

saskoel

WEST KIRKELLA AREA

Pressure Survey and Fluid Analysis

0954C

saskoïl

1500 Chateau Tower 1920 Broad Street
P.O. Box 1550
Regina, Saskatchewan S4P 3C4
Telephone (306) 565-7000

February 11, 1982

Manitoba Department of Energy and Mines
Mineral Resources Division
Petroleum Branch
989 Century Street
WINNIPEG, Manitoba
R3H 0W4

ATTENTION: Mr. L. Robert Dubreuil
Chief Petroleum Engineer

Dear Sir:

Re: Pressure Survey and Fluid Sample Analysis
West Kirkella Area

Attached for your inspection are the reservoir fluid study, water analysis, and pressure buildup study as requested.

A pressurized bottom hole fluid sample was obtained from 5-18-12-29 WPM and the corresponding PVT analysis is presented. The results of a separator test are shown and it is found that the stock tank oil gravity (at standard conditions) is 26.2 API. The gas/oil ratio measured is 1.77. The formation volume factor is 1.024. The saturation pressure is 586 kPa (gauge) at reservoir temperature.

An analysis of produced water from 13-18-12-29 WPM (sampled at wellhead) is attached. Some notable results are a resistivity of 0.170 ohm/meters at 25°C and a pH of 6.6.

A pressure buildup survey was conducted at 12-18 and 5-18-12-29 WPM. An extrapolated reservoir pressure of 983 psig (6775 kPag) is exhibited at 12-18. An average reservoir pressure of 987 psig (6805 kPag) is found for 5-18. Permeability is very high due to the fracture system present in the formation.

Saskatchewan Oil and Gas Corporation

A pressure buildup survey is proposed for the West Kirkella area this coming fall to assess the need for pressure maintenance.

If you have any questions regarding this submission please contact myself or Gene Kowch.

Yours truly,



R.M. Decker
Junior Petroleum Engineer

BD/tk

PVT Study

CORE LABORATORIES-CANADA, LTD.



1981-11-27

Saskatchewan Oil and Gas Corporation
1500, 1920 Broad Street
Regina, Saskatchewan
S4P 3V2

Attention: Mr. Bob Decker

Reservoir Fluid Study

Saskoil West Kirkella 5-18-12-29 (WIM)
West Kirkella Field, Manitoba, Canada
Our File Number: 7013-81-247

Gentlemen:

Subsurface samples of reservoir fluid were taken from the above subject well by a representative of Core Laboratories-Canada Ltd. on 1981-10-29 and submitted to our laboratory for a reservoir fluid study.

A portion of the reservoir fluid was transferred at high pressure to a high pressure-windowed cell and then heated at a constant pressure to the reported reservoir temperature of 28.9°C. The pressure-volume relations of the fluid were measured during a constant expansion down to 586 kPa (gauge). The saturation pressure was determined to be 586 kPa (gauge) at 28.9°C. The results of this test are shown on pages 1 and 2 of this report.

The viscosity of the fluid was determined at 28.9°C from 34 474 kPa (gauge) down to 689 kPa (gauge). This data is summarized on page 3.

One separator flash test was performed at 0 kPa (gauge) and 26.7°C. The results of this test are on page 4.

The composition of the reservoir fluid was determined by low temperature, fractional distillation and is shown on pages 5 and 6.

Thank you for the opportunity to perform this study for you. Should you have any questions concerning this data, please contact us.

Yours truly,

CORE LABORATORIES-CANADA LTD.

A handwritten signature in black ink, appearing to read "Tom B. Martin".

Tom B. Martin

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Petroleum Reservoir Engineering
 CALGARY, ALBERTA

Page 1 of 8
 File 7013-81-247
 Well Saskoil West
Kirkella 5-18-12-29 (W1M)

VOLUMETRIC DATA OF RESERVOIR FLUID SAMPLE

1. Saturation pressure (bubble point pressure) 586 kPa (gauge) @ 28.9 °C
2. Thermal expansion of saturated oil @ 34 474 kPa (gauge) = $\frac{V@ 28.9 \text{ °C}}{V@ 21.7 \text{ °C}}$ = 1.00500
3. Density at saturation pressure: 889.2 kg/m³ @ 28.9 °C
4. Compressibility of saturated oil @ reservoir temperature: Vol/Vol/MPa:

| | | | | | |
|------|---------------|--------|---------------|-------|---|
| From | <u>586</u> | kPa to | <u>3 447</u> | kPa = | <u>8.41×10^{-4}</u> |
| From | <u>3 447</u> | kPa to | <u>6 895</u> | kPa = | <u>6.70×10^{-4}</u> |
| From | <u>6 895</u> | kPa to | <u>13 790</u> | kPa = | <u>6.44×10^{-4}</u> |
| From | <u>13 790</u> | kPa to | <u>20 684</u> | kPa = | <u>6.03×10^{-4}</u> |
| From | <u>20 684</u> | kPa to | <u>27 579</u> | kPa = | <u>5.76×10^{-4}</u> |
| From | <u>27 579</u> | kPa to | <u>34 474</u> | kPa = | <u>5.63×10^{-4}</u> |

