POINTED MOUNTAIN P-24

C-1

PRESSURE FALLOFF TEST

JUNE, 1977

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JUNE 1977, FALLOFF TEST

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POINTED MOUNTAIN P-24 (C-1)

INTRODUCTION

The Amoco Pointed Mountain P-24 (C-1) water disposal well was drilled from February 11 - March 26, 1972 to handle produced water from the Nahanni formation in the Pointed Mountain gas field. The well was completed on April 9, 1972 in the Mattson Sand over the intervals 3624' - 3644' KB, 3812' - 3854' KB, 4212' - 4250' KB, 4520' - 4566' KB, and 4930' - 5030' KB. Each interval was acidized after perforation. The well began injection on September 14, 1972.

The latest injectivity test conducted on April 7, 1976 showed an injection rate of 2880 BWPD at 2150 psig. The original test conducted on April 9, 1972 indicated that at 2150 psig wellhead pressure only about 1300 BWPD could be injected. The increase was concluded to be the result of fracturing. Also after the well has been on injection over a period in excess of 10 days a sudden pressure increase occurs. As a result of the above a pressure falloff test was conducted on the well from June 13-16, 1977 to further evaluate the reservoir properties. This report presents the data and calculations from this test.

SUMMARY

The pressure falloff test was conducted on the Pointed Mountain C-1 well to determine reservoir characteristics and explain the increase in injectivity indicated by the injectivity tests of April 9, 1972 and April 7, 1976.

A small fracture was indicated from the test with a slight wellbore improvement or negative skin damage shown. Another reason for the increase in injectivity could be attributed to the variation in the procedures when conducting the two injectivity tests. Increase in injection pressure after 10 days could be attributed to wellbore plugging as the injected water contained a black suspension of iron sulphide. The increase could also be caused by a reservoir boundary near the well, however, the data appears to be masked by skin damage in the wellbore. The static bottomhole pressure calculated to the M.P.P. depth of 4327' KB was 2500 psig.

The well was injecting at a rate of 605 BWPD at a pressure of 1822 psig prior to the test.

DISCUSSION

The pressure falloff test on the Pointed Mountain C-1 water disposal well was conducted by Northern Area and Pointed Mountain Plant personnel from June 13-16, 1977. Water injection samples were taken by the testing crews and forwarded to Chemical and Geological Laboratories Limited for analysis. Page B-1 is the completed water analysis. The injection rate prior to shut in was monitored through the existing metering facilities at the well.

During the test, bottomhole pressure recorders were not run. Consequently, care was

taken to ensure accurate measurement of surface data. The wellhead injection pressure was converted to a bottomhole pressure utilizing the "Flowing Pressure Gradients for Water Injection" graph from "Pressure Gradient Curves for Producing and Injection Wells" published by the Amoco Production Company Research Department. The recorded shut in surface pressures were converted to M.P.P. utilizing the gradient of the injected water.

