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PHYSICAL PROPERTIES OF EASTERN KANSAS CRUDE OILS

by

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ABSTRACT

Pertinent physical properties of 453 samples of crude oil from eastern Kansas are given. The samples tested were obtained from fields being produced by both primary and secondary recovery methods.

Physical properties measured were: A.P.I. gravity, absolute viscosity at three temperatures, and oil-water interfacial tension. All the tests are reported in tabular form and curves showing the correlation between A.P.I. gravity and viscosity are given.

INTRODUCTION

For more than three quarters of a century oil has been produced from the relatively shallow sands of eastern Kansas. After production of oil by primary methods ceased to be profitable, many eastern Kansas fields were abandoned. In some, however, productivity has been increased by repressuring with air or gas. In addition, water flooding has restored and sustained production long after primary production would have become uneconomical. During recent years the trend has been steadily toward production of an increasing quantity of oil by water flooding. The importance of these operations is indicated by the more than eleven million barrels of oil produced annually in Kansas by this method. Most of the water flooding is being done in the eastern part of the State.

The rate of development for secondary recovery operations in the past has been influenced by numerous factors both domestic and foreign. Fluctuation in the price paid for oil influences the rate of production, which in turn controls the rate of development of new secondary recovery projects. Demand for oil would increase should foreign relations worsen and a shooting war become a reality. The importing of foreign oil into the United States influences the domestic market. All of these factors have exerted influence in the past and will continue to influence the petroleum industry in the future. Many fields that were abandoned in the past after depletion by primary production may, in the future, be economic secondary recovery projects.

The purpose of this investigation was to gather information concerning present active production, which could be used to encourage further secondary recovery development. This information may also indicate that some abandoned fields can be successfully flooded. Also, if presently producing fields have to be abandoned, the information will be helpful in future secondary recovery development.

Secondary recovery operations have brought a new importance to certain technical data that formerly were not obtained. These data include physical properties of crude oil. Once a pool is abandoned it is extremely difficult and expensive to determine the physical properties of the crude oil formerly produced; also data for many active producing areas are not available. In order to obtain an adequate background of factual data on these old pools, which constitute potential secondary recovery operations, the State Geological Survey has started the gathering of data on existing pools. This report gives the results of the first part of this study.

It is planned that further sampling and laboratory work will expand the scope of this information in conjunction with studies of subsurface stratigraphy and investigations of the petrography of the reservoir rocks. The ultimate goal is to assemble information that will make it posible at some time in the future to estimate more accurately in advance the response of various crude oils to flooding production technique or to any other technique that may be developed.

General information on oil and gas developments in eastern Kansas has been published by the Survey (Jewett, 1954) and an annual review of petroleum development is also published by the Geological Survey. The annual report (Ver Wiebe and others, 1954) summarized developments during 1953 and Plate 1 of that report was the source of pool locations for Figure 1 of this report. The annual development reports published by the Geological Survey now contain a special summary of secondary recovery operations, particularly in eastern Kansas.

SAMPLING PROCEDURE

The samples were gathered during the months of June, July, and August of 1950, 1951, 1952, and 1953 from the eastern Kansas area. The locations of the wells from which samples were taken are shown in Figure 1 and are listed in Table 1. A fresh sample was obtained wherever possible, but a few of the samples had to be taken from stock tanks. It is realized that results are not completely comparable, owing to weathering, but the data obtained are sufficiently similar to retain the correct relative position among the samples. Most of the oil has little or no gas in solution when produced.

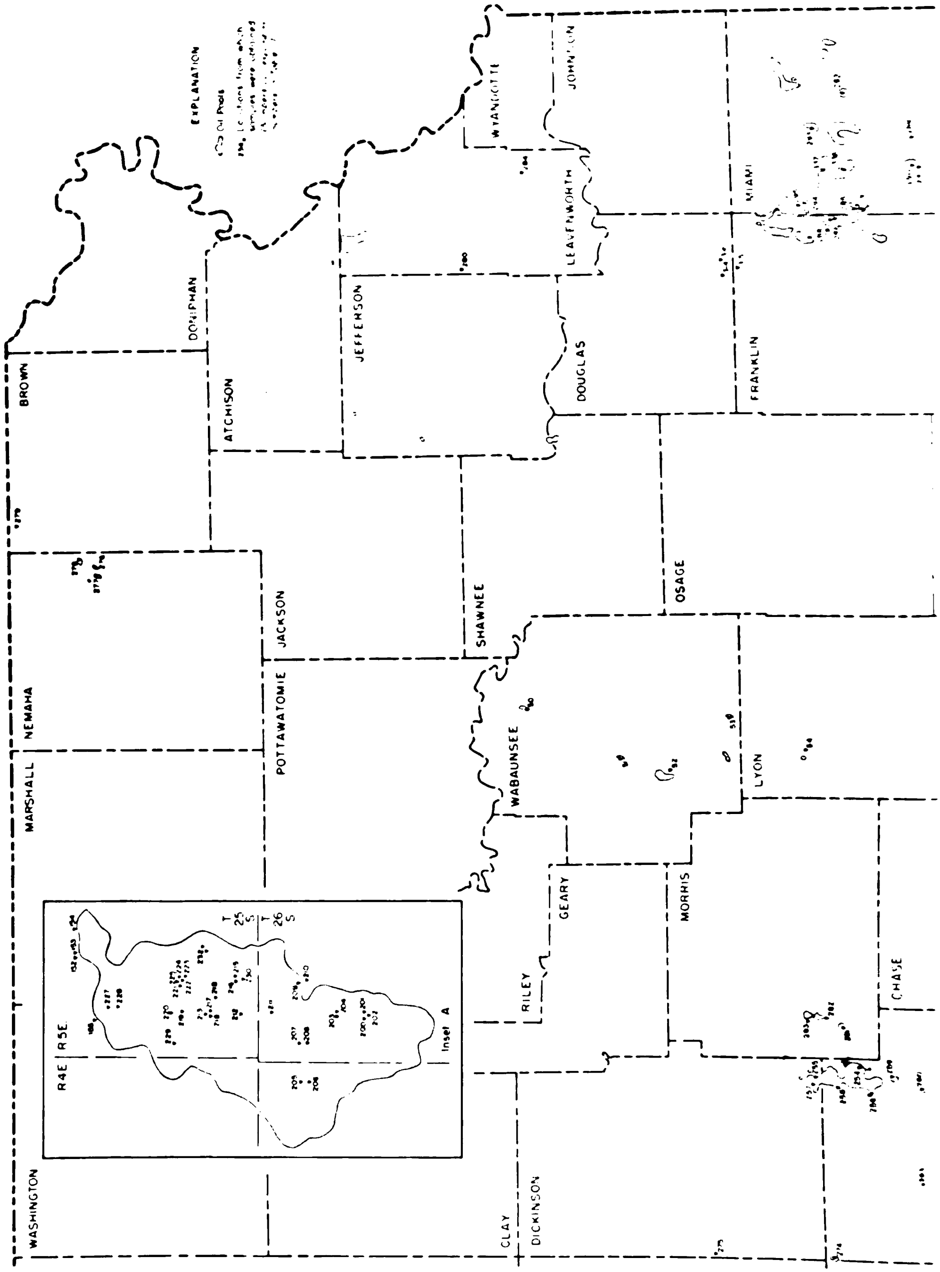
The sampling technique was designed to secure fresh uncontaminated samples from each well visited. Samples were taken from the bleeder connection at the well head, so: (1) a fresh sample direct from the well head was assured and (2) the sample was obtained before any chemical had been added to the oil. Before the sample was collected sufficient oil was run from the bleeder to assure that any dead oil that might have been trapped in the bleeder connections would not be included in the sample. Samples were collected in one-gallon glass jugs, which were sealed immediately. These were tested by the Petroleum Engineering Laboratory at the University of Kansas soon after delivery.

If possible, a sample was taken from each producing formation in a field. In the large producing areas, such as the El Dorado field, more samples were taken, owing to the great areal extent of the field. In such areas a checkerboard pattern was used to assure representative samples from the field.

There was some doubt as to the effect of a time lapse between collecting and testing the samples; therefore, they were tested as soon as they were brought in to the laboratory. Some of the samples were then retested approximately one month later to determine whether there was any change in the properties of the the oil during this time. For all samples tested the observed changes in physical properties were within the range of experimental error. Samples that had a tight emulsion, as many of the heavier oils did, were centrifuged before testing, to assure a water-free sample. If the well sampled was producing at a high water-oil ratio, the water and oil were allowed to separate and the water was drained off to assure sufficient oil for testing.