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Petroleum Reservoir Engineering
CALGARY, ALBERTA

Page 2 of 8
File 7013-81-247
Well Saskoil West Kirkella
5-18-12-29 (W1M)

PRESSURE-VOLUME RELATIONS AT 28.9°C

| <u>Gauge Pressure, kPa</u> | <u>Relative Volume, V/Vsat (1)</u> |
|------------------------------------|--|
| 34 474 | 0.9791 |
| 31 026 | 0.9810 |
| 27 579 | 0.9829 |
| 24 132 | 0.9849 |
| 20 684 | 0.9868 |
| 17 237 | 0.9888 |
| 13 790 | 0.9909 |
| 10 342 | 0.9930 |
| 6 895 | 0.9953 |
| 3 447 | 0.9976 |
| 2 758 | 0.9981 |
| 2 068 | 0.9987 |
| <u>586</u> | <u>1.0000</u> |

(1) Cubic metres at indicated pressure and temperature per cubic meter of saturated oil.

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Page 3 of 8
File 7013-81-247
Well Saskoil West
Kirkella 5-18-12-29 (W1M)

VISCOSITY AT 28.9°C

| <u>Gauge Pressure, kPa</u> | <u>Oil Viscosity, mPa·s</u> |
|------------------------------------|---------------------------------|
| 34 474 | 35.871 |
| 31 026 | 33.923 |
| 27 579 | 31.881 |
| 24 132 | 29.885 |
| 20 684 | 27.840 |
| 17 237 | 25.842 |
| 13 790 | 23.890 |
| 10 342 | 21.843 |
| 6 895 | 19.842 |
| 3 447 | 17.887 |
| 689 | 16.350 |

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Page 4 of 8
 File 7013-81-247
 Well Saskoil West
Kirkella 5-18-12-29 (W1M)

SEPARATOR TEST OF RESERVOIR FLUID SAMPLE

| Separator Gauge Pressure, kPa | Separator Temperature °C | Gas/Oil Ratio (1) | Gas/Oil Ratio (2) | Stock Tank Oil Gravity, °API @ 15.56°C | Formation Volume Factor (3) | Separator Volume Factor (4) | Relative Density of Liberated Gas (AIR = 1.000) |
|-------------------------------|--------------------------|-------------------|-------------------|--|-----------------------------|-----------------------------|---|
| 0 | 26.7 | 1.77 | 1.77 | 26.2 | 1.024 | 1.008 | 1.140 |
| | | | — | | | | |
| | Total | | 1.77 | | | | |

- (1) Cubic metres of gas @ 101.325 kPa (absolute) and 15°C per cubic metre of oil @ indicated pressure and temperature.
- (2) Cubic metres of gas @ 101.325 kPa (absolute) and 15°C per cubic metre of stock tank oil @ 15°C.
- (3) Cubic metres of saturated oil @ 586 kPa (gauge) and 28.9 °C per cubic metre of stock tank oil @ 15°C.
- (4) Cubic metres of oil @ indicated pressure and temperature per cubic metre of stock tank oil @ 15°C.

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COMPANY Saskatchewan Oil and Gas Corporation
 LOCATION LSD 5-18-12-29 W1M
 SAMPLED FROM Bottom Hole

