OILFIELD RESEARCH LABORATORIES
536 NORTH HIGHLAND - CHANUTE, KANSAS - PHONE HE1-2650

October 2, 1968

The Dow Chemical Company
Brazos Division
P. O. Box 22468
Houston, Texas 77027

Gentlemen:

Enclosed herewith is the report of the analysis of the Cable tool core taken from the A. Johnson Lease, Well No. W-14, Douglas County, Kansas, and submitted to our laboratory on September 17, 1968.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:dp

4 c. - Houston, Texas
2 c. - Chanute, Kansas

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Brazos

Company The Dow Chemical Co., Division Lease A. Johnson Well No. W-14

Location 1735' FNL & 1655' FEL

Section ~~26~~ 1 ? Twp. 15S Rge. 20E County Douglas State Kansas

Name of Sand	Squirrel
Top of Core	803.0
Bottom of Core	856.8
Top of Pay Sand	817.0
Bottom of Pay Sand	838.9
Total Feet of Permeable Sand (Analyzed)	32.4
Total Feet of Floodable Sand	16.5

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 15	7.3	7.3
15 - 25	3.9	11.2
25 - 50	12.0	23.2
50 - 100	1.9	25.1
100 & above	7.3	32.4

Average Permeability Millidarcys	47.2
Average Percent Porosity	21.4
Average Percent Oil Saturation	34.3
Average Percent Water Saturation	60.0
Average Oil Content, Bbls./A. Ft.	589.
Total Oil Content, Bbls./Acre	20,327.
Average Percent Oil Recovery by Laboratory Flooding Tests	9.7
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	181.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	2,945.
Total Calculated Oil Recovery, Bbls./Acre - (Primary & Secondary)	3,760.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

The sand was cored in salt water. The top 15.9 feet of core was sampled by a representative of Oilfield Research Laboratories and the remainder by an employee of the client.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
803.0 - 804.4	Brownish gray shaly sandstone.
804.4 - 805.8	Soft gray shale.
805.8 - 806.2	Light brown shaly sandstone.
806.2 - 806.9	Gray laminated sandstone and shale.
806.9 - 808.0	Grayish brown fine grained shaly sandstone.
808.0 - 808.9	Alternate thin layers of sandstone and shale.
808.9 - 809.5	Gray fine grained shaly sandstone.
809.5 - 810.5	Alternate thin layers of sandstone and shale.
810.5 - 811.1	Grayish brown shaly sandstone.
811.1 - 811.7	Soft gray shale.
811.7 - 813.6	Light brown shaly sandstone.
813.6 - 814.6	Soft gray shale.
814.6 - 816.3	Light brown shaly sandstone.
816.3 - 826.0	Brown fine grained sandstone.
826.0 - 826.6	Brown fine grained micaceous slightly shaly sandstone.
826.6 - 830.0	Gray sandy limestone.
830.0 - 841.4	Dark brown fine grained micaceous sandstone.

Depth Interval, Feet	Description
841.4 - 842.0	Gray sandy shale.
842.0 - 850.8	Brown fine grained micaceous slightly shaly sandstone.
850.8 - 852.0	Brown carbonaceous shaly sandstone.
852.0 - 856.0	Gray carbonaceous sandstone.
856.0 - 856.8	Gray carbonaceous sandstone.

Coring was started at a depth of 803.0 feet in brownish gray shaly sandstone and completed at 856.8 feet in gray carbonaceous sandstone. This core shows a total of 44.8 feet of sandstone. For the most part, the pay is made up of brown to dark brown fine grained sandstone.

PERMEABILITY

For the sake of distribution, the core was divided into three sections. The weighted average permeability of the upper, middle, and lower sections is 19.0, 68.0, and 18.2 millidarcys respectively; the overall average being 47.2 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a very irregular permeability profile. The permeability of the sand varies from 0.48 to a maximum of 194. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fair weighted average percent oil saturation, namely, 34.3. The weighted average percent oil saturation of the upper, middle, and lower sections is 11.9, 43.6, and 35.3 respectively. The weighted average percent water saturation of the upper, middle, and lower sections is 80.6, 51.0, and 59.9 respectively; the overall average being 60.0 (See Table III). This gives an overall weighted average

total fluid saturation of 94.3 percent.

Apparently that part of the cored section extending from a depth of 803.0 to 816.3 feet (upper section) is gas sand.

The weighted average oil content of the upper, middle, and lower sections is 171, 770, and 590 barrels per acre foot respectively; the overall average being 589. The total oil content, as shown by this core, is 20,327 barrels per acre of which 14,779 barrels are in the pay sand section (See Table III).