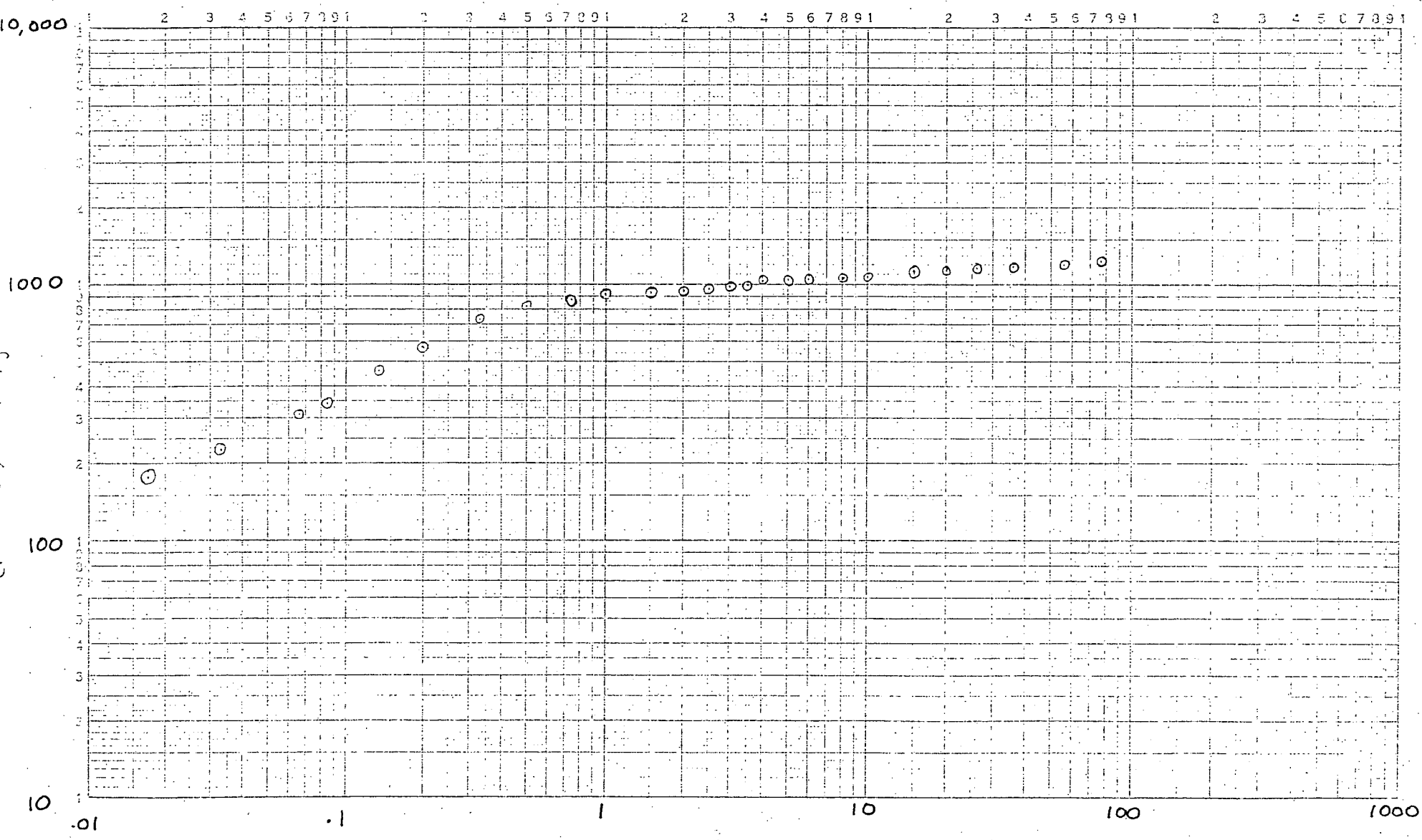
POINTED MOUNTAIN P-24 (C-1)

SURFACE PRESSURE (PSIG)	BOTTOMHOLE PRESSURE (PSIG)	(Pf-Ps) Δ P (PSIG)	SHUT IN TIME Δ T (HOURS)	SHUT IN TIME Δ T
1710	3615	180	0.017	0.13
1662	3567	228	0.033	0.18
1580	3485	310	0.067	0.26
1550	3455	340	0.083	0.29
1430	3335	460	0.133	0.36
1322	3227	568	0.20	0.45
1165	3070	725	0.33	0.57
1072	2977	818	0.50	0.71
1008	2913	882	0.75	0.87
986	2891	904	1.00	1.00
962	2867	928	1.50	1.22
936	2841	954	2.00	1.42
919	2824	971	2.50	1.58
910	2815	980	3.00	1.73
895	2800	995	3.50	1.87
883	2788	1007	4.00	2.00
875	2780	1015	4.50	2.12
867	2772	1023	5.00	2.24
860	2765	1030	5.50	2.35
853	2758	1037	6.00	2.45
846	2751	1044	6.50	2.55
841	2746	1049	7.00	2.65
836	2741	1054	7.50	2.74
830	2735	1060	8.00	2.83
821	2726	1069	9.00	3.00
810	2715	1080	10.00	3.16
802	2707	1088	11.00	3.32
794	2699	1096	12.00	3.46
786	2691	1104	13.00	3.61
778	2683	1112	14.00	3.74
771	2676	1119	15.00	3.87
764	2669	1126	16.00	4.00
758	2663	1132	17.00	4.12
754	2659	1136	18.00	4.24
750	2656	1139	19.00	4.36
746	2651	1144	20.00	4.47
743	2648	1147	21.00	4.58
740	2645	1150	22.00	4.69
738	2643	1152	23.00	4.80
735	2640	1155	24.00	4.90
730	2635	1160	26.00	5.10
725	2630	1165	28.00	5.29
722	2627	1168	30.00	5.48
718	2623	1172	32.00	5.66
715	2620	1175	34.00	5.83
712	2617	1178	36.00	6.00
709	2614	1181	38.00	6.16
706	2611	1184	40.00	6.32
703	2608	1187	42.00	6.48
701	2606	1189	44.00	6.63
699	2604	1191	46.00	6.78