PAGE 6 of 8
 FILE 7013-81-247

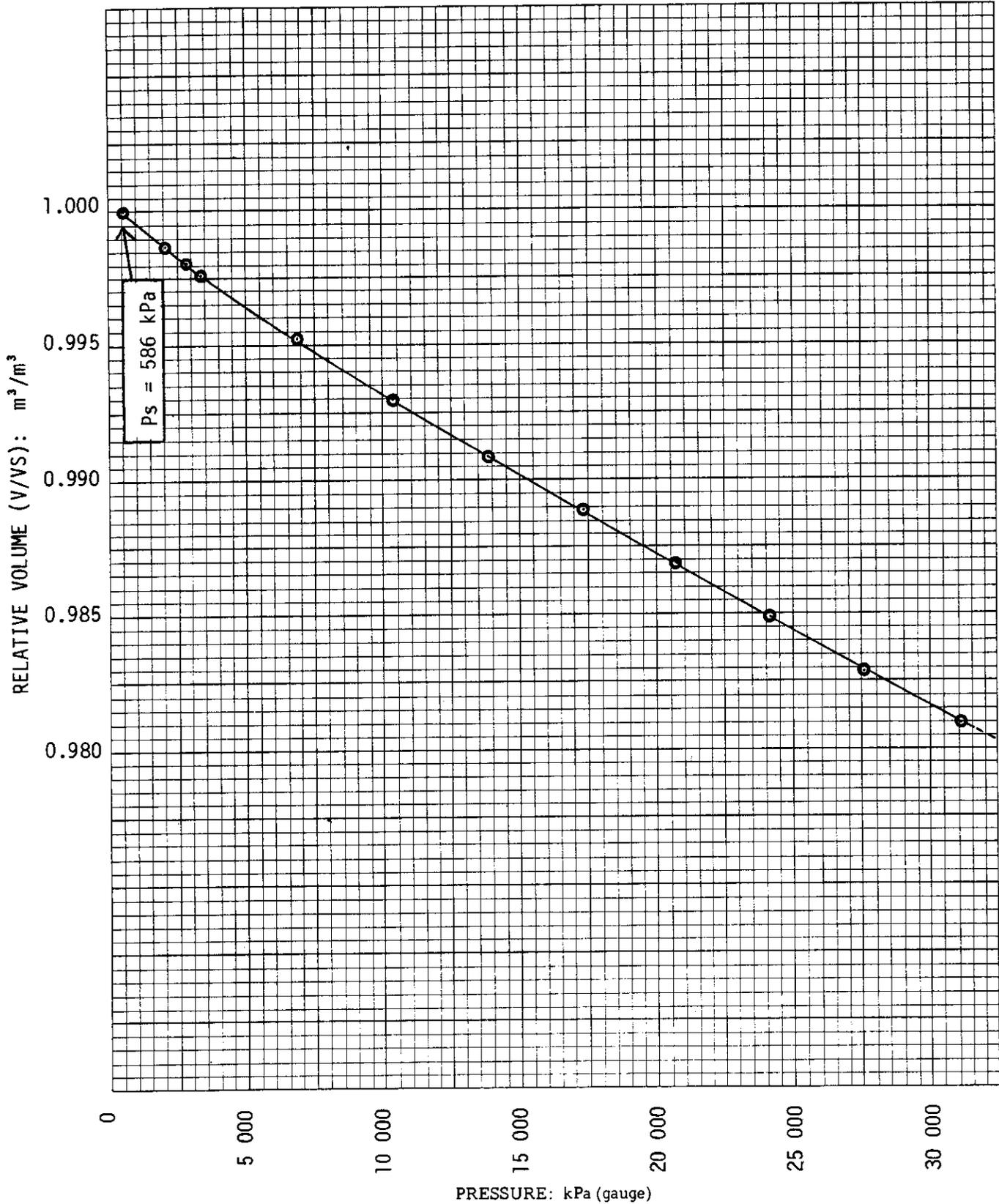
Analysis of C₆+ Fraction to C₃₀+

| <u>Boiling Point Range (°C)</u> | <u>Component</u> | <u>Carbon Number</u> | <u>Mole Fraction</u> | <u>Mass Fraction</u> |
|---------------------------------|---|--------------------------------|----------------------|----------------------|
| 36.1- 68.9 | Hexanes | C ₆ | .0149 | .0055 |
| 68.9- 98.3 | Heptanes | C ₇ | .0376 | .0160 |
| 98.3-125.6 | Octanes | C ₈ | .0504 | .0244 |
| 125.6-150.6 | Nonanes | C ₉ | .0445 | .0242 |
| 150.6-173.9 | Decanes | C ₁₀ | .0498 | .0300 |
| 173.9-196.1 | Undecanes | C ₁₁ | .0484 | .0321 |
| 196.1-215.0 | Dodecanes | C ₁₂ | .0470 | .0339 |
| 215.0-235.0 | Tridecanes | C ₁₃ | .0407 | .0318 |
| 235.0-252.2 | Tetradecanes | C ₁₄ | .0452 | .0380 |
| 252.2-270.6 | Pentadecanes | C ₁₅ | .0374 | .0337 |
| 270.6-287.8 | Hexadecanes | C ₁₆ | .0384 | .0369 |
| 287.8-302.8 | Heptadecanes | C ₁₇ | .0289 | .0295 |
| 302.8-317.2 | Octadecanes | C ₁₈ | .0313 | .0338 |
| 317.2-330.0 | Nonadecanes | C ₁₉ | .0274 | .0311 |
| 330.0-344.4 | Eicosanes | C ₂₀ | .0228 | .0274 |
| 344.4-357.2 | Heneicosanes | C ₂₁ | .0218 | .0273 |
| 357.2-369.4 | Docosanes | C ₂₂ | .0189 | .0249 |
| 369.4-380.0 | Tricosanes | C ₂₃ | .0182 | .0251 |
| 380.0-391.1 | Tetracosanes | C ₂₄ | .0151 | .0217 |
| 391.1-401.7 | Pentacosanes | C ₂₅ | .0139 | .0207 |
