

OILFIELD RESEARCH LABORATORIES

- REGISTERED ENGINEERS -

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November 1, 1962

C. H. Schwader, et al
P.O. Box 338
Topeka, Kansas

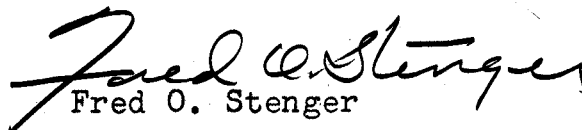
Gentlemen:

Enclosed herewith is the report of the analysis of the Cable Tool core taken from the Woods Lease, Well No. 4, Franklin County, Kansas, and submitted to our laboratory on October 25, 1962.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES


Fred O. Stenger

FOS:rf

1 c. - Jim Guinotte

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GENERAL INFORMATION & SUMMARY

Company	C.H. Schwader, et al	Lease	Woods	Well No.	4
Location	SW $\frac{1}{4}$				
Section	29	Twp.	15S	Rge.	20E
		County	Franklin		State
					Kansas
Name of Sand					Squirrel
Top of Core					738.0
Bottom of Core					767.4
Top of ^{Good} Sand					739.0
Bottom of Sand					762.6
Total Feet of Permeable Sand	(Analyzed)				19.6
Total Feet of Floodable Sand	(Analyzed)				13.6
Distribution of Permeable Sand:					
Permeability Range Millidarcys	Feet	Cum. Ft.			
0 - 100	6.5	6.5			
100 - 200	7.5	14.0			
200 & above	5.6	19.6			
Average Permeability Millidarcys					142.8
Average Percent Porosity					21.2
Average Percent Oil Saturation					39.4
Average Percent Water Saturation					45.5
Average Oil Content, Bbls./A. Ft.					655.
Total Oil Content, Bbls./Acre					15,245.
Average Percent Oil Recovery by Laboratory Flooding Tests					4.8
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.					86.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre					1,166.
Total Calculated Oil Recovery, Bbls./Acre	(Primary & Secondary)				4,790.
Packer Setting, Feet					-
Viscosity, Centipoises @ 78°F.					302.
A. P. I. Gravity, degrees @ 60 °F					21.2
Elevation, Feet					

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Water was used in the coring of the sand in this well. The core was sampled and the samples sealed in cans by a representative of this laboratory. The well was drilled in a semi-virgin area.

FORMATION CORED

The detailed log of the formation cored is as follows:

<u>Depth Interval,</u> <u>Feet</u>	<u>Description</u>
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738.0 - 739.0	- Brown, laminated, shaly sandstone.
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739.0 - 746.0	- Brown, laminated, slightly shaly sandstone.
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746.0 - 750.0	- Gray and brown sandy limestone.
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750.0 - 757.0	- Brown shaly sandstone.
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757.0 - 758.0	- Soft gray shale.
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758.0 - 762.6	- Brown shaly sandstone.
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762.6 - 767.4	- Shale.
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Coring was started at a depth of 738.0 feet in brown, laminated, shaly sandstone and completed at 767.4 feet in shale. This core shows a total of 19.6 feet of sandstone. For the most part, the pay is made up of brown, shaly, to slightly shaly sandstone, the upper section containing shaly laminations.

PERMEABILITY

For the sake of distribution, the core was divided into two sections. The weighted average permeability of the upper and lower sections is 121.8 and 157.5 millidarcys respectively; the overall average being 142.8 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a rather irregular permeability profile and a wide range of permeability. The permeability of the sand varies from impermeable to a maximum of 331. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fairly good weighted average percent oil saturation, namely, 39.4. The weighted average percent oil saturation of the upper and lower sections is 44.0 and 34.7 respectively. The weighted average percent water saturation of the upper and lower sections is 45.0 and 46.1 respectively; the overall average being 45.5 (See Table III). This gives an overall weighted average total fluid saturation of 84.9 percent.

