Volume, cc	Bulk Volume, cc	Porosity, Per Cent	Compressibility, PV/PV/PSIX10^{-6} (1)	(2)
B2 (Rannoch)	361	13.6	20.40	53.35	38.2	-	-
		34.0	20.33	53.28	38.2	13.0	7.9
		68.0	20.20	53.15	38.0	13.6	8.3
		102.0	20.06	53.01	37.9	15.2	9.3
		136.1	19.90	52.85	37.7	17.3	10.6
		170.1	19.72	52.67	37.4	19.5	11.9
		204.1	19.51	52.46	37.2	21.8	13.3

(1) Measured in laboratory under hydrostatic Loading conditions.
(2) Uniaxial loading conditions, transformed from hydrostatic data as per Teeuw, Dirk: "Prediction of Formation Compaction from Laboratory Compressibility Data," Trans., AIME (1971) 251, 263-271.

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ROCK COMPRESSIBILITY DATA

Sample Number	Pressure, Bars: Initial External	Pressure, Bars: Effective Overburden	Pore Volume,cc	Bulk Volume,cc	Porosity, Per Cent	Compressibility,PV/PV/PSIX10^{-6} (1)	Compressibility,PV/PV/PSIX10^{-6} (2)
D2 (Rannoch)	361	13.6	13.37	35.24	37.9	-	-
		34.0	13.26	35.13	37.8	21.8	13.3
		68.0	13.15	35.02	37.5	17.6	10.7
		102.0	13.02	34.89	37.3	21.6	13.2
		136.1	12.87	34.74	37.0	24.7	15.1
		170.1	12.71	34.58	36.8	24.3	14.8
		204.1	12.56	34.43	36.5	22.5	13.7

(1) Measured in laboratory under hydrostatic Loading conditions.
(2) Uniaxial loading conditions, transformed from hydrostatic data as per Teeuw, Dirk: "Prediction of Formation Compaction from Laboratory Compressibility Data," Trans., AIME (1971) 251, 263-271.

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ROCK COMPRESSIBILITY DATA

Sample Number	Pressure, Bars Initial External	Pressure, Bars Effective Overburden	Pore Volume, cc	Bulk Volume, cc	Porosity, Per Cent	Compressibility, PV/PV/PSIX10^{-6} (1)	Compressibility, PV/PV/PSIX10^{-6} (2)
C2 Rannoch	361	13.6	21.31	56.34	37.8	-	-
		34.0	21.23	56.26	37.7	13.2	8.1
		68.0	21.09	56.12	37.6	12.3	7.5
		102.0	20.96	55.99	37.4	12.6	7.7
		136.1	20.83	55.86	37.3	14.0	8.5
		170.1	20.67	55.70	37.1	18.0	11.0
		204.1	20.46	55.49	36.9	21.6	13.2

(1) Measured in laboratory under hydrostatic Loading conditions.
(2) Uniaxial loading conditions, transformed from hydrostatic data as per Teeuw, Dirk: "Prediction of Formation Compaction from Laboratory Compressibility Data," Trans., AIME (1971) 251, 263-271.

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ROCK COMPRESSIBILITY DATA

Sample Number	Pressure, Bars: Initial External	Pressure, Bars: Effective Overburden	Pore Volume, cc	Bulk Volume, cc	Porosity, Per Cent	Compressibility, PV/PV/PSIX10^{-6} (1)	Compressibility, PV/PV/PSIX10^{-6} (2)
E2 (Rannoch)	361	13.6	15.43	45.90	33.6	-	-
		34.0	15.40	45.87	33.6	7.4	4.5
		68.0	15.34	45.81	33.5	8.4	5.1
		102.0	15.27	45.74	33.4	8.6	5.2
		136.1	15.20	45.67	33.3	9.3	5.7
		170.1	15.13	45.60	33.2	10.0	6.1
		204.1	15.05	45.52	33.1	11.6	7.1
		238.1	14.96	45.43	32.9	16.6	10.1
		272.1	14.81	45.28	32.7	36.2	22.1

(1) Measured in laboratory under hydrostatic Loading conditions.
(2) Uniaxial loading conditions, transformed from hydrostatic data as per Teeuw, Dirk: "Prediction of Formation Compaction from Laboratory Compressibility Data," Trans., AIME (1971) 251, 263-271.

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