LABORATORY FLOODING TESTS

Part of the sand in this core responded fairly well to laboratory flooding tests, as a total recovery of 2,945 barrels of oil per acre was obtained from 16.3 feet of sand. The weighted average percent oil saturation was reduced from 45.3 to 35.6, or represents an average recovery of 9.7 percent. The weighted average effective permeability of the samples is 3.69 millidarcys, while the average initial fluid production pressure is 25.9 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 33 samples tested, 31 produced water and 16 oil. This indicates that approximately 49 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.

CONCLUSION

On the basis of above data, we estimate that approximately 3,760 barrels of oil per acre or an average of 228 barrels per acre foot can be recovered from the area, represented by this core, by

efficient primary and waterflood operations. The following data and assumptions were used in calculating the above oil recovery value:

Original formation volume factor	1.05
Present formation volume factor	1.01
Irreducible water saturation, percent	36.0
Primary recovery, estimated, percent	None
Present oil saturation, percent	61.6
Average porosity, percent	22.8
Oil saturation after flooding, percent	35.6
Performance factor, percent	50.0
Net floodable pay sand, feet	16.5

This core shows a fairly clean pay sand section (817.0 to 838.9 feet) having a good oil saturation, a rather high water saturation, and good porosity and permeability. The hole should be plugged back to a depth of 839. feet.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company The Dow Chemical Co., Brazos Division Lease A. Johnson Well No. W-14

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	803.1	15.9	20	69	89	247	0.48	1.4	1.4	346	0.67
2	807.1	18.8	8	87	95	117	3.3	1.1	2.5	129	3.63
3	809.1	20.2	9	70	79	141	14.	0.6	3.1	85	8.40
4	810.0	17.8	8	87	95	110	Imp.	1.0	4.1	110	0.00
5	811.0	20.3	13	82	95	205	1.5	0.6	4.7	123	0.90
6	812.5	18.9	13	84	97	191	3.7	1.3	6.0	248	4.81
7	813.5	19.3	12	82	94	180	11.	0.6	6.6	108	6.60
8	814.8	24.3	7	80	87	132	109.	0.7	7.3	92	76.40
9	815.8	19.1	12	84	96	178	37.	1.0	8.3	178	37.00
10	816.5	20.8	27	66	93	436	23.	0.7	9.0	305	16.10
11	817.5	23.2	30	65	95	540	125.	1.0	10.0	540	125.00
12	818.5	22.7	42	56	98	740	115.	0.9	10.9	666	103.50
13	819.0	22.1	23	66	89	395	194.	0.6	11.5	237	116.40
14	820.0	23.9	31	66	97	575	155.	1.2	12.7	690	186.00
15	821.5	19.5	36	48	84	550	33.	1.3	14.0	715	42.90
16	822.5	18.3	36	62	98	511	26.	0.8	14.8	409	20.80
17	823.0	20.7	43	52	95	691	39.	1.0	15.8	691	39.00
18	824.5	18.2	31	61	92	438	40.	1.2	17.0	526	48.00
19	825.5	21.2	42	51	93	691	26.	1.0	18.0	691	26.00
F-20	826.3	23.4	51	-	-	927	-	0.4	18.4	371	-
20	826.5	19.7	56	42	98	856	4.7	0.2	18.6	171	0.94
21	830.5	25.4	61	36	97	1,202	103.	1.3	19.9	1,562	133.90
22	832.0	25.9	57	41	98	1,145	58.	1.0	20.9	1,145	58.00
23	832.8	24.1	49	43	92	916	102.	1.6	22.5	1,466	163.20
24	834.8	23.7	48	48	96	882	40.	1.3	23.8	1,147	52.00

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company The Dow Chemical Co., Brazos Division Lease A. Johnson Well No. W-14

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.		
25	835.6	23.9	56	41	97	1,038	54.	0.9	24.7	939	49.60
26	836.6	21.6	49	48	97	821	39.	1.0	25.7	821	39.00
27	837.6	23.7	56	41	97	1,030	44.	0.9	26.6	927	39.60
28	838.3	22.2	49	45	94	844	20.	0.9	27.5	760	18.00
29	839.5	21.9	44	54	98	748	25.	1.4	28.9	1,047	35.00
30	841.0	23.6	31	65	96	568	31.	1.1	30.0	625	34.10
31	843.5	21.4	31	65	96	515	17.	1.3	31.3	669	22.10
F-32	844.9	22.2	27	-	-	431	-	0.7	32.0	302	-
32	845.0	20.1	28	69	97	437	11.	0.5	32.5	218	5.50
33	848.0	21.4	39	53	92	648	15.	1.0	33.5	648	15.00
34	850.0	20.5	39	59	98	620	2.7	1.0	34.5	620	2.70

