

OILFIELD RESEARCH LABORATORIES

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October 28, 1959

J. H. Wagner Drilling Company
P. O. Box 751
El Dorado, Kansas

Gentlemen:

Enclosed herewith is the report of the analysis of the 3½" Rotary core taken from the Musson Lease, Well No. 4, Cowley County, Kansas, and submitted to our laboratory on October 23, 1959.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES


Carl L. McElrea

CLM:cs

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10-34-3E

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GENERAL INFORMATION & SUMMARY

Company J. H. Wagner Drilling Company Lease Musson Well No. 4

Location SE $\frac{1}{4}$, SW $\frac{1}{4}$, SW $\frac{1}{4}$

Section 16 Twp. 34S Rge. 3E County Cowley State Kansas

Name of Sand	Bartlesville
Top of Core	3362.0
Bottom of Core	3395.0
Top of Sand	3372.0
Bottom of Sand	?
Total Feet of Permeable Sand	(Analyzed) 12.5
Total Feet of Floodable Sand	(Analyzed) 8.1

Distribution of Permeable Sand:
Permeability Range
Millidarcys

	Feet	Cum. Ft.
0 - 5	3.4	3.4
5 - 15	2.5	5.9
15 - 30	2.5	8.4
30 - 60	1.7	10.1
60 & above	2.4	12.5

Average Permeability Millidarcys	29.5
Average Percent Porosity	17.4
Average Percent Oil Saturation	12.4
Average Percent Water Saturation	61.9
Average Oil Content, Bbls./A. Ft.	169.
Total Oil Content, Bbls./Acre	2,161.
Average Percent Oil Recovery by Laboratory Flooding Tests	1.0
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	15.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	18.
Total Calculated Oil Recovery, Bbls./Acre	2,050.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

A fresh water mud was used as the circulating fluid during the coring of the sand.

Samples were taken from the core and sealed in cans by a representative of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

<u>Depth Interval, Feet</u>	<u>Description</u>
3362.0 - 3366.6	- Shale.
3366.6 - 3371.5	- Gray shaley sandstone.
3371.5 - 3372.0	- Shale.
3372.0 - 3378.3	- Grayish light brown slightly shaley sandstone.
3378.3 - 3378.7	- Gray laminated shaley sandstone.
3378.7 - 3389.8	- Grayish light brown slightly shaley sandstone.
3389.8 - 3394.1	- Gray shaley sandstone.
3394.1 - 3395.0	- Grayish light brown slightly shaley sandstone.

Coring was started at a depth of 3362.0 feet in shale and completed at 3395.0 feet in grayish light brown slightly shaley sandstone. This core shows a total of 23.0 feet of sandstone. For the most part, the pay is made up of grayish light brown slightly shaley sandstone.

PERMEABILITY

For the sake of distribution, the core was divided into two sections. The weighted average permeability of the upper and lower sections is 41.0 and 9.0 millidarcys respectively; the overall average being 29.5 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has an irregular permeability profile. The permeability of the sand varies from 0.57 to a maximum of 129 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a low weighted average percent oil saturation, namely, 12.4. The weighted average percent oil saturation of the upper and lower sections is 12.9 and 11.4 respectively. The weighted average percent water saturation of the upper and lower sections is 61.3 and 63.4 respectively; the overall average being 61.9 (See Table III). This gives an overall weighted average total fluid saturation of 74.3 percent. This low total fluid saturation indicates considerable fluid was lost during coring, part of which probably was oil.

In an effort to determine whether or not any flushing of the sand occurred during coring, all of the saturation samples were analyzed for chloride content. The results of these tests are given in Tables VI and VII. From the data given in these tables and on the coregraph, it is evident that considerable flushing did occur during coring, as the water in the sand in the zones of higher permeability had the lower chloride content.

The weighted average oil content of the upper and lower sections is 184 and 144 barrels per acre foot respectively; the overall average being 169. The total oil content, as shown by this core, is 2,161 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

Because of the low oil saturation one could not expect the sand in this core to respond satisfactorily to laboratory flooding tests. However, a total recovery of 18 barrels of oil per acre was obtained from 1.2 feet of sand, represented by one sample. The percent oil saturation was reduced from 19.0 to 18.0, or represents a recovery of 1.0 percent. The effective permeability of the sample is 5.95 millidarcys, while the

initial fluid production pressure is 20 pounds per square inch (See Table IV).

By observing the data given in Table IV, you will note that of the 11 samples tested, 9 produced water and 1 oil. This indicates that approximately 82 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a fairly uniform effective permeability.

CONCLUSION

From a study of the enclosed data, we believe that efficient primary production methods will recover approximately 1,150 barrels of oil per acre from the area represented by this core. Efficient repressuring of the reservoir within the vicinity of this well should recover an additional 900 barrels of oil per acre, or an average of 111 barrels of oil per acre foot from the 8.1 feet of floodable sand analyzed. The following factors and assumptions were used in calculating these recoveries:

Original formation volume factor	1.21
True water saturation, percent	43.0
Primary oil recovery	None
Calculated present oil saturation, percent	47.1
Porosity, percent	18.0
Oil saturation at abandonment, percent	20.0
Performance factor, percent	55.0

The sand in the cored section has low oil and high water saturations and good permeability for the depth. It is evident from the analysis results that the oil saturation was reduced to residual values during coring.