PHYSICAL PROPERTIES

The A.P.I. gravity has been used to correlate other physical properties, as well as to indicate origin and similarity of crude oils; thus gravity was measured for each crude oil sample. Also because the price of crude oil is based on the gravity, this property is generally available even for abandoned fields. Thus it could be used as a basis for estimating other physical properties if samples are not available.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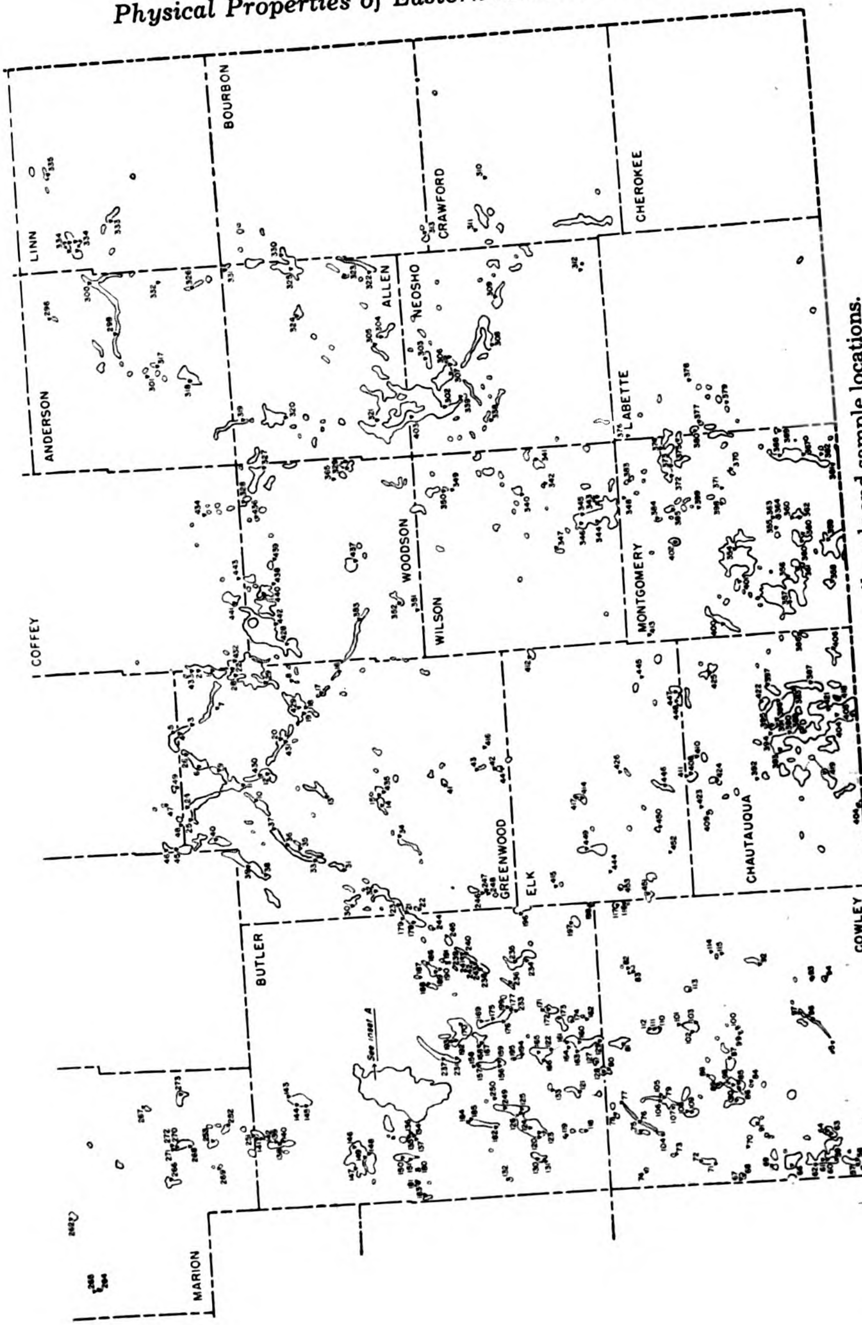

Fig. 1.—Map of eastern Kansas showing oil pools and sample locations.

Viscosity is a direct measurement of an oil's resistance to flow. In a given sand body, the greater the viscosity of the oil the greater the pressure drop required to move the oil through the sand. Also because the viscosity of the water in the various formations and that of injected water are nearly identical and both are lower than the viscosity of the crude oil, there is a pronounced tendency for the injected water to by-pass the more viscous oil. The water, having a lower viscosity than the oil, will flow more readily through the sand.

When two immiscible liquids such as water and oil are brought together, an interface forms at their surface of contact. This interface contracts to occupy the smallest possible area. If the interface is formed in a capillary, the liquid that wets the capillary tends to spread a thin film over the capillary wall, increasing the interfacial surface area between the two liquids. The tendency for the interface to contract is still present, however, so that the liquid that wets the capillary enters the tube, decreasing the interfacial area; this action produces a force that will displace the other fluid. As the capillary becomes smaller this force increases. In a system of fine capillaries such as occur in many reservoir rocks, this force becomes an important factor in displacing oil with water. The tendency for the interface to contract is called interfacial tension. The determination of this physical property is included in this study as a measure of the role of the oil-water interface in water-flooding operations.

Gravity: The A.P.I. gravity for samples 284 through 427 and 432 through 453 was determined by hydrometers according to A.P.I. standard 526-39 (A.S.T.M., 1949). The gravity of each of the remaining samples was determined by use of the Westphal balance. This method consists essentially of weighing a plummet in water and then in oil, then comparing the two weights. This method was used because it was thought to be accurate and more rapid than the hydrometers.

The determinations were made at room temperature and the National Petroleum Oil Tables (U.S. Dept. of Commerce, 1936) were used to correct the values to 60° F. These tables were also used as a basis of determining the gravity at other desired temperatures.

Gravities measured ranged from a low of 18.7 to a high of 44.5 degrees A.P.I., 15.2% being above 40 degrees A.P.I., 38.0% between 35 and 40 degrees A.P.I., 31.9% between 30 and 35 degrees AP.I., and 14.9% below 30 degrees A.P.I.

Viscosity: The viscosity of each oil was determined at 70, 100, and 120° F. For most of the samples, a modified Ostwald viscosimeter was used. The procedure employed was the tentative method of tests for kinematic viscosity (A.S.T.M., 1949-designation D445-46T Method B). The method is based on the time required for approximately 3 cc of oil to flow through a capillary tube about 3 inches in length. If the samples were too viscous for the range of Ostwald tubes available, or if the layer of oil left in the draining capillary was so heavy that it prevented the determination of the level of the interface, the Synchro-Lectric viscosimeter was used to measure the viscosity. This method measures the drag produced by the oil on a spindle operating at a constant speed when the spindle is immersed in the oil.

Although A.P.I. standard 533-43 (A.S.T.M., 1949) provides a convenient method for finding viscosity at any temperature between two given temperatures at which the viscosity is measured, the viscosities in these tests were determined at three temperatures in order to provide a check on this particular procedure. Also, it should be noted that the viscosity can be ascertained accurately at other temperatures between the three determinations presented here. It is also possible to determine viscosities at temperatures slightly above or below these values.

The range of viscosities measured is given in Table 1 and is shown graphically in Figures 2, 3, and 4.

Interfacial Tension: The interfacial tension of the first few samples was measured by means of the double cylinder apparatus described by Bartell (1938). This method consists of placing oil in one of the cylinders and water in the other and determining the height to which water rises in a capillary tube located vertically between the two liquids. By taking into consideration the difference in density between the oil and water, a simple calculation will give the numerical value of interfacial tension. The measurements were made at 80° F., as this temperature could be maintained conveniently.