The weighted average oil content of the upper and lower sections is 672 and 618 barrels per acre foot respectively; the overall average being 655. The total oil content, as shown by this core, is 15,245 barrels per acre (See Table III).

VISCOSITY

The viscosity of a sample of crude oil taken from the stock tank is 609 centipoises at 60 degrees F. and 302 centipoises at 78°F. The A.P.I. gravity of the oil is 21.2 degrees at 60 degrees F.

LABORATORY FLOODING TESTS

Considering the low gravity and high viscosity of the oil, the sand in this core responded fairly well to laboratory flooding tests; as a total recovery of 1,166 barrels of oil per acre was obtained from 13.6 feet of sand. The weighted average percent oil saturation was reduced from 38.5 to 33.7, or represents an average recovery of 4.8 percent. The weighted average effective permeability of the samples is 6.86 millidarcys, while the average initial fluid production pressure is 20.4 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 20 samples tested, 16 produced water and 14 oil. This indicates that approximately 70 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand, for the most part, has a fairly good effective permeability to water.

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CONCLUSION

On the basis of the above data it is believed that an efficient primary and secondary operation in the vicinity of this well should recover approximately 2,370 and 2,420 barrels of oil per acre respectively. The following data and assumptions were used in calculating these recovery values:

Original formation volume factor	1.05
Reservoir water saturation, percent,	38.0
Primary recovery, estimated, percent	7.0
Present oil saturation, percent	52.0
Average porosity, percent	22.8
Oil saturation after flooding, percent	33.7
Performance factor, percent	55.0
Net floodable pay sand, feet	13.6

This core shows a sand section having a good oil saturation, a fairly moderate water saturation and good permeability both to air and water.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company C.H. Schwader, et al Lease Woods Well No. 4

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	738.1	18.1	55	40	95	771	-	1.0	1.0	771	-
2	739.1	24.8	42	39	81	806	83.	0.5	1.5	403	41.50
3	740.1	23.1	48	37	85	859	202.	1.0	2.5	859	202.00
4	741.1	21.8	42	54	96	710	101.	1.0	3.5	710	101.00
5	742.1	22.5	47	45	92	820	102.	1.0	4.5	820	102.00
6	743.1	20.2	36	51	87	564	111.	1.0	5.5	564	111.00
7	744.1	22.2	42	47	89	722	135.	1.0	6.5	722	135.00
8	745.1	24.0	37	46	83	689	147.	1.5	8.0	1033	220.50
9	746.1	25.0	51	35	86	989	Imp.	0.5	8.5	494	0.00
10	747.1	8.1	19	65	84	119	Imp.	1.0	9.5	119	0.00
11	748.1	12.2	57	32	89	540	61.	1.0	10.5	540	61.00
12	749.1	16.7	53	42	95	686	Imp.	1.5	12.0	1029	0.00
13	750.1	20.6	33	41	74	526	77.	0.5	12.5	263	38.50
14	751.1	22.0	40	44	84	683	81.	1.0	13.5	683	81.00
15	752.1	24.6	38	38	76	724	147.	1.0	14.5	724	147.00
16	753.1	22.9	38	47	85	675	139.	1.0	15.5	675	139.00
17	754.1	22.0	15	51	66	256	95.	1.0	16.5	256	95.00
18	755.1	23.5	33	48	81	601	46.	1.0	17.5	601	46.00
19	756.1	22.5	36	51	87	628	60.	1.5	19.0	942	90.00
20	758.1	23.2	25	45	70	450	236.	0.5	19.5	225	118.00
21	759.1	21.6	26	53	79	436	274.	1.0	20.5	436	274.00
22	760.1	22.8	37	47	84	654	331.	1.0	21.5	654	331.00
23	761.1	24.6	38	40	78	724	212.	1.0	22.5	724	212.00
24	762.1	23.4	50	43	93	907	230.	1.1	23.6	998	253.00
Total									-----	15,245	

