● CORE ANALYSIS ● WATER REPRESSURING ENGINEERING ● WATER ANALYSIS ● FLOODING WATER TREATMENT ● SURVEYING

OILFIELD RESEARCH LABORATORIES

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April 19, 1962

Linn Flood
Route 1
Grain Valley, Missouri

Gentlemen:

Enclosed herewith is the report of the analysis of the Cable Tool core taken from the Nolen Lease, Well No. 13, Linn County, Kansas, and submitted to our laboratory on April 14, 1962.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

Benjamin R. Pearman

BRP:rf

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GENERAL INFORMATION & SUMMARY

Company Linn Flood Lease Nolen Well No. 13

Location 300' East of #11

Section 23 Twp. 19S Rge. 22E County Linn State Kansas

Name of Sand	Bartlesville
Top of Core	620.0
Bottom of Core	638.6
Top of Sand	621.0
Bottom of Sand (Analyzed)	638.0
Total Feet of Permeable Sand	13.4
Total Feet of Floodable Sand (Analyzed)	9.4

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
10 - 50	1.5	1.5
100 - 200	7.5	9.0
200 - 300	3.0	12.0
300 - 400	0.7	12.7
400 & above	0.7	13.4

Average Permeability Millidarcys	194.7
Average Percent Porosity	22.9
Average Percent Oil Saturation	42.4
Average Percent Water Saturation	34.0
Average Oil Content, Bbls./A. Ft.	755.
Total Oil Content, Bbls./Acre	10,110.
Average Percent Oil Recovery by Laboratory Flooding Tests	12.6
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	232.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	2,179.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	4,460.
Packer Setting, Feet	
Viscosity, Centipoises @ 75°F	51.3
A. P. I. Gravity, degrees @ 60 °F	27.1
Elevation, Feet	

Fresh water was used in the coring of this well. The core was sampled and the samples sealed in cans by a representative of the laboratory. The well was drilled in virgin territory.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
620.0 - 621.0	Sandy shale.
621.0 - 629.0	Brown, laminated, slightly shaly sandstone.
629.0 - 631.3	Soft shale.
631.3 - 634.7	Brown sandstone.
634.7 - 636.0	Soft shale.
636.0 - 638.6	Dark carbonaceous, slightly calcareous sandstone.

Coring was started at a depth of 620.0 feet in sandy shale and completed at 638.6 feet in dark sandstone. This core shows a total of 14.0 feet of sandstone. For the most part, the pay is made up of brown, laminated, slightly shaly 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 204.5 and 135.4 millidarcys respectively; the overall average being 194.7 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a rather irregular permeability profile. The permeability of the sand varies from 14. to a maximum of 641. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 42.4. The weighted average percent oil saturation of the upper and lower sections is 41.4 and 48.4 respectively. The weighted average percent water saturation of the upper and lower sections

is 36.5 and 19.2 respectively; the overall average being 34.0 (See Table III). This gives an overall weighted average total fluid saturation of 76.4 percent. This low total fluid saturation indicates considerable fluid was lost during coring, most of which probably was oil.

The weighted average oil content of the upper and lower sections is 755 and 750 barrels per acre foot respectively; the overall average being 755. The total oil content, as shown by this core, is 10,110 barrels per acre (See Table III).

VISCOSITY

The viscosity of a sample of crude oil taken from this well during coring operations is 51.3 centipoises at 75 degrees F. The API gravity of the oil is 27.1 degrees at 60 degrees F. With other factors being favorable, a sand containing an oil of this viscosity should respond favorably to water-flooding.

LABORATORY FLOODING TESTS

The sand in this core responded well to laboratory flooding tests, as a total recovery of 2,179 barrels of oil per acre was obtained from 9.4 feet of sand. The weighted average percent oil saturation was reduced from 40.8 to 28.2, or represents an average recovery of 12.6 percent. The weighted average effective permeability of the samples is 13.80 millidarcys, while the average initial fluid production pressure is 15.5 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 12 samples tested, all produced water and 10 oil. This indicates that approximately 83 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a wide variation in effective permeability to water.

CONCLUSION

A study of the laboratory data indicates that efficient primary

and secondary operations in the vicinity of this well should recover approximately 1,330 and 3,130 barrels of oil per acre respectively.

This is an average primary recovery of 117 barrels per acre foot from 11.4 feet of sand and an average secondary recovery of 316 barrels per acre foot from 9.9 feet of floodable sand analyzed.