The double cylinder method of determining interfacial tension was time consuming and for this reason other methods were considered. The ring, Du Nouy, or tensiometer method of measuring surface tension or interfacial tension was chosen as the most prac-

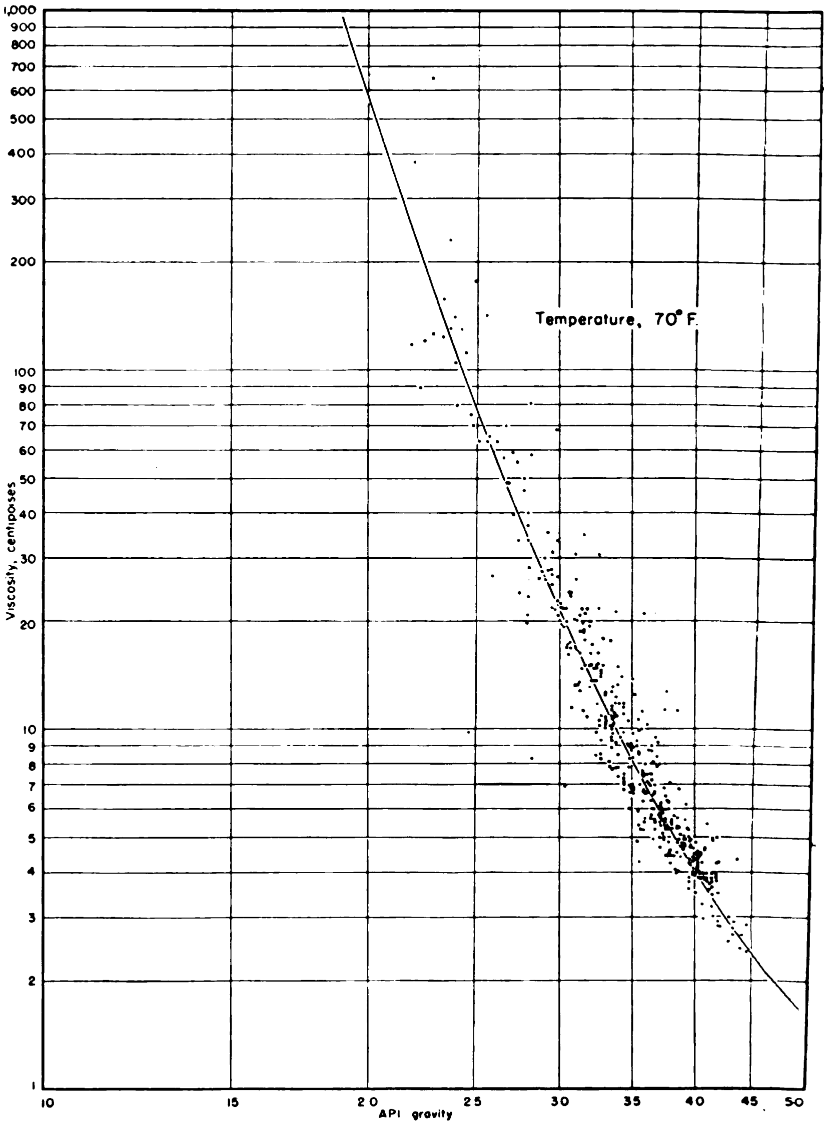

FIG. 2.—Chart showing viscosity of crude oil at 70° F. and atmospheric pressure.

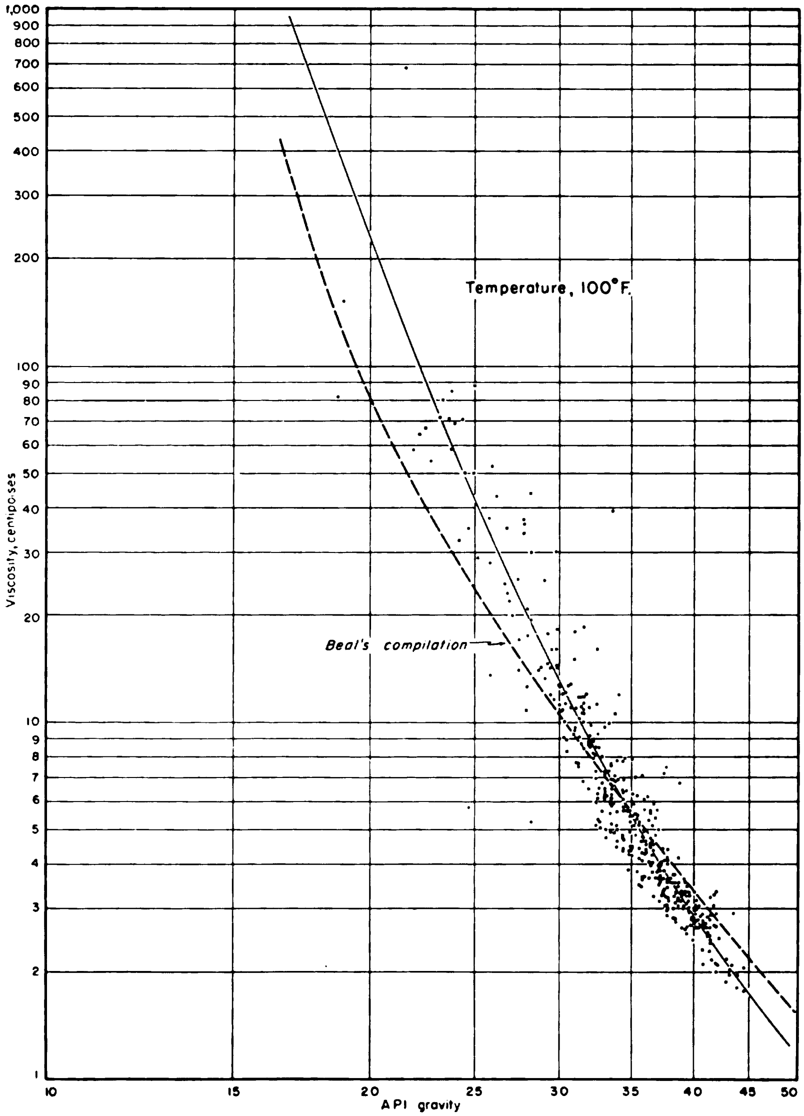

Fig. 3.—Chart showing viscosity of crude oil at 100° F. and atmospheric pressure.

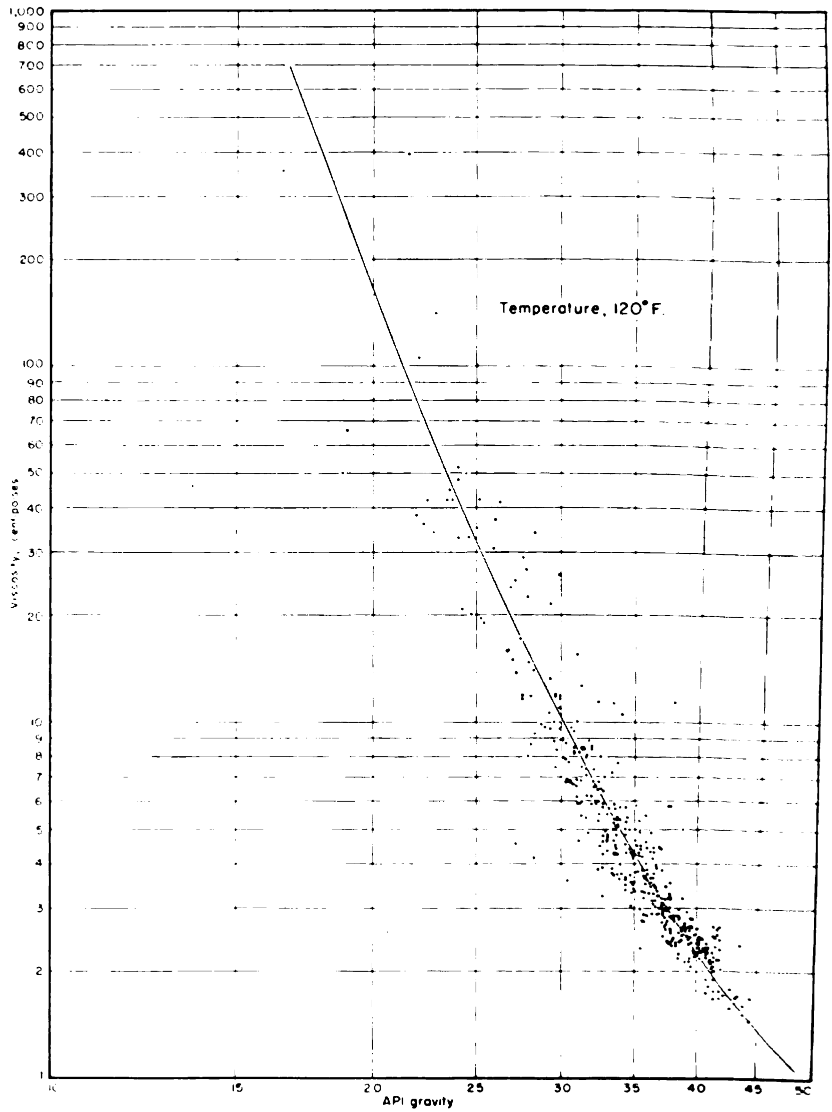

Fig. 4.—Chart showing viscosity of crude oil at 120° F. and atmospheric pressure.

tical. This method measures the force necessary to draw a platinum ring of known dimensions through the interface formed between the oil and water. Measurements were made near 80° F. whenever it was possible to maintain the room temperature at this level. Values measured at other temperatures were corrected to 80° F. by Sugden's equations.