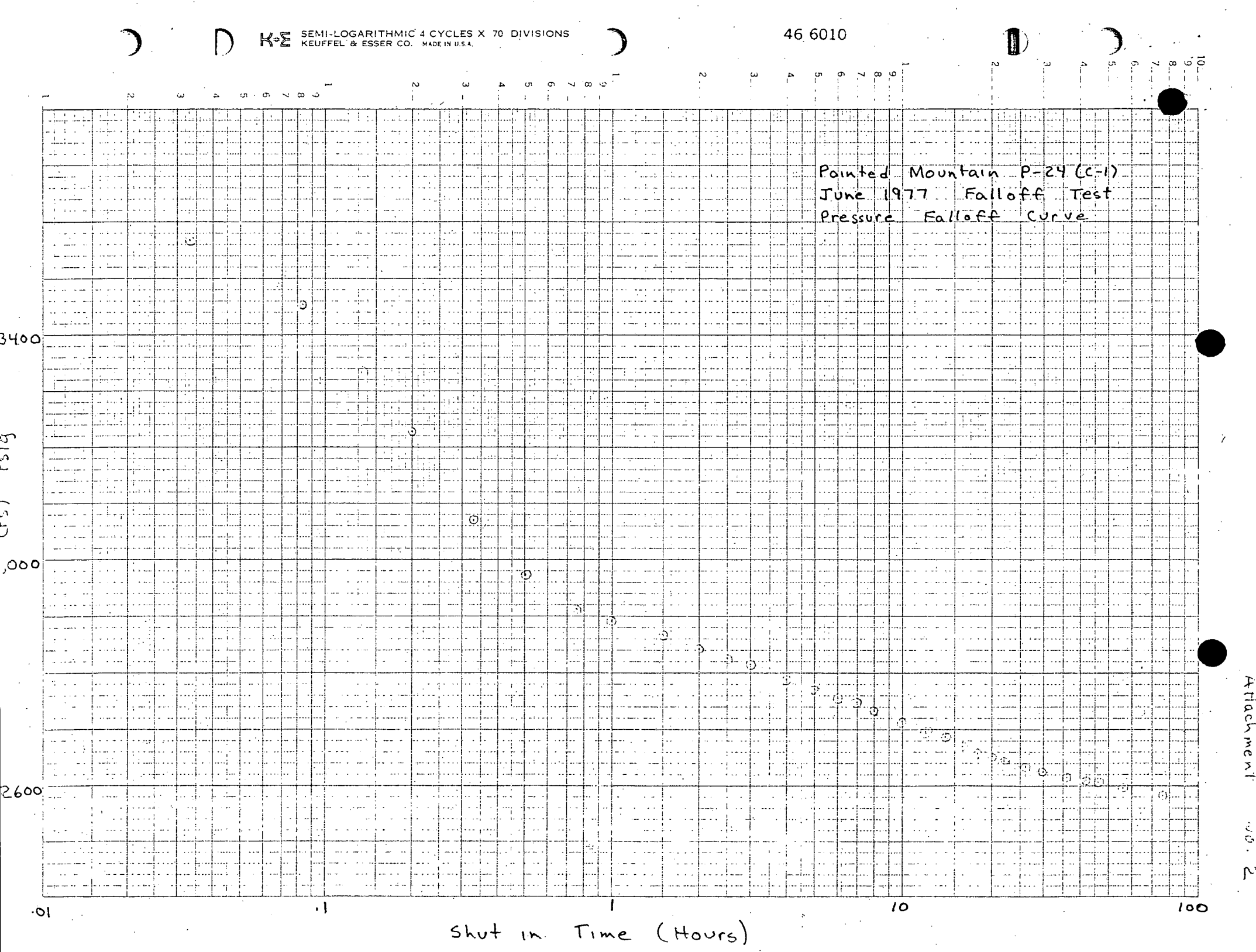
SURFACE PRESSURE (PSIG)	BOTTOMHOLE PRESSURE (PSIG)	(Pf-Ps) Δ P (PSIG)	SHUT IN TIME Δ T (HOURS)	$\sqrt{\text{SHUT IN TIME } \Delta T}$
697	2602	1193	48.00	6.93
694	2599	1196	52.00	7.21
691	2596	1199	56.00	7.48
688	2593	1202	60.00	7.75
679	2584	1211	72.00	8.49
677	2582	1213	76.00	8.72