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company The Dow Chemical Company, Brazos Division Lease A. Johnson Well No. W-14

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
803.0 - 816.3	7.3	19.0	138.41
816.3 - 838.9	18.8	68.0	1,277.94
838.9 - 850.5	6.3	18.2	114.40
803.0 - 850.5	32.4	47.2	1,530.75

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
803.0 - 816.3	8.3	19.0	11.9	80.6	171	1,419
816.3 - 838.9	19.2	22.4	43.6	51.0	770	14,779
838.9 - 850.5	7.0	21.7	35.3	59.9	590	4,129
803.0 - 850.5	34.5	21.4	34.3	60.0	589	20,327

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company The Dow Chemical Company, Brazos Division Lease A. Johnson Well No. W-14

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	803.1	15.5	18	216	0	0	18	74	216	0	Imp.	-
6	812.5	19.2	10	149	0	0	10	88	149	8	0.28	30
7	813.5	19.0	10	147	0	0	10	87	147	19	0.61	30
8	814.8	23.8	6	111	0	0	6	80	111	288	28.20	10
9	815.8	19.5	11	166	0	0	11	87	166	121	3.55	20
10	816.5	21.1	27	442	1	16	26	72	426	60	2.06	20
11	817.5	23.6	30	549	4	73	26	74	476	181	9.16	10
13	819.0	22.3	22	381	0	0	22	74	381	200	6.27	10
14	820.0	24.3	31	585	8	151	23	73	434	304	14.66	10
15	821.5	19.3	36	539	4	60	32	57	479	3	0.29	40
16	822.5	18.6	36	420	2	29	34	64	491	5	0.41	40
17	823.0	20.9	43	694	6	97	37	61	597	21	1.11	25
18	824.5	17.9	29	401	0	0	29	65	401	0	Imp.	-
19	825.5	21.6	42	704	3	50	39	60	654	16	0.60	25
20	826.3	23.4	51	927	16	291	35	60	636	226	18.73	20
21	830.5	25.3	61	1,197	21	412	40	58	785	134	7.33	20
22	832.0	25.5	57	1,128	21	416	36	62	712	115	6.30	20
23	832.8	24.5	49	932	10	190	39	59	742	45	2.44	20
24	834.8	23.4	48	871	8	145	40	58	726	6	0.29	35
25	835.6	23.6	56	1,007	14	256	42	55	751	5	0.42	40
26	836.6	22.0	49	836	7	119	42	56	717	12	0.64	35
27	837.6	23.3	56	1,013	20	362	36	62	651	23	0.83	25
28	838.3	22.5	49	856	10	175	39	58	681	16	1.24	30
29	839.5	21.4	46	764	0	0	46	54	764	2	0.17	40
30	841.0	23.7	30	552	0	0	30	69	552	50	2.88	20

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 LABORATORY FLOODING TESTS

TABLE IV

Company The Dow Chemical Company, Brazos Division Lease A. Johnson Well No. W-14

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.			
31	843.5	21.8	29	491	0	0	29	69	491	4	0.36	40
32	845.0	20.6	27	431	0	0	27	71	431	88	6.52	20
33	848.0	21.0	36	586	0	0	36	58	586	4	0.25	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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SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company The Dow Chemical Company, Brazos Division Lease A. Johnson Well No. W-14

Depth Interval, Feet	816.3 - 838.9
Feet of Core Analyzed	16.3
Average Percent Porosity	22.8
Average Percent Original Oil Saturation	45.3
Average Percent Oil Recovery	9.7
Average Percent Residual Oil Saturation	35.6
Average Percent Residual Water Saturation	63.0
Average Percent Total Residual Fluid Saturation	98.6
Average Original Oil Content, Bbls./A. Ft.	811.
Average Oil Recovery, Bbls./A. Ft.	181.
Average Residual Oil Content, Bbls./A. Ft.	630.
Total Original Oil Content, Bbls./Acre	13,215.
Total Oil Recovery, Bbls./Acre	2,945.
Total Residual Oil Content, Bbls./Acre	10,270.
Average Effective Permeability, Millidarcys	3.69
Average Initial Fluid Production Pressure, p.s.i.	25.9

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