CORRELATIONS OF PHYSICAL PROPERTIES

The A.P.I. gravity of crude oil is the physical property most universally available because it is the basis for determining the selling price. Usually the A.P.I. gravity of the oil produced is a matter of record even in the old fields that have been abandoned for several years. Therefore, gravity was used as a basis for correlating other physical properties.

The viscosity data were correlated with the A.P.I. gravity of the oil. Several methods of correlation were tried in an attempt to present the data in the best possible manner. It was found that by plotting the logarithms of the gravities against the logarithms of the viscosities, a very nearly straight line was formed. For this reason the A.P.I. gravity was plotted against the viscosity on log-log paper, the results of which are shown in Figures 2,3,4, and 5. The A.P.I. gravity scale has been expanded to three times that of the viscosity scale. The data show some scattering, but they correlate extremely well considering the geographic distribution of the samples as well as the difference in type of formation from which the samples were obtained.

Plotting the gravity against the viscosity of samples obtained from similar formations resulted in no improvement in the correlation. Therefore, it seems that the general character of all the oils in eastern Kansas is very similar.

The dashed line in Figure 3, obtained from a correlation by Beal (1946), represents viscosity measurements on 650 gas-free crude oil samples taken from 492 oil fields, 358 of which are in the United States. The correlations agree very well in the range where a mass of data is available—that is, between A.P.I. gravities of 30 and 50. The divergence at the lower gravities probably is due to the experimental difficulties in measuring the viscosity of such heavy oil.

Figure 5 shows the plot of viscosity vs. gravity for the three temperatures as shown in Figures 2,3, and 4. This plot shows the

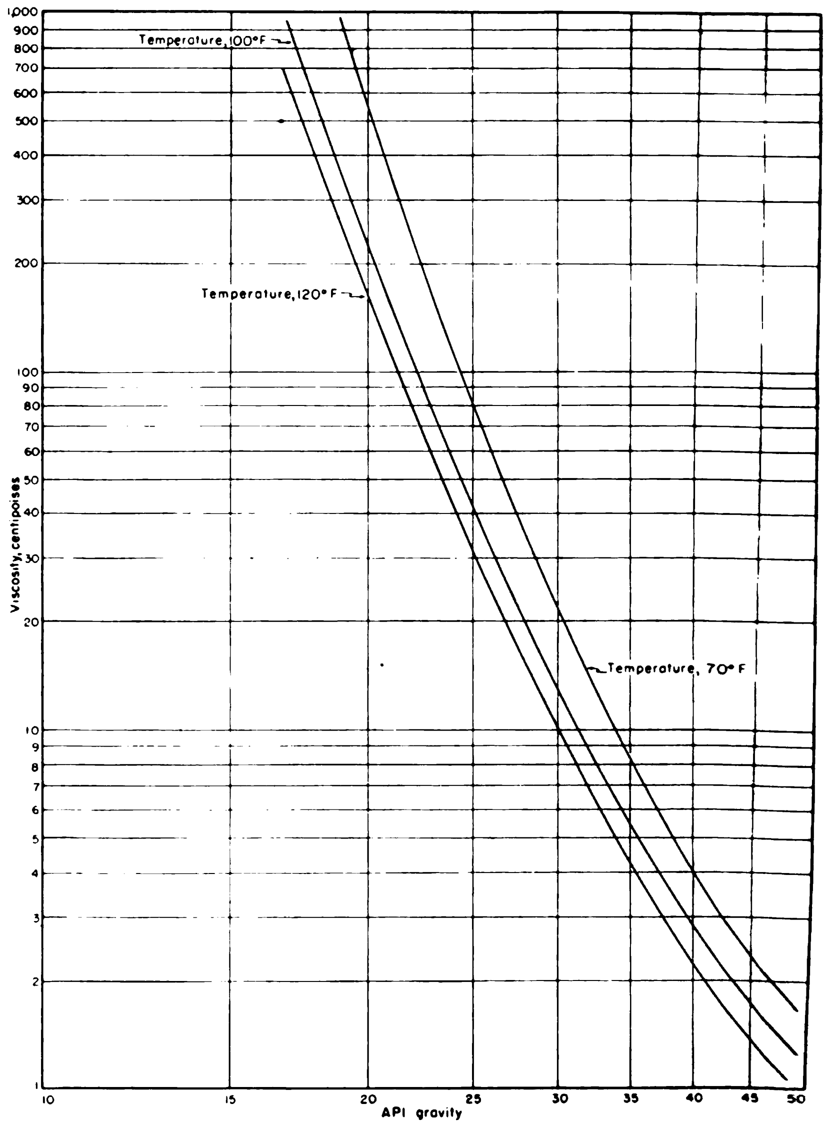

Fig. 5.—Chart showing comparison of viscosity of crude oil at 70°, 100°, and 120° F.

similarity of the three curves and also allows use of the curves for comparison with other samples of crude oil.

The data in Figure 5 were cross plotted against temperature to give a family of lines of temperature vs. viscosity (Fig.6) for the various A.P.I. gravities. By means of Figure 6 it should be possible to obtain the viscosity of any eastern Kansas crude oil at almost any temperature encountered in producing reservoirs of eastern Kansas.

An attempt to correlate interfacial tension measurements with gravity of the oil indicated that there is no apparent correlation between these two physical properties. Inasmuch as the viscosity of the oils correlated with the gravity, it would appear that there

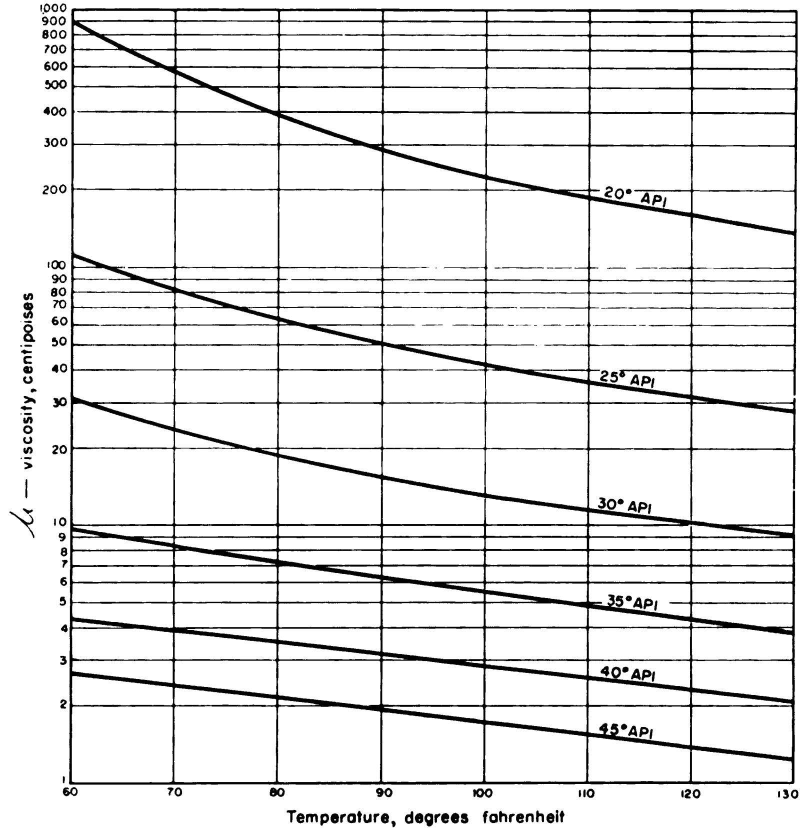

FIG. 6.—Chart showing viscosity of various crude oils as a function of temperture.

is no correlation between viscosity and interfacial tension. Therefore no effort was made to correlate these properties.