K+E LOGARITHMIC 46 7520
3 X 5 CYCLES MADE IN U.S.A.
KEUFFEL & ESSER CO.

Pointed Mountain P-24 (C-1)
June 1977 Falloff Test
Pressure Falloff Curve

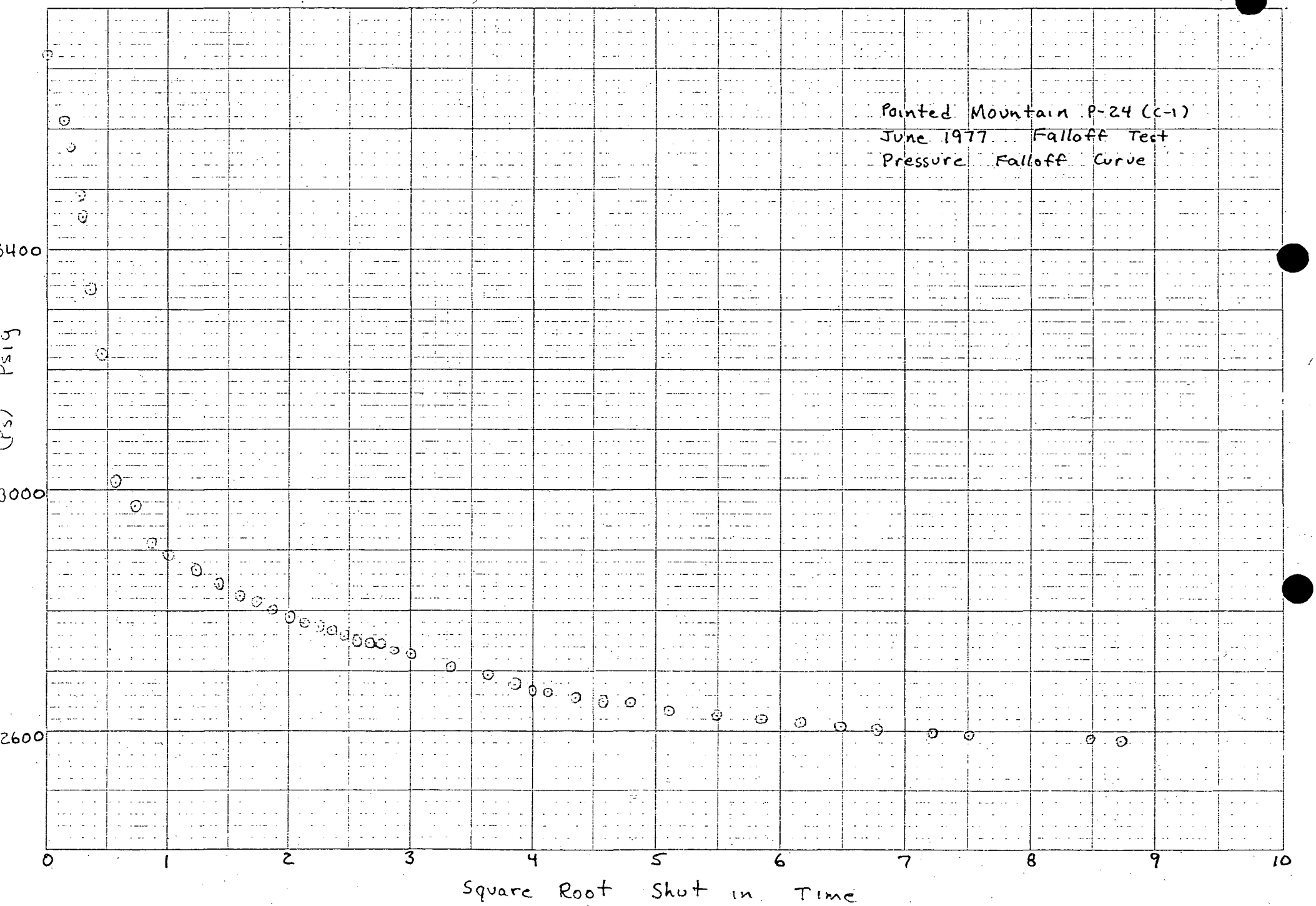