| 401.7-412.2 | Hexacosanes | C ₂₆ | .0125 | .0194 |
| 412.2-422.2 | Heptacosanes | C ₂₇ | .0117 | .0188 |
| 422.2-431.7 | Octacosanes | C ₂₈ | .0111 | .0186 |
| 431.7-441.1 | Nonacosanes | C ₂₉ | .0103 | .0179 |
| 441.1 Plus | Triacosanes Plus | C ₃₀ + | .1290 | .3280 |
| <u>AROMATICS</u> | | | | |
| 80.0 | Benzene | C ₆ H ₆ | .0011 | .0003 |
| 110.6 | Toluene | C ₇ H ₈ | .0054 | .0021 |
| 136.1-138.9 | Ethylbenzene, p + m-Xylene | C ₈ H ₁₀ | .0126 | .0057 |
| 144.4 | o-Xylene | C ₈ H ₁₀ | .0055 | .0025 |
| 168.9 | 1,2,4 Trimethylbenzene | C ₉ H ₁₂ | .0060 | .0030 |
| <u>NAPHTHENES</u> | | | | |
| 68.9 | Cyclopentane | C ₅ H ₁₀ | .0003 | .0001 |
| 72.2 | Methylcyclopentane | C ₆ H ₁₂ | .0074 | .0026 |
| 81.1 | Cyclohexane | C ₆ H ₁₂ | .0087 | .0031 |
| 101.1 | Methylcyclohexane | C ₇ H ₁₄ | .0117 | .0049 |
| | TOTAL | | .8859 | .9750 |
| | Mole Fraction of C ₇ + | | | .8535 |
| | Mass Fraction of C ₇ + | | | .9634 |
| | Calculated Relative Molecular Mass of C ₇ + | | | 278. |
| | Calculated Relative Density of C ₇ + | | | .9156 |
| | Calculated Density of C ₇ + (kg/m ³) | | | 914.7 |

The above boiling point ranges refer to the normal paraffin hydrocarbon boiling in that range. Other hydrocarbons (aromatics, olefins, naphthenes and branched hydrocarbons) may have higher or lower carbon numbers, but are grouped and reported according to their boiling point.