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TABLE 1.—*Physical properties of eastern Kansas crude oils*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises			Interfacial tension, dynes/cm @ 60°F.
					70°F.	100°F.	120°F.	
1	SE¼ 27-22-13E	1,900	"Mississippi lime"	39.2	4.976	3.349	2.612	29.14
2	SE¼ 15-22-13E	1,850	"Burgess"	37.7	5.243	3.412	2.640	23.29
3	SW¼ 10-22-12E	1,824	"Bartlesville"	40.1	4.715	3.182	2.317	26.08
4	NW¼ 4-22-12E	1,870	do	38.3	5.766	3.749	2.881	17.90
5	33-21-12E	1,800	do	38.0	4.647	3.160	2.446	25.80
6	NW¼ 14-22-11E	1,926	do	38.4	4.014	2.757	2.176	26.44
7	NW¼ 25-22-12E	1,750	do	40.0	4.048	2.823	2.249	27.30
8	NE¼ 17-24-13E	1,614	"Mississippi lime"	37.4	4.934	3.371	2.638	30.02
9	27-22-11E	1,965	"Bartlesville"	41.4	3.964	2.804	2.259	30.53
10	SE¼ 13-23-10E	2,500	do	40.4	4.541	3.050	2.463	30.31
11	8-23-11E	....	do	41.1	5.465	2.658	2.141	26.89
12	NE¼ 28-23-11E	1,930	do	41.5	4.909	3.240	2.512	23.94
13	NE¼ 36-24-10E	1,900	do	39.4	4.884	3.116	2.496	26.72
14	SW¼ 35-25-10E	1,980	"Mississippi lime"	34.8	7.014	4.527	3.545	27.59
15	36-25-10E	2,000	do	34.3	7.008	4.468	3.517	29.13
16	9-25-13E	1,520	"Bartlesville"	35.0	7.069	4.523	3.541	26.33
17	NW¼ 31-24-13E	1,786	"Mississippi lime"	36.6	6.079	4.069	3.158	31.84
18	23-24-12E	1,727	do	38.7	4.391	3.061	2.466	29.12
19	NE¼ 22-24-12E	1,650	"Bartlesville"	41.8	3.789	2.706	2.151	34.25
20	NE¼ 6-24-12E	1,800	do	41.4	3.729	2.641	2.125	34.40
21	SW¼ 10-26-8E	2,501	do	38.5	5.362	3.541	2.860	30.03
22	22-26-8E	2,500	"Mississippi lime"	30.9	17.31	9.694	6.620	34.33
23	SW¼ 2-26-8E	2,403	"Bartlesville"	37.2	6.241	3.986	2.994	30.86
24	SW¼ 1-22-10E	2,300	do	39.3	6.227	3.257	2.447	29.81
25	SE¼ 3-22-10E	2,340	do	41.3	3.580	2.515	2.061	30.55
26	SE¼ 1-22-11E	1,830	do	39.6	4.339	2.953	2.395	31.59
27	SE¼ 3-23-13E	1,835	"Mississippi lime"	39.6	4.265	2.933	2.396	31.70
28	NE¼ 9-23-13E	1,630	"Bartlesville"	37.3	6.137	4.027	3.194	34.23
29	SE¼ 29-23-13E	1,735	"Mississippi lime"	39.7	4.313	3.035	2.516	33.17
30	NE¼ 11-25-8E	2,352	"Bartlesville"	39.6	4.284	2.953	2.409	34.80
31	SE¼ 4-25-9E	2,375	do	40.7	3.989	2.773	2.282	35.59
32	NW¼ 30-25-9E	2,450	do	40.3	4.289	2.993	2.506	35.13
33	NW¼ 23-24-9E	2,200	do	41.0	3.951	2.731	2.251	30.88
34	N½ 7-26-10E	2,100	"Mississippi lime"	33.6	8.892	5.552	4.241	31.40
35	SE¼ 12-24-9E	2,250	"Bartlesville"	39.2	4.852	3.326	2.663	32.67
36	NW¼ 6-24-10E	2,300	do	40.2	4.160	2.914	2.378	11.50
37	SW¼ 28-23-10E	2,350	do	40.5	3.996	2.802	2.275	29.38
38	NE¼ 21-23-9E	2,600	do	42.1	3.534	2.479	2.025	28.47
39	NE¼ 10-23-9E	2,350	do	41.5	4.904	2.856	2.199	33.46
40	SW¼ 20-22-10E	2,350	do	40.9	3.781	2.653	2.179	30.35
41	NW¼ 7-27-11E	1,910	"Mississippi lime"	30.3	19.259	10.720	7.776	36.27
42	NE¼ 8-28-11E	785	Topeka	30.8	21.859	11.074	8.380	32.94
43	NE¼ 32-27-11E	1,949	"Mississippi lime"	26.6	56.810	24.520	16.090	34.36
44	NE¼ 17-28-11E	1,227	Kansas City	35.7	7.423	4.677	3.690	30.93

TABLE 1.—*Physical properties of eastern Kansas crude oils (continued)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises 70°F.	Viscosity, centipoises 100°F.	Viscosity, centipoises 120°F.	Interfacial tension, dynes @ 60°F
45	SW¼ 30-21-10E	2,200	"Bartlesville"	40.7	3.986	2.785	2.244	30.74
46	SW¼ 19-21-10E	2,200	do	38.9	4.964	3.360	2.695	30.35
47	SE¼ 24-21-10E	2,600	Viola	23.9	131.000	58.000	33.000	28.69
48	SW¼ 34-21-10E	2,100	Miss. "chat"	34.3	9.853	6.102	4.579	24.16
49	SE¼ 32-21-11E	1,970	"Bartlesville"	37.1	6.129	3.982	3.132	24.48
50	NE¼ 11-11-11E	2,904	Viola	23.8	230.000	85.000	48.000	39.59
51	NE¼ 2-13-10E	2,935	do	24.4	132.000	71.000	50.000	40.00
52	NW¼ 3-14-10E	....	do	26.8	70.000	35.000	24.000	37.80
53	10-15-11E	3,230	Simpson	21.6	1905.000	685.000	392.000	38.43
54	NE¼ 25-16-10E	2,950	"Hunton"	28.3	81.000	44.000	34.000	33.28
55	SW¼ 7-35-3E	3,475	"Bartlesville"	39.5	3.883	2.677	2.190	27.02
56	NW¼ 18-35-3E	3,760	Simpson	41.6	3.030	2.158	1.767	29.73
57	NW¼ 32-34-3E	3,421	"Mississippi lime"	33.9	13.393	7.796	5.795	34.16
58	NW¼ 32-34-3E	3,398	"Bartlesville"	35.1	13.740	7.937	5.865	34.36
59	SE¼ 17-34-3E	3,360	do	38.8	11.370	6.785	5.023	32.97
60	SE¼ 8-34-3E	2,588	"Layton"	37.3	6.220	4.047	3.216	25.38
61	SE¼ 8-34-3E	3,314	"Bartlesville"	37.1	5.867	3.874	3.033	31.10
62	NW¼ 5-34-3E	3,334	"Chat"	40.6	4.264	2.895	2.330	25.84
63	NW¼ 13-34-3E	3,371	"Burgess"	39.1	5.598	3.661	2.927	32.98
64	NW¼ 13-34-3E	2,842	Kansas City	38.4	5.366	3.554	2.812	33.81
65	SE¼ 17-35-4E	3,248	"Bartlesville"	40.2	4.574	3.057	2.451	29.43
66	SE¼ 20-33-3E	3,200	do	41.4	3.460	2.459	2.031	31.44
67	NW¼ 19-32-3E	3,501	Arbuckle	36.5	5.990	3.909	3.105	33.93
68	SE¼ 19-32-3E	2,760	"Bartlesville"	38.0	4.228	2.872	2.317	26.16
69	NE¼ 8-33-3E	3,500	Arbuckle	40.8	2.976	2.117	1.741	29.26
70	NW¼ 26-32-3E	2,690	Kansas City	39.7	4.080	2.802	2.265	32.40
71	NW¼ 4-32-3E	3,200	Arbuckle	37.4	4.941	3.288	2.627	28.22
72	SE¼ 28-31-3E	2,090	"Stalnaker"	38.4	4.868	3.247	2.582	32.61
73	SE¼ 10-31-3E	3,100	Arbuckle	36.8	5.507	3.657	2.907	36.34
74	NE¼ 29-30-3E	1,808	"Hoover"	36.3	6.288	4.080	3.183	35.96
75	SE¼ 19-30-4E	2,850	"Bartlesville"	37.8	4.512	3.089	2.480	35.74
76	SE¼ 20-30-4E	2,825	do	39.4	3.596	2.549	2.069	36.58
77	SW¼ 11-30-4E	2,800	do	38.0	4.258	2.940	2.381	31.83
78	NE¼ 9-30-4E	3,306	Arbuckle	25.9	26.870	13.540	9.322	28.62
79	SE¼ 2-31-4E	2,950	"Bartlesville"	39.8	3.927	2.711	2.197	35.53
80	NW¼ 4-30-5E	2,600	do	41.2	3.702	2.581	2.104	35.40
81	NW¼ 13-30-5E	2,835	do	40.4	4.490	3.047	2.471	34.43
82	SW¼ 21-30-7E	2,840	"Mississippi lime"	39.9	3.976	2.731	2.230	33.80
83	NE¼ 29-30-7E	2,890	"Chat"	40.1	4.060	2.783	2.264	31.84
84	NE¼ 36-32-4E	1,800	"Hoover"	38.2	5.318	3.548	2.850	31.14
85	SE¼ 24-32-4E	1,742	"U. Hoover"	40.8	3.926	2.746	2.230	34.96
86	SW¼ 24-32-4E	3,000	"Bartlesville"	40.3	4.010	2.781	2.247	33.43
87	SE¼ 16-32-5E	3,090	do	43.0	3.050	2.173	1.839	33.61
88	NE¼ 6-32-5E	2,300	"Layton"	40.2	4.366	2.980	2.415	33.32