Attachment No. 1



Attachment No. 2

Pointed Mountain P-24 (C-1)
June 1977 Falloff Test
Pressure Falloff Curve



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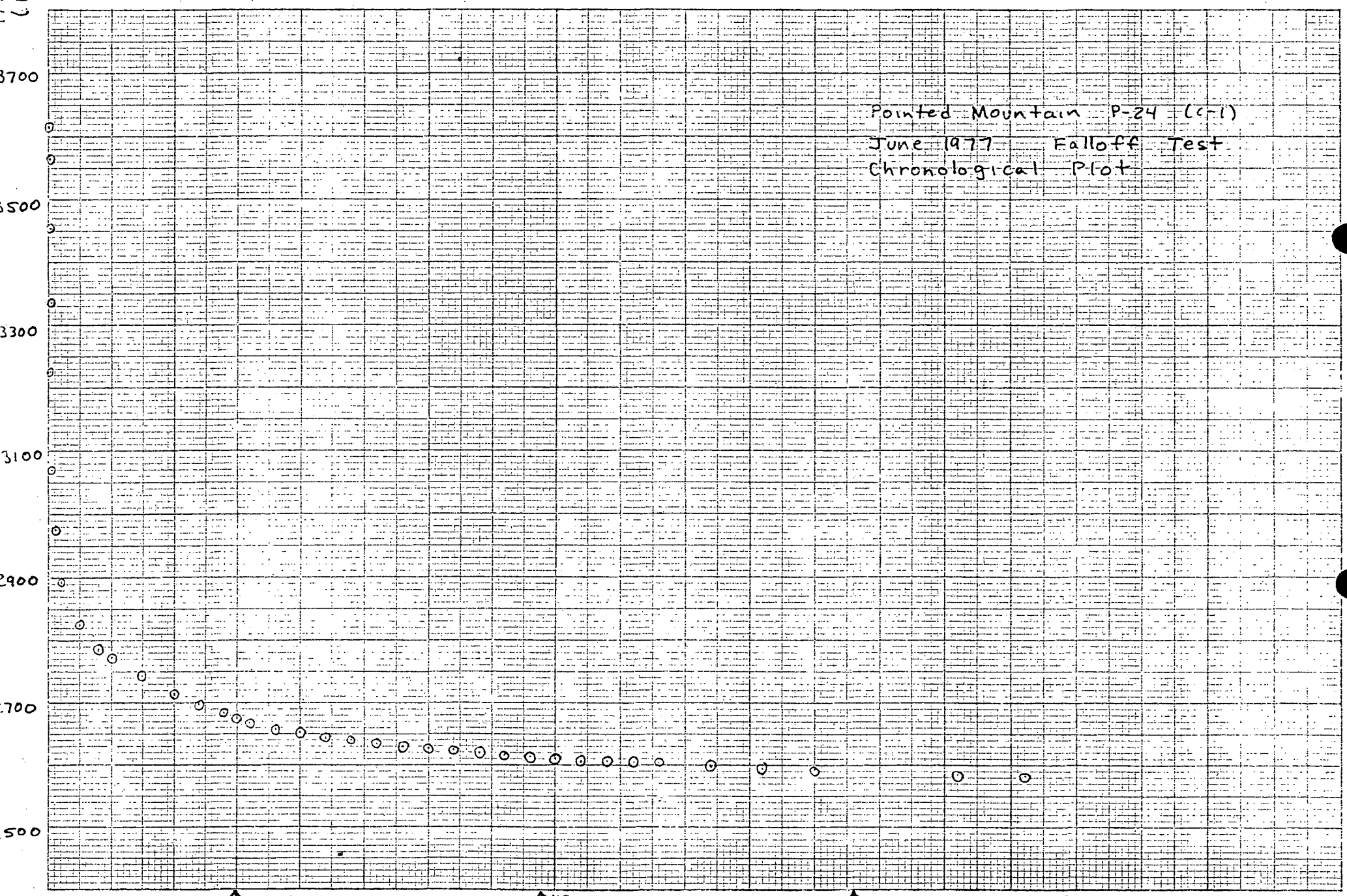