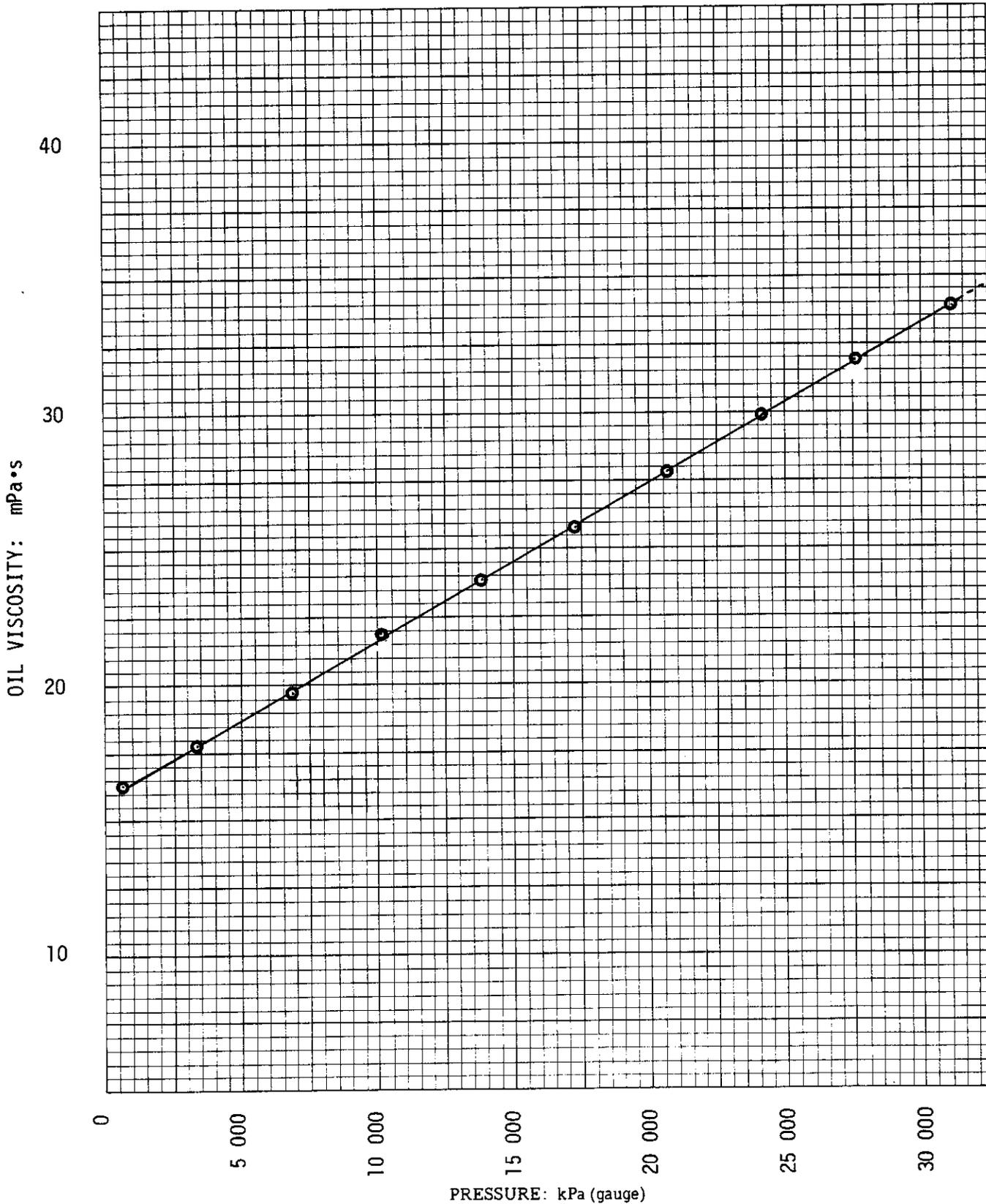
RELATIVE VOLUME (V/V_S) AT 28.9°C

| | | | |
|---------|--|-----------|----------|
| Company | Saskatchewan Oil and Gas Corporation | Formation | |
| Well | Saskoil West Kirkella 5-18-12-29 (W1M) | Province | Manitoba |
| Field | West Kirkella | Country | Canada |



OIL VISCOSITY AT 28.9°C

| | | | |
|---------|--|-----------|----------|
| Company | Saskatchewan Oil and Gas Corporation | Formation | |
| Well | Saskoil West Kirkella 5-18-12-29 (WIM) | Province | Manitoba |
| Field | West Kirkella | Country | Canada |



Water Analysis



CORE LABORATORIES - CANADA LTD.
Petroleum Reservoir Engineering
CALGARY ALBERTA



Plastic
CONTAINER IDENTITY

WATER ANALYSIS

7023-81-201
LABORATORY NUMBER

Saskatchewan Oil And Gas Corporation
OPERATOR

1 of 1
PAGE

LSD 13-18-29-1 W1M
LOCATION

West Kirkella 13-18-29-1
WELL OR SAMPLE LOCATION NAME

539.9 536.2
KB ELEV. GRD. ELEV.

Kirkella, Manitoba
FIELD OR AREA

Lower Daly
POOL OR ZONE

Bob Decker
SAMPLER

4 Litres of Water
TEST RECOVERY

TEST TYPE & NO.

Wellhead

POINT OF SAMPLE

AMT. & TYPE CUSHION

MUD RESISTIVITY ^{°C}

763.5 - 765

PUMPING FLOWING GAS LIFT SWAB

758.5 - 760.5

WATER m³/d OIL m³/d GAS m³/d

TEST INTERVALS OR PERFS.

SEPARATOR RESERVOIR

CONTAINER ^{°C}
WHEN SAMPLED

CONTAINER ^{°C}
WHEN RECEIVED

SEPARATOR

PRESSURES, KPa

TEMPERATURES, °C

81 10 29

81 11 02

81 11 02

SS

DATE SAMPLED (Y/M/D)

DATE RECEIVED (Y/M/D)

DATE ANALYSED (Y/M/D)

ANALYST

REMARKS

| ION | mg/L | mg Fraction | MEQ/L |
|-----|--------------|-------------|-------|
| Na | 12000 | .3174 | 522.0 |
| K | 310 | .0082 | 7.9 |
| Ca | 1366 | .0361 | 68.2 |
| Mg | 465 | .0123 | 38.3 |
| Ba | | | |
| Sr | | | |
| Fe | NOT DETECTED | | |
| | | | |

| ION | mg/L | mg Fraction | MEQ/L |
|------------------|---------|-------------|-------|
| Cl | 18944 | .5010 | 534.4 |
| Br | | | |
| I | | | |
| HCO ₃ | 978 | .0259 | 16.0 |
| SO ₄ | 3746 | .0991 | 78.0 |
| CO ₃ | 0 | .0000 | .0 |
| OH | 0 | .0000 | .0 |
| H ₂ S | PRESENT | | |