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company C.H. Schwader, et al		Lease Woods		Well No. 4	
Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.		
739.0 - 748.5	8.0	121.8	974.00		
750.0 - 762.6	11.6	157.5	1824.50		
739.0 - 762.6	19.6	142.8	2798.50		
Depth Interval, Feet	Feet of Core Analyzed	Average Percent Oil Saturation	Average Percent Water Saturation	Average Oil Content Bbl./A. Ft.	Total Oil Content Bbls./Acre
738.0 - 750.0	12.0	44.0	45.0	672	8,064
750.0 - 762.6	11.6	34.7	46.1	618	7,181
738.0 - 762.6	23.6	39.4	45.5	655	15,245

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

C. H. Schwader, et al			Lease		Woods		Well No. 4				
Sample No.	Depth, Feet	Effective Porosity Percent	Original Oil Saturation		Oil Recovery		Residual Saturation		Volume of Water Recovered cc ^a	Effective Permeability mD/darcy ^{cc}	Initial Fluid Production Pressure Lbs./Sq./In.
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water			
2	739.1	24.9	42	812	7	136	35	59	187	5.34	20
3	740.1	23.2	48	864	3	54	45	54	278	9.97	20
6	743.1	20.3	36	567	3	47	33	55	60	2.26	30
7	744.1	22.1	42	720	4	68	38	53	97	3.34	20
9	746.1	25.0	51	990	0	0	51	35	0	Imp.	50+
10	747.1	8.2	19	121	0	0	19	65	0	Imp.	50+
11	748.1	12.1	57	534	0	0	57	32	0	Imp.	50+
12	749.1	16.7	53	688	0	0	53	42	0	Imp.	50+
13	750.1	20.7	33	530	5	80	28	65	205	5.25	20
14	751.1	21.9	40	680	4	68	36	60	69	1.36	20
15	752.1	24.5	38	722	7	134	31	63	317	11.05	20
16	753.1	23.0	38	678	3	52	35	55	121	2.58	20
17	754.1	22.1	15	257	0	0	15	65	161	5.24	20
18	755.1	23.6	33	604	4	74	29	63	188	6.62	20
19	756.1	22.6	36	632	5	88	31	59	199	16.60	10
20	758.1	23.3	25	452	0	0	25	59	179	4.20	20
21	759.1	21.7	26	437	2	33	24	65	363	11.21	20
22	760.1	22.9	37	658	7	124	30	53	180	5.86	20
23	761.1	24.5	38	724	9	172	29	58	293	7.76	20
24	762.1	23.5	50	912	5	91	45	50	25	1.02	30

Notes: cc—cubic centimeter.

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

^{cc}—Determined by passing water through sample which still contains residual oil.

Company C. H. Schwader, et al

Lease

Woods

Well No.

4

Oilfield Research Laboratories

SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company	C.H. Schwader, et al	Lease	Woods	Well No.	4
Depth Interval, Feet	739.0 - 744.5	750.0 - 762.6	739.0 - 762.6		
Feet of Core Analyzed	3.5	10.1	13.6		
Average Percent Porosity	22.3	23.0	22.8		
Average Percent Original Oil Saturation	42.1	37.4	38.5		
Average Percent Oil Recovery	3.9	5.3	4.8		
Average Percent Residual Oil Saturation	38.2	32.1	33.7		
Average Percent Residual Water Saturation	54.7	58.8	57.8		
Average Percent Total Residual Fluid Saturation	92.9	90.9	91.5		
Average Original Oil Content, Bbls./A. Ft.	730.	665.	682.		
Average Oil Recovery, Bbls./A. Ft.	68.	92.	86.		
Average Residual Oil Content, Bbls./A. Ft.	662.	573.	596.		
Total Original Oil Content, Bbls./Acre	2,557.	6,719.	9,276.		
Total Oil Recovery, Bbls./Acre	237.	929.	1,166.		
Total Residual Oil Content, Bbls./Acre	2,320.	5,790.	8,110.		
Average Effective Permeability, Millidarcys	5.21	7.44	6.86		
Average Initial Fluid Production Pressure, p.s.i.	22.8	19.6	20.4		

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