TABLE 1.—*Physical properties of eastern Kansas crude oils (continued)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises 70°F.	100°F.	120°F.	Interfacial tension, dynes/cm @ 60°F.
89	NE¼ 12-32-4E	2,570	Kansas City	36.7	7.095	4.557	3.626	34.66
90	NE¼ 22-32-4E	2,300	"Layton"	39.4	5.225	3.465	2.801	36.18
91	SE¼ 31-32-4E	3,140	"Bartlesville"	41.5	3.481	2.419	1.999	30.88
92	NE¼ 8-33-7E	2,655	Mississippian	36.0	8.006	4.941	3.879	33.15
93	NE¼ 12-34-6E	3,100	"Mississippi lime"	37.6	6.350	4.092	3.220	33.76
94	SE¼ 13-34-6E	....	....	39.5	4.984	3.325	2.672	33.30
95	NE¼ 22-34-5E	2,980	"Bartlesville"	37.1	8.007	5.005	3.852	33.59
96	SE¼ 6-34-6E	2,945	do	36.7	9.530	5.904	4.483	33.29
97	SE¼ 32-33-6E	2,950	do	37.0	9.218	5.669	4.442	32.45
98	SE¼ 24-32-4E	1,458	"L. Peacock"	40.2	4.494	2.978	2.411	32.09
99	NE¼ 25-32-5E	3,000	"Mississippi lime"	37.5	6.858	4.439	3.486	35.05
100	NW¼ 30-32-6E	2,232	"Layton"	38.1	5.449	3.622	2.850	36.84
101	NW¼ 20-31-6E	2,970	"Bartlesville"	38.6	5.381	3.577	2.842	33.98
102	SW¼ 30-31-6E	2,990	do	40.1	4.449	3.016	2.426	29.06
103	NW¼ 32-31-6E	2,300	"Peru"	40.0	4.850	3.349	2.636	33.14
104	NW¼ 6-31-4E	2,840	"Bartlesville"	37.6	4.488	3.051	2.439	30.66
105	SE¼ 2-31-4E	3,000	do	38.5	4.006	2.799	2.273	32.27
106	NW¼ 2-31-4E	3,000	do	39.8	4.099	2.814	2.269	33.36
107	SW¼ 10-31-4E	3,000	do	40.5	3.853	2.666	1.416	31.84
108	SE¼ 21-31-4E	3,350	Arbuckle	37.8	4.464	2.992	2.402	28.93
109	SE¼ 21-31-4E	2,300	"Peru"	39.3	5.297	3.525	2.793	32.12
110	SE¼ 6-31-6E	(2,821) 2,849	"Bartlesville"	37.7	6.541	4.179	3.296	31.67
111	NE¼ 6-31-6E	(2,846) 2,883	do	34.9	9.180	5.668	4.329	34.11
112	SE¼ 31-30-6E	(2,840) 2,894	do	39.0	4.927	3.324	2.653	31.40
113	NE¼ 25-31-6E	2,170	"Layton"	33.7	12.430	6.815	5.105	33.92
114	NE¼ 10-32-7E	2,127	do	35.7	7.574	4.757	3.709	34.10
115	SW¼ 15-32-7E	2,850	"Bartlesville"	35.6	5.287	3.482	2.787	33.30
116	SW¼ 21-30-8E	2,220	Kansas City	35.2	8.364	5.163	3.828	35.34
117	SW¼ 16-30-8E	2,225	do	35.6	8.516	5.263	3.858	35.65
118	NW¼ 20-29-4E	1,900	Lansing	39.1	4.738	3.082	2.499	30.14
119	SE¼ 6-29-4E	2,530	Arbuckle	30.0	20.970	11.252	7.959	32.17
120	SE¼ 19-28-4E	2,496	do	32.4	8.450	5.166	3.842	31.42
121	SE¼ 13-29-4E	2,790	"Bartlesville"	37.3	5.339	3.538	2.824	33.43
122	SW¼ 36-28-5E	2,796	do	41.4	3.634	2.533	2.069	30.50
123	SW¼ 20-28-4E	1,700	Lansing	33.6	10.095	6.082	4.507	33.13
124	SE¼ 17-28-4E	2,450	Arbuckle	33.3	7.886	4.783	3.781	32.59
125	SW¼ 11-28-4E	2,600	Simpson	32.7	8.545	5.253	3.252	31.61
126	SE¼ 10-28-4E	2,000	Kansas City	33.3	8.138	5.072	3.900	32.17
127	NW¼ 34-29-5E	2,810	"Bartlesville"	38.1	5.521	3.547	2.817	31.07
128	SW¼ 33-29-5E	2,800	do	39.3	4.410	2.992	2.396	33.67
129	SE¼ 36-29-5E	2,800	do	40.9	3.878	2.701	2.256	29.66
130	NW¼ 23-28-3E	3,000	Simpson	32.6	10.663	6.372	4.801	34.01

TABLE 1.—*Physical properties of eastern Kansas crude oils (continued)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises			Interfacial tension, dynes cm. @ 60°F
					70°F.	100°F.	120°F.	
131	NE¼ 27-28-3E	3,025	do	31.0	13.258	7.751	5.906	33.06
132	SE¼ 32-27-3E	3,100	do	33.5	10.702	5.829	4.295	35.76
133	SW¼ 31-28-5E	2,794	"U. Bartlesville"	36.4	7.116	4.541	3.492	35.55
134	SE¼ 5-26-4E	2,200	Kansas City	32.8	14.386	8.042	5.834	34.33
135	SE¼ 5-26-4E	2,250	Viola	39.2	3.764	2.627	2.134	31.86
136	SE¼ 5-26-4E	2,450	Simpson	39.0	3.740	2.646	2.139	32.90
137	SE¼ 5-26-4E	2,270	Mississippian	43.3	2.687	1.945	1.637	31.69
138	SE¼ 17-23-4E	2,410	Viola	35.1	6.647	4.245	3.361	32.58
139	SE¼ 17-23-4E	2,175	Kansas City	34.2	14.079	7.772	5.755	33.18
140	SE¼ 17-23-4E	2,350	"Hunton"	33.9	7.408	4.687	3.613	31.92
141	NW¼ 4-23-4E	2,100	Kansas City	29.9	25.328	12.650	9.060	32.45
142	NW¼ 4-23-4E	2,400	"Hunton"	35.7	5.227	3.485	2.768	29.62
143	NW¼ 29-23-5E	2,475	Miss. "chat"	40.7	3.272	2.317	1.895	33.14
144	NW¼ 31-23-5E	2,475	do	41.4	3.210	2.280	1.863	34.71
145	NW¼ 6-24-5E	2,475	do	42.0	2.921	2.104	1.749	31.48
146	SE¼ 31-24-4E	2,710	"Potwin chat"	44.0	2.464	1.804	1.510	31.76
147	SW¼ 35-24-3E	2,725	"Mississippi lime"	42.0	2.849	2.043	1.676	32.50
148	NE¼ 12-25-3E	2,700	do	42.2	2.836	2.099	1.714	31.24
149	SW¼ 1-25-3E	2,700	do	43.3	2.790	2.030	1.675	33.83
150	NW¼ 36-25-3E	2,713	Miss. "chat"	44.0	2.666	1.945	1.605	31.76
151	NW¼ 1-26-3E	2,690	do	43.4	2.901	2.086	1.716	26.40
152	NW¼ 3-25-5E	2,544	Arbuckle	31.2	12.911	7.471	5.523	33.55
153	NW¼ 3-25-5E	2,445	Viola	34.7	6.776	4.305	3.327	29.06
154	NW¼ 2-25-5E	2,238	"Peru"	38.6	4.567	3.138	2.438	32.16
155	SW¼ 5-25-5E	722	Admire	34.9	6.825	4.345	3.404	28.58
156	SE¼ 34-27-5E	3,125	Arbuckle	33.3	10.283	6.226	4.723	31.39
157	NE¼ 22-27-5E	2,771	"Bartlesville"	32.9	15.121	6.788	4.913	27.53
158	SE¼ 15-27-5E	2,776	do	40.4	4.505	3.082	2.465	33.78
159	SW¼ 35-27-5E	2,770	do	39.8	4.686	3.172	2.530	31.46
160	NE¼ 24-29-5E	2,800	do	39.6	4.731	3.129	2.496	32.39
161	SW¼ 7-29-6E	2,835	"Mississippi lime"	39.0	5.122	3.385	2.696	33.48
162	NE¼ 28-29-6E	2,803	do	35.3	9.284	5.569	4.224	35.36
163	SE¼ 14-29-5E	2,800	"Bartlesville"	35.5	8.645	5.502	4.213	36.74
164	SW¼ 12-29-5E	2,800	do	37.8	5.631	3.635	2.868	30.76
165	NE¼ 26-28-5E	2,800	do	41.7	4.941	3.290	2.595	28.49
166	SE¼ 27-28-5E	2,800	do	41.9	5.032	3.348	2.657	30.70
167	SW¼ 19-27-6E	2,150	Kansas City	34.3	11.098	6.465	4.850	33.03
168	SW¼ 19-27-6E	2,750	"Bartlesville"	38.7	6.437	4.169	3.227	29.65
169	SW¼ 22-27-6E	3,050	Viola	35.4	5.892	3.806	2.986	32.42
170	NE¼ 9-27-6E	3,150	do	34.3	6.804	4.355	3.388	31.40
171	NE¼ 34-28-6E	2,138	Kansas City	35.3	9.003	5.591	4.332	33.94
172	SE¼ 34-28-6E	2,825	Mississippian	40.0	4.367	2.972	2.396	31.90
173	SE¼ 4-29-6E	2,800	"Bartlesville"	40.7	3.859	2.693	2.170	33.86
174	NW¼ 16-29-6E	2,500	"Peru"	35.3	12.513	7.079	5.331	36.77

