

OILFIELD RESEARCH LABORATORIES

- REGISTERED ENGINEERS -

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November 2, 1961

Kent Kimball, et al
222 Wright Building
Tulsa, Oklahoma

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Dunavan Lease, Well No. P-5, Linn County, Kansas, and submitted to our laboratory on October 28, 1961.

Your business is greatly appreciated.

Very truly yours, ,

OILFIELD RESEARCH LABORATORIES


Benjamin R. Pearman

BRP:rf

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GENERAL INFORMATION & SUMMARY

Company Kent Kimball, et al Lease Dunavan Well No. P-5
 Location 1260' East of West line & 650' North of South line, NE
 Section 34 Twp. 21S Rge. 23E County Linn State Kansas

Name of Sand	Squirrel
Top of Core	445.0
Bottom of Core	487.0
Top of Sand	449.0
Bottom of Sand	480.0
Total Feet of Permeable Sand	28.8
Total Feet of Floodable Sand	11.4

Distribution of Permeable Sand:
Permeability Range
Millidarcys

Feet

Cum. Ft.

0 - 5	15.4	15.4
5 - 10	1.0	16.4
10 - 50	10.4	26.8
50 - 100	1.0	27.8
100 & above	1.0	28.8

Average Permeability Millidarcys	16.9
Average Percent Porosity	19.1
Average Percent Oil Saturation	42.9
Average Percent Water Saturation	42.5
Average Oil Content, Bbls./A. Ft.	651.
Total Oil Content, Bbls./Acre	18,715.
Average Percent Oil Recovery by Laboratory Flooding Tests	17.1
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	269.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	3,070.
Total Calculated Oil Recovery, Bbls./Acre	3,500.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

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Fresh water mud was used as the circulating fluid in coring this well. The core was sampled and the samples sealed in cans by Oilfield Research Laboratories personnel. The well was drilled in non-virgin territory.

FORMATION CORED

The detailed log of the formation cored is as follows:

<u>Depth Interval,</u>	<u>Description</u>
<u>Feet</u>	

445.0 - 449.0	Laminated sandy shale.
449.0 - 453.4	Brown slightly shaley sandstone.
453.4 - 466.6	Laminated sandstone and shale.
466.6 - 475.0	Dark brown slightly shaley sandstone.
475.0 - 479.0	Dark carbonaceous slightly shaley sandstone.
479.0 - 480.0	Dark carbonaceous calcareous sandstone.
480.0 - 484.5	Dark carbonaceous shaley sandstone.
484.5 - 485.0	Gray limestone.
485.0 - 487.0	Shale.

Coring was started at a depth of 445.0 feet in laminated sandy shale and completed at 487.0 feet in shale. For the most part, the pay is made up of brown to dark brown slightly shaley sandstone.

PERMEABILITY

For the sake of distribution, the core was divided into four sections. The weighted average permeability of the four sections is 24.9, 2.7, 47.1 and 2.6 millidarcys respectively; the overall average being 16.9 (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 0.23 to a maximum of 102. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fairly good weighted average percent oil saturation, namely, 42.9. The weighted average percent oil saturation of the four sections is 42.0, 29.5, 53.3 and 55.1 respectively. The weighted average percent water saturation of the four sections is 44.3, 59.5, 25.6 and 30.8 respectively; the overall average being 42.5 (See Table III). This gives an overall weighted average total fluid saturation of 85.4 percent.

The weighted average oil content of the four sections is 649, 420, 853 and 824 barrels per acre foot respectively; the overall average being 651. The total oil content, as shown by this core, is 18,715 barrels per acre of which 8,827 barrels are in the pay sand section (See Table III).