TOTAL SOLIDS mg/L

BY EVAPORATION @ 110°C BY EVAPORATION @ 180°C

37812

AT IGNITION

CALCULATED

1.0332 @ 15.4°C
SPECIFIC GRAVITY

1.3400 @ 25
REFRACTIVE INDEX

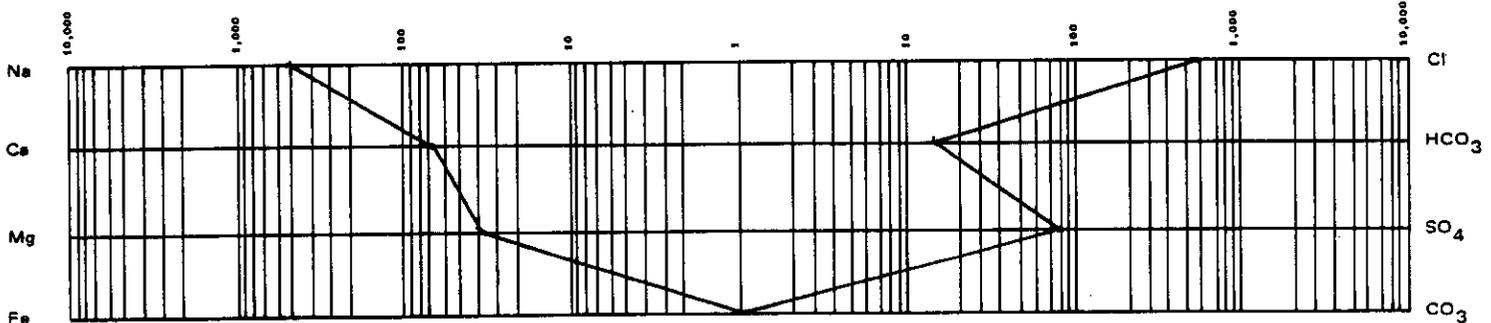
6.6

pH

.170 @ 25°C

RESISTIVITY (OHM/METERS)

LOGARITHMIC PATTERN MEQ PER LITRE



REMARKS

NaCl EQUIVALENT = 35623.

Pressure Survey

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Pressure Buildup Test

ANALYSIS

KIRKELLA FIELD

Daly Formation

Prepared By:
Gene Kowch, Dipl.T

Buildup Test

12-18-12-29 W1

CONCLUSION:

12-18 showed an extrapolated sandface pressure of 6775 Kpag. Comparison with virgin formation pressure from drillstem test analysis (May, 1981) shows no pressure depletion.

Based on PVT analysis values of 5-18, permeability calculations show a very high permeability of 42,505.9 md. This high value indicates a fractured formation, as confirmed by review of the $\log\Delta T - \log\Delta P$ line slope of 1:4.

ANALYSIS:

$$\text{Slope } m = 1 \text{ kpag/cycle} = 0.145 \text{ psig/cycle}$$

PERMEABILITY DATA: Data from PVT analysis on 5-18

$$\begin{aligned} q &= 43.45 \text{ BFPD} & C_t &= 6.7 \times 10^{-4} \text{ (psi}^{-1}\text{)} \\ \mu &= 19.569 \text{ cp} & B &= 1.024 \\ \phi &= 0.08 & h &= 7.0 \text{ m} = 22.97 \text{ ft.} \\ & & A &= 43,560 \text{ ft}^2 \end{aligned}$$

PIHR > Pwf . . . no slope change has occurred

PERMEABILITY:

$$\begin{aligned} K &= \frac{162.6 \text{ qmB}}{mh} = \frac{162.6(43.45)(19.569)(1.024)}{0.145(22.97)} \\ &= 42,505.968 \text{ md} \end{aligned}$$

Pressure Comparison :

Pressure Survey : July, 1981 Pextrapolated 6775 Kpag

DST Analysis : May, 1980 Pextrapolated 6565 Kpag

Because of the highly fractured nature of the formation, flow is not radial and may not be laminar. Darcy equations used with Horner Plot analysis yield only "relative" permeability value, indicative only that permeability is very high.

As the well was flowing to surface, pressure build-up rate was limited to the compressibility of the fluid. Running the bomb into a full wellbore for a pressure test achieved a gradient that was almost identical to that of the gradient test. The result is an extremely short build-up time that is not accurately analyzed by conventional methods.

A review of the log ΔT vs Log ΔP graph shows a slope of $\frac{1}{4}$, indicative of a fractured formation. (SPEJ Sept. 1981).