TABLE 1.—*Physical properties of eastern Kansas crude oils (continued)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises 70°F.	100°F.	120°F.	Interfacial tension, dynes/cm @ 60°F.
175	NW¼ 34-27-6E	3,075	Viola	34.8	6.036	3.886	3.066	30.53
176	NE¼ 4-28-6E	3,083	do	35.8	5.538	3.633	2.891	31.56
177	NW¼ 11-28-6E	3,037	Simpson	36.3	5.641	3.661	2.909	31.26
178	NW¼ 16-26-8E	2,525	"Bartlesville"	37.8	6.323	4.139	3.272	36.17
179	NE¼ 9-26-8E	2,480	"Cattleman"	39.6	4.904	3.282	2.665	32.39
180	SE¼ 3-26-3E	2,706	Miss. "chat"	42.9	2.578	1.873	1.573	31.61
181	SW¼ 4-26-3E	2,771	do	44.5	2.855	2.047	1.686	30.16
182	SW¼ 23-27-4E	2,000	Kansas City	36.1	6.731	4.297	3.319	29.46
183	SE¼ 7-26-3E	2,866	Miss. "chat"	43.0	3.054	2.161	1.786	32.29
184	SW¼ 10-27-4E	2,035	Kansas City	32.8	14.184	8.063	5,978	34.94
185	SW¼ 10-27-4E	2,455	Arbuckle	40.1	4.176	2.842	2.308	31.21
186	SW¼ 23-26-7E	2,800	"Mississippi lime"	32.6	10.314	6.111	4.664	33.66
187	SE¼ 16-26-7E	2,731	do	33.8	9.191	5.630	4.282	35.36
188	SE¼ 20-26-7E	2,208	Kansas City	35.8	7.471	4.667	3.659	33.18
189	SW¼ 27-26-7E	2,700	"Mississippi lime"	33.1	10.385	6.245	4.637	33.94
190	SW¼ 27-26-7E	2,175	Kansas City	33.5	10.227	6.117	4.635	34.94
191	NW¼ 2-27-7E	2,655	"Bartlesville"	41.4	3.821	2.658	2.175	34.03
192	SE¼ 6-27-6E	3,100	Viola	34.2	9.511	5.719	4.296	29.58
193	NE¼ 6-27-6E	2,750	"Bartlesville"	34.7	9.062	5.632	4.264	33.22
194	NE¼ 14-28-5E	2,700	do	39.0	5.061	3.261	2.609	31.77
195	NW¼ 11-28-5E	2,700	do	38.6	4.982	3.309	2.659	31.25
196	NW¼ 21-28-8E	2,725	"Mississippi lime"	37.2	4.714	3.163	2.530	28.45
197	NE¼ 19-29-8E	2,784	do	40.0	3.514	2.459	2.021	30.54
198	SE¼ 33-29-8E	2,250	Kansas City	37.9	5.456	3.619	2.857	25.48
199	NW¼ 11-28-6E	2,750	"Mississippi lime"	34.7	7.868	4.905	3.714	32.76
200	20-26-5E	2,533	Arbuckle	33.8	7.830	4.951	3.763	34.77
201	20-26-5E	2,548	Simpson	33.5	7.729	4.932	3.747	28.72
202	20-26-5E	2,620	Viola	34.3	7.568	4.800	3.668	33.27
203	17-26-5E	2,455	Arbuckle	35.1	6.858	4.416	3.383	32.70
204	17-26-5E	1,694	Lansing	35.1	6.835	4.411	3.377	33.51
205	12-26-4E	2,400	Arbuckle	33.9	7.830	4.993	3.780	32.06
206	12-26-4E	1,703	Lansing	35.8	6.722	4.319	3.321	33.54
207	7-26-5E	2,432	Arbuckle	34.9	6.995	4.499	3.492	30.64
208	7-26-5E	1,711	Lansing	36.6	5.614	3.823	3.021	33.09
209	9-26-5E	2,427	Arbuckle	34.3	7.289	4.760	3.655	32.14
210	9-26-5E	2,580	Simpson	37.1	5.096	3.508	2.756	32.56
211	5-26-5E	2,455	Arbuckle	34.3	7.129	4.718	3.640	30.95
212	32-25-5E	636	Admire	36.5	5.804	3.955	3.127	28.74
213	29-25-5E	2,450	Simpson	38.0	4.484	3.139	2.487	32.12
215	33-25-5E	2,437	Arbuckle	36.8	6.707	4.330	3.371	23.61
216	33-25-5E	632	Admire	37.6	5.318	3.546	2.782	29.80
217	29-25-5E	638	do	37.5	5.476	3.605	2.774	26.18
218	29-25-5E	2,493	Arbuckle	36.7	5.544	3.659	2.901	23.92
219	20-25-5E	578	Admire	36.5	6.507	4.185	3.298	31.37

TABLE 1.—*Physical properties of eastern Kansas crude oils (continued)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises 70°F.	Viscosity, centipoises 100°F.	Viscosity, centipoises 120°F.	Interfacial tension, dynes @ 60°F
220	20-25-5E	703	do	37.2	5.609	3.707	2.945	33.94
221	21-25-5E	2,407	Arbuckle	34.9	6.969	4.483	3.469	12.64
222	21-25-5E	552	Admire	36.3	6.998	4.489	3.464	26.51
223	21-25-5E	665	do	35.6	7.072	4.483	3.348	33.24
224	21-25-5E	1,537	Douglas	37.0	5.791	3.807	2.992	27.34
225	21-25-5E	1,480	do	37.1	5.538	3.643	2.886	25.94
227	8-25-5E	2,458	Viola	37.4	4.942	3.301	2.640	33.34
228	8-25-5E	2,449	Arbuckle	38.3	4.421	2.996	2.428	28.9[illegible]
229	19-25-5E	2,561	"Mississippi lime"	44.5	2.441	1.757	1.467	27.65
230	33-25-5E	2,002	Kansas City	33.6	9.721	5.891	4.511	30.13
231	2-27-5E	2,700	"Bartlesville"	37.6	5.908	3.847	3.036	32.51
232	27-25-5E	2,250	Marmaton	37.8	4.842	3.223	2.575	31.57
233	NW¼ 11-28-6E	....	Arbuckle	36.0	5.664	3.695	2.891	29.04
234	SE¼ 22-28-7E	2,350	"Peru"	35.9	10.092	6.126	4.688	33.08
235	NE¼ 15-28-7E	2,700	"Mississippi lime"	36.1	7.175	4.545	3.539	32.70
236	NW¼ 8-28-7E	2,700	"Bartlesville"	38.2	5.670	3.559	2.775	26.80
237	SE¼ 26-26-5E	2,756	do	38.4	5.680	3.763	2.978	33.00
238	NW¼ 27-27-7E	2,750	do	40.9	4.645	2.911	2.340	32.04
239	NW¼ 13-27-7E	2,690	"Cattleman"	36.4	7.514	4.754	3.748	32.78
240	NW¼ 13-27-7E	2,100	Kansas City	37.4	5.103	3.385	2.693	30.92
241	NE¼ 14-27-7E	2,725	"Bartlesville"	39.9	4.500	3.055	2.465	26.11
242	NW¼ 23-27-7E	3,100	Arbuckle	30.8	16.868	9.230	6.654	29.23
243	NW¼ 23-27-7E	2,750	"Bartlesville"	41.9	3.866	2.673	2.166	30.72
244	SW¼ 29-26-8E	2,750	do	36.6	8.106	5.142	3.976	33.09
245	Lot 27 6-27-8E	2,750	do	37.2	5.884	3.838	2.996	32.43
246	NW¼ 36-27-8E	2,700	Arbuckle	30.7	23.665	12.258	8.552	33.75
247	NW¼ 36-27-8E	2,450	Mississippian	37.8	4.879	3.266	2.639	29.64
248	NW¼ 36-27-8E	1,825	"Peru"	35.7	6.368	4.109	3.213	32.28
249	SE¼ 35-27-4E	2,050	Kansas City	37.3	6.003	3.927	3.102	30.14
250	SE¼ 25-27-4E	2,565	Arbuckle	32.7	8.264	5.090	3.908	27.69
251	SE¼ 33-22-4E	2,125	Kansas City	32.9	18.109	9.763	7.083	33.37
252	SW¼ 14-22-4E	2,545	Viola	33.5	9.333	5.850	4.259	31.06
253	SW¼ 4-22-4E	2,460	"Hunton"	33.9	8.563	5.313	4.042	29.28
254	NE¼ 26-17-4E	2,350	"Mississippi lime"	36.5	8.994	5.756	4.460	34.28
255	NE¼ 34-16-4E	2,350	Miss. "chat"	35.7	11.269	7.134	5.495	34.85
256	NE¼ 32-17-4E	2,400	do	36.5	8.700	5.558	4.336	31.95
257	NE¼ 33-16-4E	2,350	do	31.6	20.044	11.324	8.180	32.52
258	SW¼ 9-17-4E	2,350	do	35.5	10.632	6.587	5.016	35.55
259	NW¼ 10-18-4E	2,375	do	36.8	8.416	5.385	4.182	32.02
260	SW¼ 28-18-4E	2,375	do	41.7	4.432	3.078	2.534	31.17
261	SE¼ 6-19-4E	2,375	do	31.9	13.182	7.791	5.904	33.67
262	SE¼ 12-19-2E	2,850	Viola	32.5	30.398	16.033	11.419	35.60
263	NW¼ 34-18-2E	....	do	31.5	34.918	18.506	12.765	37.35
264	SW¼ 27-19-1E	2,830	do	18.7	235.000	82.000	50.000	46.58