Attachment No 4

POINTED MOUNTAIN P-24 (C-1)
JUNE 1977, FALLOFF TEST

DATA AND CALCULATIONS

INJECTION DATA

Cumulative Injection - 775,396 BBLS
Injection rate prior to shut in - 605 BWPD

WELL DATA

rw = Well bore radius - 0.23 ft
h = Net thickness - 246 ft
u = Water viscosity - 0.7 cp
ϕ = Porosity - 0.05

ct = System compressibility
ct = cw + cr
ct = $2.75 \times 10^{-6} + 6.50 \times 10^{-6}$
ct = 9.25×10^{-6} psi^{-1}

Pf = Injecting pressure prior to shut in - 3795 psig

VERTICAL FRACTURE LENGTH

Slope m = 210 psi/log cycle
Slope ml = 1320 $psi/hour^{\frac{1}{2}}$

$$Lf = \frac{0.639}{ml} \sqrt{\frac{(qw)\ (m)}{(\phi)\ (h)\ (ct)}}$$

$$Lf = \frac{0.639}{1320} \sqrt{\frac{(605)\ (210)}{(.05)\ (246)\ (9.25 \times 10^{-6})}} = 16.2$$

INTERWELL Kh

$$Kwh = \frac{162.6\ (qw)\ (uw)}{m}$$

$$Kwh = \frac{162.6\ (605)\ (0.7)}{210} = 328$$

$$Kw = \frac{Kwh}{h}$$

$$Kw = \frac{328}{246} = 1.33 \text{ md}$$

LATERAL EXTENT OF RESERVOIR TEST COVERED

$$rinv = 0.0328 \sqrt{\frac{(Kw)\ (\Delta t)}{(\phi)\ (uw)\ (ct)}}$$

$$rinv = 0.0328 \sqrt{\frac{(1.33)\ (76)}{(.05)\ (0.7)\ (9.25 \times 10^{-6})}} = 580 \text{ ft}$$

SKIN FACTOR AND PRESSURE LOSS DUE TO SKIN

Plhr = 2920 psig

$$s = 1.151 \left[\frac{(Pwf - Plhr)}{m} - \log 10 \left(\frac{Kw}{(\phi)\ (uw)\ (ct)\ (rw^2)} \right) + 3.23 \right]$$

$$s = 1.151 \left[\frac{(3795 - 2920)}{210} - \log 10 \left(\frac{1.33}{(.05)\ (.7)\ (9.25 \times 10^{-6})\ (.23^2)} \right) + 3.23 \right]$$

$$s = 1.151\ (4.17 - 7.89 + 3.23) = -0.56$$

Δ P skin = 0.87 (m) (s)