DATA SHEET
W. KIRKELLA 12-18

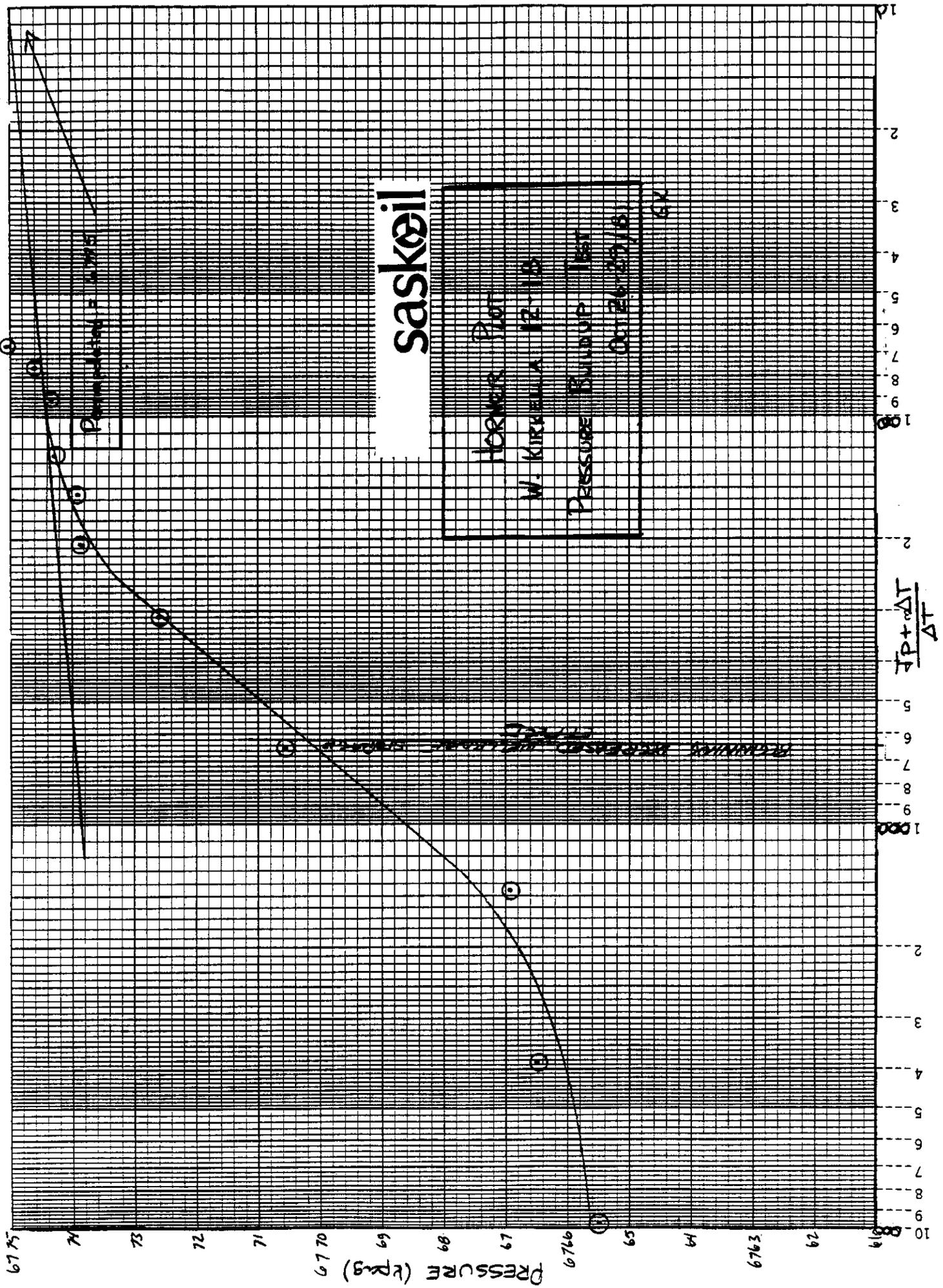
$T_p = 4932 \text{ L}$

| $\frac{T_p + \Delta T}{\Delta T}$ | ΔT (hrs) | P (Kpag) | ΔP (Kpag) |
|-----------------------------------|------------------|----------|-------------------|
| 24,661.0 | 0.2 | 6761.1 | 0 |
| 9,865.0 | 0.5 | 6765.6 | 4.5 |
| 3,289.0 | 1.5 | 6766.5 | 5.4 |
| 1,410.0 | 3.5 | 6766.9 | 5.8 |
| 658.6 | 7.5 | 6770.6 | 9.5 |
| 319.2 | 15.5 | 6772.7 | 11.6 |
| 210.9 | 23.5 | 6773.9 | 12.8 |
| 157.6 | 31.5 | 6773.9 | 12.8 |
| 125.9 | 39.5 | 6774.3 | 13.2 |
| 104.8 | 47.5 | 6774.3 | 13.2 |
| 89.9 | 55.5 | 6774.3 | 13.2 |
| 78.7 | 63.5 | 6774.7 | 13.6 |
| 69.8 | 71.7 | 6775.1 | 14.0 |