LABORATORY FLOODING TESTS

The first and third sections of sand in this core responded well to laboratory flooding tests, as a total recovery of 3,070 barrels of oil per acre was obtained from 11.4 feet of sand. The weighted average percent oil saturation was reduced from 49.0 to 31.9, or represents an average recovery of 17.1 percent. The weighted average effective permeability of the samples is 0.735 millidarcys, while the average initial fluid production pressure is 36.5 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 28 samples tested, 11 produced water and oil. This indicates that approximately 39 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

Based on the results of the laboratory tests, it appears that an efficient water-flood in the vicinity of this well could recover approximately 3,500 barrels of oil per acre. This represents an average

recovery of 307 barrels per acre foot from the 11.4 feet of floodable pay sand analyzed in this core. The above recovery values were calculated using the following data and assumptions:

Original formation volume factor	1.04
Present formation volume factor	1.02
Reservoir water saturation, percent	24.0
Primary recovery, estimated, percent	3.0
Average porosity, percent	20.3
Abandonment oil saturation, percent	31.9
Performance factor, percent	50.0
Net floodable pay sand, feet	11.4

This core shows a slightly shaley pay sand section having a good oil saturation, a moderate water saturation and a somewhat low effective permeability to water. The above recovery values were calculated assuming satisfactory injection rates can be established.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Kent Kimball, et al Lease Dunavan Well No. P-5

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	450.1	20.0	35	45	80	544	13.	1.6	1.6	870	20.80
2	451.1	18.4	44	48	92	629	29.	1.0	2.6	629	29.00
3	452.1	20.4	48	43	91	760	31.	1.0	3.6	760	31.00
4	453.1	20.9	46	40	86	746	36.	0.8	4.4	597	28.80
5	456.1	15.7	26	63	89	317	11.	1.0	5.4	317	11.00
6	457.1	21.4	55	36	91	913	2.4	1.0	6.4	913	2.40
7	458.1	16.5	23	67	90	295	0.59	1.0	7.4	295	0.59
8	459.1	16.0	26	66	92	323	2.0	1.0	8.4	323	2.00
9	460.1	19.9	51	31	82	787	0.23	1.0	9.4	787	0.23
10	461.1	17.3	24	68	92	322	0.40	1.0	10.4	322	0.40
11	462.1	18.2	23	66	89	325	0.29	1.0	11.4	325	0.29
12	463.1	17.1	27	68	95	358	10.	1.0	12.4	358	10.00
13	464.1	18.2	26	60	86	367	0.97	1.0	13.4	367	0.97
14	465.1	15.1	13	81	94	152	0.63	1.0	14.4	152	0.63
15	466.1	19.6	30	49	79	457	0.84	1.0	15.4	457	0.84
16	467.1	20.6	56	21	77	894	102.	1.0	16.4	894	102.00
17	468.1	19.2	56	23	79	835	22.	1.0	17.4	835	22.00
18	469.1	19.2	53	29	82	790	41.	1.0	18.4	790	41.00
19	470.1	21.7	59	27	86	994	41.	1.0	19.4	994	41.00
20	471.1	22.0	54	27	81	922	43.	1.0	20.4	922	43.00
21	472.1	21.4	45	25	70	748	53.	1.0	21.4	748	53.00
22	473.1	20.3	50	27	77	788	28.	1.0	22.4	788	28.00
23	474.1	20.5	58	32	90	922	3.3	1.4	23.8	1291	4.62
24	475.1	20.6	60	24	84	958	1.2	0.6	24.4	575	0.72
25	476.1	17.1	31	44	75	411	2.7	1.0	25.4	411	2.70
26	477.1	19.5	47	36	83	711	3.5	1.0	26.4	711	3.50
27	478.1	19.1	65	24	89	963	2.0	1.4	27.8	1348	2.80
28	479.1	18.0	67	24	91	936	2.4	1.0	28.8	936	2.40
								Total	-----	18,715	

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company		Lease		Well No.	
Kent Kimball, et al		Dunavan		P-5	
Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.		
449.0 - 453.4	4.4	24.9	109.60		
455.6 - 466.6	11.0	2.7	29.35		
466.6 - 473.6	7.0	47.1	330.00		
473.6 - 480.0	6.4	2.6	16.74		
449.0 - 480.0	28.8	16.9	485.69		
Depth Interval, Feet	Feet of Core Analyzed	Average Percent Porosity	Average Percent Oil Saturation	Average Percent Water Saturation	Total Oil Content Bbls./Acre
449.0 - 453.4	4.4	19.9	42.0	44.3	2,856
455.6 - 466.6	11.0	17.7	29.5	59.5	4,616
466.6 - 473.6	7.0	20.6	53.3	25.6	5,971
473.6 - 480.0	6.4	19.1	55.1	30.8	5,272
449.0 - 480.0	28.8	19.1	42.9	42.5	18,715