Δ P skin = 0.87 (210) (-0.56) = -102

AVERAGE RESERVOIR PRESSURE

$$\text{Extrapolation Time} = \frac{379\ (\phi)\ (uw)\ (ct)\ (re^2)}{(Kw)}$$

$$\text{Extrapolation Time} = \frac{379\ (.05)\ (0.7)\ (9.25 \times 10^{-6})\ (1053^2)}{1.33}$$

= 102 hrs

Static Bottomhole Pressure = 2500 psig

INJECTIVITY INDEX

$$II = \frac{qw}{(Pf-Ps)} = \frac{605}{(3795 - 2500)} = 0.47$$

CONDITION RATIO

$$CR = \frac{2(m)\ (\log re/rw)}{(Pf-Ps)} = \frac{2(210)\ (\log \frac{1053}{.23})}{(3795 - 2500)} = 1.19$$

PSEUDO SKIN

Pseudo skin = 3795 - 3800 = -5 psig

CHEMICAL & GEOLOGICAL LABORATORIES LTD.

EDMONTON — FORT ST. JOHN — CALGARY

— WATER ANALYSIS —

CONTAINER IDENTITY

LABORATORY NUMBER
E77-6840

OPERATOR NAME AND ADDRESS
AMOCO CANADA PETROLEUM COMPANY LTD.

SAMPLE LOCATION

WELL OR SAMPLE LOCATION NAME
POINTED MTN. C-1 WATER INJ.

ELEVATIONS KB GRD

FIELD OR AREA

POOL OR ZONE

NAME OF SAMPLER

COMPANY

TEST TYPE & NO.

TEST RECOVERY

TEST INTERVAL OR PERFS

POINT OF SAMPLE

AMT. & TYPE OF CUSHION

MUD RESISTIVITY @ °F

TYPE OF PRODUCTION
PUMPING FLOWING GAS LIFT SWAB

PRODUCTION RATES
WATER BBLS/D OIL BBLS/D GAS MCF/D

PRESSURES - PSIG
SEPARATOR TREATER RESERVOIR CONTAINER WHEN SAMPLED WHEN RECEIVED

TEMPERATURES (°F)
SEPARATOR TREATER CONTAINER WHEN SAMPLED WHEN RECEIVED

DATE SAMPLED (D/M/Y) DATE RECEIVED (D/M/Y) DATE ANALYZED (D/M/Y) ANALYST REMARKS

15/06/77 21/06/77 A. MILLER

ION	MG/L	MG%	MEQ/L	ION	MG/L	MG%	MEQ/L
Na	5967	29.33	259.55	Cl	12260	60.27	345.73
K				Br			
Ca	1552	7.63	77.42	I			
Mg	190	0.93	15.58	HCO_3	207	1.02	3.40
Ba				SO_4	165	0.81	3.42
Sr				CO_3	NIL		
Fe	PRESENT			OH	NIL		
				H_2S	PRESENT		

TOTAL SOLIDS Mg/L

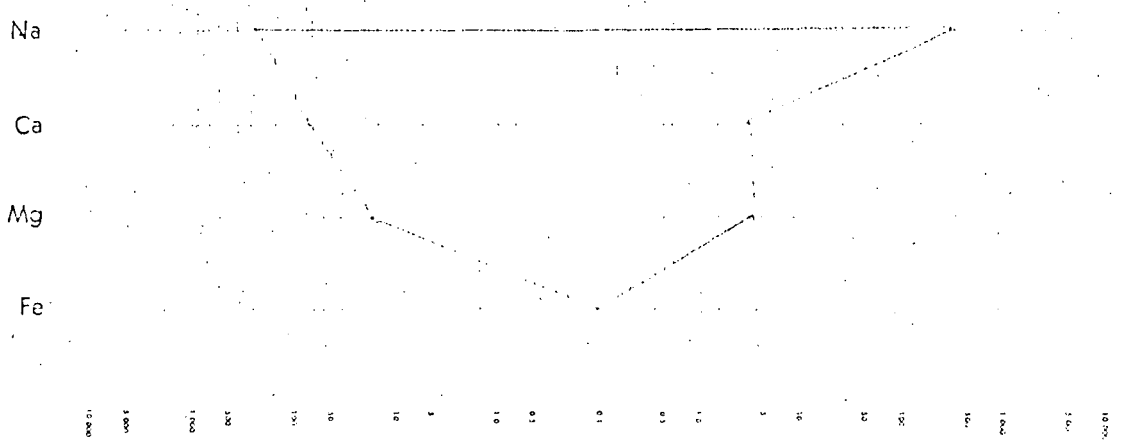
BY EVAPORATION @ 110°C: 21410
BY EVAPORATION @ 180°C:
AT IGNITION: 19165
CALCULATED: 20341