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RESULTS OF PERMEABILITY TESTS

TABLE I

Company J. H. Wagner Drilling Company Lease Musson Well No. 4

Sample No.	Depth Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	3373.9	47.	0.7	0.7	32.90
2	3374.4	66.	0.5	1.2	33.00
3	3375.9	7.4	0.7	1.9	5.18
4	3376.4	1.8	0.5	2.4	0.90
5	3377.9	3.7	0.8	3.2	2.96
6	3378.4	Imp.	0.4	3.6	0.00
7	3379.9	1.4	0.7	4.3	0.98
8	3380.4	24.	0.5	4.8	12.00
9	3381.9	84.	0.7	5.5	58.80
10	3382.4	48.	0.5	6.0	24.00
11	3383.9	22.	0.7	6.7	15.40
12	3384.4	41.	0.5	7.2	20.50
13	3385.9	129.	0.7	7.9	90.30
14	3386.4	62.	0.5	8.4	31.00
15	3387.9	6.5	0.7	9.1	4.55
16	3388.4	4.8	0.5	9.6	2.40
17	3389.9	0.57	0.4	10.0	0.23
18	3390.4	9.2	0.5	10.5	4.60
19	3391.9	18.	0.7	11.2	12.60
20	3392.4	3.3	0.5	11.7	1.65
21	3393.9	9.0	0.6	12.3	5.40
22	3394.4	15.	0.6	12.9	9.00

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RESULTS OF SATURATION TESTS

TABLE II

Company J. H. Wagner Drilling Company Lease Musson Well No. 4

Sat. No.	Depth, Feet	Effective Porosity Percent	Percent Saturation		Oil Content Bbls./A. Ft.	Feet of Core		Total Oil Content Bbls./Acre
			Oil	Water		Total	Ft.	
2	3374.1	22.6	10	59	175	1.2	1.2	210
4	3376.1	18.1	13	63	183	1.2	2.4	220
6	3378.1	15.6	11	65	133	0.8	3.2	106
8	3380.1	16.0	9	62	112	1.2	4.4	134
10	3382.1	18.7	19	52	276	1.2	5.6	332
12	3384.1	17.6	14	66	191	1.2	6.8	229
14	3386.1	18.3	14	63	199	1.2	8.0	239
16	3388.1	15.7	16	55	195	1.2	9.2	234
18	3390.1	14.3	7	75	78	0.9	10.1	70
20	3392.1	16.6	9	70	116	1.2	11.3	139
F-22	3394.0	15.4	2	-	24	0.6	11.9	14
22	3394.2	17.6	19	54	260	0.9	12.8	234
Total								2,161

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company J. H. Wagner Drilling Company Lease Musson Well No. 4

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
3373.5 - 3386.7	8.0	41.0	327.92
3387.5 - 3394.7	4.5	9.0	40.43
3373.5 - 3394.7	12.5	29.5	368.35

Depth Interval, Feet	Feet of Core Analyzed	Average Percent Porosity	Average Percent Oil Saturation	Average Percent Water Saturation	Average Oil Content Bbl./A. Ft.	Total Oil Content Bbls./Acre
3373.5 - 3386.7	8.0	18.2	12.9	61.2	184	1,470
3387.5 - 3395.0	4.8	15.9	11.4	63.4	444	691
3373.5 - 3395.0	12.8	17.4	12.4	61.9	169	2,161

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company J. H. Wagner Drilling Company Lease Musson Well No. 4

Sample No.	Depth, Feet	Effective Porosity Percent	Original Oil Saturation		Oil Recovery		Residual Saturation		Volume of Water Recovered cc*	Effective Permeability Millidarcys**	Initial Fluid Production Pressure Lbs./Sq./In.
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water			
2	3374.1	22.5	12	210	0	0	12	69	70	1.64	20
4	3376.1	18.4	10	143	0	0	10	77	21	0.600	30
6	3378.1	15.3	14	166	0	0	14	78	0	Imp.	50+
8	3380.1	15.9	7	86	0	0	7	77	0	Imp.	50+
10	3382.1	18.8	19	277	1	15	18	79	141	5.95	20
12	3384.1	18.0	17	238	0	0	17	81	113	3.96	20
14	3386.1	18.1	11	154	0	0	11	81	66	2.28	20
16	3388.1	16.0	13	161	0	0	13	79	27	0.620	20
18	3390.1	14.4	4	45	0	0	4	84	3	0.200	50
20	3392.1	17.0	6	79	0	0	6	87	61	2.48	20
22	3394.0	15.4	2	24	0	0	2	82	8	0.300	40

Notes: cc—cubic centimeter.

*—Volume of water recovered at the time of maximum oil recovery.

**—Determined by passing water through sample which still contains residual oil.

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RESULTS OF WATER DIFFERENTIATION TESTS

TABLE VI

Company J. H. Wagner Drilling Company Lease Musson Well No. 4

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation	
			Connate	Drilling & Foreign Total
2	3374.1	6,580		
4	3376.1	101,800		
6	3378.1	129,000		
8	3380.1	130,000		
10	3382.1	15,000		
12	3384.1	16,800		
14	3386.1	101,000		
16	3388.1	145,000		
18	3390.1	138,000		
20	3392.1	72,500		
22	3394.2	45,100		

Note: ppm — parts per million

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SUMMARY OF WATER DIFFERENTIATION TESTS

TABLE VII

Company J. H. Wagner Drilling Company Lease Musson Well No. 4

<u>Depth Interval, Feet</u>	<u>Chloride Content of Brine in Sand, ppm</u>	<u>Average Percent Connate Water</u>	<u>Average Percent Drilling & Foreign Water</u>
3373.5 - 3386.7	68,630		
3387.5 - 3395.0	101,380		
3373.5 - 3395.0	79,910		

Note: ppm — parts per million.