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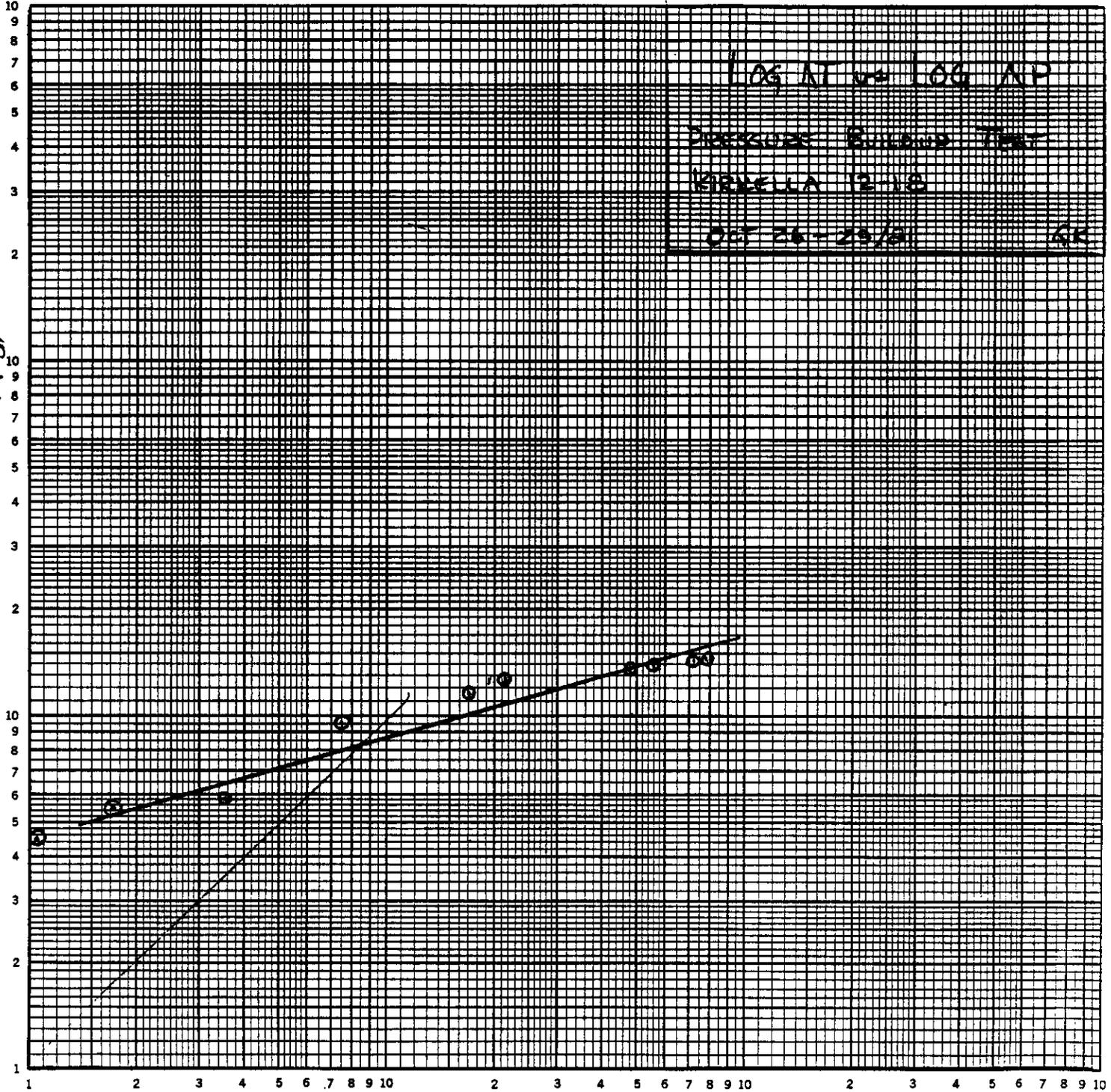
HERVORS PLOT
 W. KIRKALLA 12-13
 PRESSURE BUILDUP TEST
 OCT 26 1961
 6X

Pressure: 5.05



ΔP (kPa) 46 7402

K&S LOGARITHMIC 3 X 3 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.



7.5

ΔT (h)

BUILDUP TEST

5-18-12-29

PRESSURE BUILDUP TEST ANALYSIS

KIRKELLA 5-18

DISCUSSION:

Although the Horner Plot exhibits radical shape, it should be noted that there is only a 3.4 psig (22kpag) variance in pressure data. As the well is a flowing well, the sandface pressure was realized almost instantaneously once the recorder had reached run depth. Because there is no buildup curve to analyze, the only fact for report is that permeability is high, average pressure at sandface is 6805 Kpag, and no depletion in pressure is realized when DST data is compared to this figure.

saskoöl

HORNER PLOT
 KIRKELA 5-1B
 PRESSURE BUILDUP TEST

OCTOBER