ORGANIC MATTER: PRESENT

SPECIFIC GRAVITY @ 60°F: 1.017
REFRACTIVE INDEX @ 25°C: 1.3364

OBSERVED PH: 6.8 @ 75 °F
RESISTIVITY (Ohm/meters) @ 25°C: 0.356

LOGARITHMIC PATTERN MEQ PER LITER



Remarks and Conclusions

The water had a black suspension of iron sulfide.

TEST DATA SHEET FOR PRESSURE FALLOFF TESTS

WELL NAME: Pointed Mountain C-1

DATE OF TEST: June 13, 1977 SHEET NO: 1

FLOWING CONDITIONS

PRESSURE - DEADWEIGHT: 1821

- RECORDED: 1825

TEMPERATURE: 100°F

RATE: .42 BBLS/min

SHUT-IN CONDITIONS

TIME	ΔT	TUBING PRESSURE DEADWEIGHT	TUBING PRESSURE RECORDED	TEMPERATURE
9:00	SI			
9:01	1 min	1710	1690	
9:02	2 min	1662	1650	
9:04	4 min	1580	1560	
9:05	5 min	1550		
9:08	8 min	1430	1425	
9:12	12 min	1322	1310	
9:20	20 min	1165	1160	

WELL NAME: Pointed Mountain C-1

DATE OF TEST: June 13, 1977 SHEET NO: 2

TIME	ΔT	TUBING PRESSURE DEADWEIGHT	TUBING PRESSURE RECORDED	TEMPERATURE
9:30	30 min	1072	1060	
9:45	45 min	1008	1000	
10:00	1 hr	986	970	
10:30	1½ hr	962	950	
11:00	2 hr	936	920	
11:30	2½	919	900	
12:00	3	910	890	
12:30	3½	895	870	
1:00	4	883	860	
1:30	4½	875	855	
2:00	5	867	850	
2:30	5½	860	845	
3:00	6	853	840	
3:30	6½	846	830	
4:00	7	841	825	
4:30	7½	836	815	
5:00	8	830	805	
6:00	9	821	800	
7:00	10	810	795	
8:00	11	802	780	

WELL NAME: Pointed Mountain C-1

DATE OF TEST: June 13 - 14, 1977 SHEET NO: 3

TIME	ΔT	TUBING PRESSURE DEADWEIGHT	TUBING PRESSURE RECORDED	TEMPERATURE
9:00	12	794	775	
10:00	13	786	765	
11:00	14	778	755	
12:00	15	771	750	
1:00	16	764	745	
2:00	17	758	740	
3:00	18	754	735	
4:00	19	750	730	
5:00	20	746	720	
6:00	21	743	715	
7:00	22	740	710	
8:00	23	738	710	
9:00	24	735	700	
11:00	26	730	700	
1:00	28	725	700	
3:00	30	722	700	
5:00	32	718	690	
7:00	34	715	690	
9:00	36	712	685	
11:00	38	709	685	

WELL NAME: Pointed Mountain C-1

DATE OF TEST: June 14 - 16, 1977 SHEET NO: 4

TIME	ΔT	TUBING PRESSURE DEADWEIGHT	TUBING PRESSURE RECORDED	TEMPERATURE
1:00	40	706	680	
3:00	42	703	680	
5:00	44	701	675	
7:00	46	699	675	
9:00	48	697	670	
1:00	52	694	670	
5:00	56	691	670	
9:00	60	688	665	
9:00	72	679	650	
1:00	76	677	650	