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Kent Kimball, et al Lease Dunavan Well No. P-5

Sample No.	Depth, Feet	Effective Porosity Percent	Original Oil Saturation		Oil Recovery		Residual Saturation		Volume of Water Recovered cc ^a	Effective Permeability Millidarcys	Initial Fluid Production Pressure Lbs./Sq./In.
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water			
1	450.1	19.8	35	538	7	108	28	67	9	0.400	50
2	451.1	18.6	44	636	14	202	30	68	6	0.200	50
3	452.1	20.8	48	776	13	210	35	62	40	1.200	30
4	453.1	20.5	46	732	14	223	32	64	72	3.30	30
5	456.1	16.0	24	298	0	0	24	64	0	Imp.	-
6	457.1	21.2	56	921	0	0	56	37	0	Imp.	-
7	458.1	16.7	24	216	0	0	24	67	0	Imp.	-
8	459.1	15.9	23	284	0	0	23	68	0	Imp.	-
9	460.1	20.1	49	764	0	0	49	30	0	Imp.	-
10	461.1	17.7	21	289	0	0	21	70	0	Imp.	-
11	462.1	18.2	25	353	0	0	25	67	0	Imp.	-
12	463.1	16.9	29	380	0	0	29	67	0	Imp.	-
13	464.1	18.4	23	329	0	0	23	64	0	Imp.	-
14	465.1	15.0	15	175	0	0	15	80	0	Imp.	-
15	466.1	19.9	28	432	0	0	28	50	0	Imp.	-
16	467.1	20.1	56	873	21	328	35	55	12	0.300	30
17	468.1	19.5	56	847	24	363	32	66	32	1.30	20
18	469.1	19.6	53	805	23	350	30	67	28	0.900	20
19	470.1	21.2	59	970	27	444	32	66	22	0.600	30
20	471.1	21.8	54	914	22	372	32	65	3	0.200	30
21	472.1	21.0	45	734	14	228	31	56	5	0.200	50
22	473.1	20.5	50	795	14	222	36	62	6	0.200	50
23	474.1	20.5	59	939	0	0	59	30	0	Imp.	-
24	475.1	20.4	59	934	0	0	59	26	0	Imp.	-
25	476.1	17.5	29	394	0	0	29	47	0	Imp.	-
26	477.1	19.4	45	678	0	0	45	38	0	Imp.	-
27	478.1	18.8	67	978	0	0	67	22	0	Imp.	-
28	479.1	18.3	64	909	0	0	64	26	0	Imp.	-

Notes: cc—cubic centimeter.

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

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SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company	Kent Kimball, et al	Lease	Dunavan	Well No.	P-5
Depth Interval, Feet	449.0 - 453.4	466.6 - 473.6	449.0 - 473.6		
Feet of Core Analyzed	4.4	7.0	11.4		
Average Percent Porosity	19.9	20.5	20.3		
Average Percent Original Oil Saturation	42.0	53.3	49.0		
Average Percent Oil Recovery	11.2	20.7	17.1		
Average Percent Residual Oil Saturation	30.8	32.6	31.9		
Average Percent Residual Water Saturation	65.5	62.4	63.6		
Average Percent Total Residual Fluid Saturation	96.3	95.0	95.5		
Average Original Oil Content, Bbls./A. Ft.	649.	848.	771.		
Average Oil Recovery, Bbls./A. Ft.	173.	329.	269.		
Average Residual Oil Content, Bbls./A. Ft.	476.	519.	502.		
Total Original Oil Content, Bbls./Acre	2,859.	5,938.	8,797.		
Total Oil Recovery, Bbls./Acre	763.	2,307.	3,070.		
Total Residual Oil Content, Bbls./Acre	2,096.	3,631.	5,727.		
Average Effective Permeability, Millidarcys	1.06	0.529	0.735		
Average Initial Fluid Production Pressure, p.s.i.	40.0	32.9	36.5		

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