The following data and assumptions were used in calculating the above recovery values:

Original formation volume factor	1.06
Reservoir water saturation, percent	30.0
Primary recovery, estimated, percent	7.0
Average porosity, percent	23.6
Oil saturation after flooding, percent	28.2
Performance factor, percent	55.0
Net floodable pay sand, feet	9.9

This core shows a pay sand section having a good oil saturation, a low water saturation and good effective permeability to water.

The above recovery values were calculated assuming that satisfactory injection rates are maintained throughout the life of the flood.

Several flood pot samples were unobtainable because of the soft nature of the sand; however, the saturation data on these samples are such that they have been included in the recovery calculations.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Linn Flood Lease Nolen Well No. 13

Sample No.	Depth, Feet	Effective Porosity Percent	Percent Saturation			Oil Content Bbls. / A Ft.	Perm., Mill.	Feet of Sand		Total Oil Content	Perm. Capacity Ft. X md.
			Oil	Water	Total			Ft.	Cum. Ft.		
1	621.1	21.2	39	37	76	642	47.	0.5	0.5	321	28.50
2	622.1	22.2	35	35	70	602	14.	1.0	1.5	602	14.00
3	623.1	23.2	42	40	82	756	144.	1.0	2.5	756	144.00
4	624.1	22.8	34	37	71	602	249.	1.0	3.5	602	249.00
5	625.1	22.8	45	44	89	796	142.	1.0	4.5	796	142.00
6	626.1	23.2	39	33	72	702	222.	1.0	5.5	702	222.00
7	627.1	22.4	41	37	78	712	137.	1.0	6.5	712	137.00
8	628.1	24.7	38	35	73	728	188.	1.5	8.0	1,092	282.00
9	631.6	25.4	44	30	74	867	641.	0.7	8.7	606	448.70
10	632.5	24.8	51	31	82	980	222.	1.0	9.7	980	222.00
11	633.5	23.8	47	41	88	868	189.	1.0	10.7	868	189.00
12	634.5	24.6	43	38	81	820	366.	0.7	11.4	574	256.20
13	636.1	22.6	54	22	76	948	197.	0.6	12.0	569	118.20
14	637.1	18.6	46	18	64	664	109.	1.4	13.4	930	152.60
								Total -------		10,110	

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company Linn Flood Lease Nolen Well No. 13

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
621.0 - 634.7	11.4	204.5	2,334.40
636.0 - 638.0	2.0	135.4	270.80
621.0 - 638.0	13.4	194.7	2,605.20

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
621.0 - 634.7	11.4	23.4	41.4	36.5	755	8,611
636.0 - 638.0	2.0	19.8	48.4	19.2	750	1,499
621.0 - 638.0	13.4	22.9	42.4	34.0	755	10,110

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Linn Flood Lease Nolen Well No. 13

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	Bbls./A. Ft.			
1	621.1	21.4	39	646	16	265	23	62	381	7	0.398	35
2	622.1	22.0	35	597	4	68	31	57	529	38	1.47	20
4	624.1	23.0	34	606	8	143	26	64	463	289	17.28	15
5	625.1	23.0	45	802	19	338	26	56	464	119	5.04	15
6	626.1	23.4	39	707	10	181	29	58	526	283	15.20	10
7	627.1	22.7	41	722	14	246	27	63	476	133	6.72	15
8	628.1	24.4	38	719	7	133	31	61	586	156	9.30	15
9	631.6	25.7	44	876	21	419	23	59	457	416	41.60	10
10	632.5	24.8	51	980	23	442	28	56	538	276	25.20	10
12	634.5	24.9	43	830	10	193	33	55	637	278	22.24	10
13	636.1	22.8	52	918	0	0	52	26	918	62	3.98	25
14	637.1	18.2	47	664	0	0	47	23	664	53	3.78	25

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SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company Linn Flood Lease Nolen Well No. 13

Depth Interval, Feet	621.0 - 634.7
Feet of Core Analyzed	9.4
Average Percent Porosity	23.6
Average Percent Original Oil Saturation	40.8
Average Percent Oil Recovery	12.6
Average Percent Residual Oil Saturation	28.2
Average Percent Residual Water Saturation	59.3
Average Percent Total Residual Fluid Saturation	87.5
Average Original Oil Content, Bbls./A. Ft.	746.
Average Oil Recovery, Bbls./A. Ft.	232.
Average Residual Oil Content, Bbls./A. Ft.	514.
Total Original Oil Content, Bbls./Acre	7,011.
Total Oil Recovery, Bbls./Acre	2,179.
Total Residual Oil Content, Bbls./Acre	4,832.
Average Effective Permeability, Millidarcys	13.80
Average Initial Fluid Production Pressure, p.s.i.	15.5

NOTE: Only those samples which recovered oil were used in calculating the above averages.