TABLE 1.—*Physical properties of eastern Kansas crude oils (continued)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises 70°F.	100°F.	120°F.	Interfacial tension, dynes/cm @ 60°F.
265	SW¼ 27-19-1E	2,930	Simpson	29.7	68.000	30.000	26.000	35.78
266	SW¼ 11-21-3E	2,800	"Hunton"	38.1	44.922	17.197	11.423	26.27
267	NE¼ 31-20-5E	2,550	"Misener"	37.5	4.990	3.366	2.697	29.78
268	NE¼ 29-21-4E	2,400	Viola	33.0	10.458	6.270	4.696	31.96
269	NW¼ 12-22-3E	2,474	"Mississippi lime"	36.3	7.553	4.676	3.644	30.83
270	SE¼ 17-21-4E	2,050	Kansas City	32.5	21.882	11.357	8.075	31.20
271	SE¼ 17-21-4E	2,380	"Hunton"	33.1	10.143	6.170	4.658	22.46
272	SE¼ 17-21-4E	2,400	Viola	32.4	9.798	5.959	4.486	34.64
273	SW¼ 21-21-5E	2,302	do	31.7	10.949	6.564	4.916	32.61
274	SW¼ 6-17-1E	2,689	Miss. "chat"	33.5	11.685	6.984	5.202	34.94
275	NW¼ 31-14-1E	2,500	"Burgess"	32.5	16.417	9.324	6.830	21.63
276	NW¼ 26-2-14E	2,874	"Hunton"	22.8	648.000	260.000	142.000	38.24
277	NW¼ 27-2-14E	3,560	Viola	28.3	58.000	30.000	27.000	36.86
278	NW¼ 13-2-14E	2,826	"Hunton"	25.1	178.000	88.000	42.000	36.87
279	SW¼ 3-1-15E	2,580	do	26.0	142.000	52.000	37.000	37.35
280	3-10-20E	1,450	McLouth	23.4	124.000	72.000	42.000	37.37
281	NE¼ 15-17-5E	2,265	Miss. "chat"	33.8	21.383	10.660	7.720	32.89
282	NE¼ 2-17-5E	2,200	do	29.5	27.000	17.000	12.000	35.92
283	26-16-5E	2,200	do	31.0	21.000	15.000	10.000	34.13
284	SW¼ 10-11-22E	....	"Peru"	30.0	22.71	12.60	8.94	37.82
285	SE¼ 26-17-21E NE¼ 35-17-21E	....	do	32.4	14.97	8.11	6.02	19.98
286	15-17-21E	....	do	32.1	15.11	8.55	6.63	33.44
287	NW¼ 15-17-21E	....	"Squirrel"	32.2	14.89	8.84	6.61	34.06
288	SW¼ 32-16-21E	....	do	31.6	17.66	10.01	7.13	33.27
289	NW¼ 29-18-23E	....	"Peru"	28.2	37.15	19.43	14.10	31.76
290	NE¼ 27-18-22E	....	do	28.0	40.37	20.94	14.96	32.59
291	SW¼ 26-18-22E	....	do	27.9	50.3	37.0	29.2	32.38
292	19-17-24E	....	do	33.4	10.79	6.68	5.04	28.99
293	NW¼ 4-17-23E	....	do	33.6	9.51	5.96	4.42	31.94
294	NW¼ 36-16-21E	....	"Squirrel"	29.3	27.9	14.6	10.6	22.41
295	NW¼ 36-16-21E	....	do	33.2	12.50	7.34	5.74	38.61
296	2-20-20E	....	do	28.0	23.46	12.54	8.72	33.58
297	....	....	do	35.1	8.97	5.87	4.28	26.35
298	N½ 16-21-20E	....	do	34.8	8.33	5.64	4.25	29.26
300	33-20-21E	....	"Squirrel"	36.1	6.70	4.41	3.51	33.05
301	34-21-19E	....	do	28.2	8.35	5.25	4.17	37.54
302	27-27-18E	....	"Bartlesville"	30.5	17.46	10.16	6.84	37.20
303	15-27-19E	....	do	27.9	46.0	36.2	22.5	35.86
304	19-26-20E	....	do	29.8	26.59	14.30	9.64	33.27
305	13-26-19E	....	do	31.4	14.73	8.72	6.17	33.27
306	(33-34)-27-19E	....	do	32.3	13.62	8.21	6.00	34.51
307	32-27-19E	....	do	31.6	14.99	8.39	6.27	37.82
308	26-28-19E	....	do	29.9	21.92	12.09	8.93	32.55

TABLE 1.—*Physical properties of eastern Kansas crude oils (continued)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises 70°F.	100°F.	120°F.	Inter- ten- dyne-
309	35-28-20E	....	"Bartlesville"	30.5	17.20	8.36	6.97	[illegible]
310	NE¼ 31-28-23E	....	do	28.6	26.48	14.13	9.88	[illegible]
311	W½ 28-28-22E	....	do	27.3	39.43	20.16	13.86	[illegible]
312	SE¼ 19-30-21E	....	do	29.4	21.80	12.07	8.90	[illegible]
313	S½ 19-27-22E	....	do	26.3	63.5	43.0	41.5	[illegible]
314	9-15-20E	....	"Squirrel"	25.5				[illegible]
315	22-15-20E	....	do	24.8	74.0	35.0	20.0	[illegible]
316	11-15-20E	....	do	24.0	105.0	71.0	52.0	[illegible]
317	2-22-19E	....	do	36.2	7.49	4.65	3.77	[illegible]
318	28-22-19E	....	do	33.7	10.97	6.96	5.16	[illegible]
319	N½ 27-23-18E	....	do	31.6	19.03	10.69	7.97	[illegible]
320	NW¼ 22-24-18E	....	"Bartlesville"	18.9	216.0	152.0	63.0	[illegible]
321	16-26-18E	....	do	30.1	19.69	10.80	7.92	[illegible]
322	SW¼ 16-26-21E	....	do	32.2	13.56	7.93	5.93	[illegible]
323	SE¼ 32-25-21E	....	do	29.6	21.54	11.68	8.44	[illegible]
324	SW¼ 34-24-20E	....	do	21.8	118.0	58.0	38.0	[illegible]
325	NE¼ 33-24-21E	....	do	27.5	33.59	17.14	11.76	[illegible]
326	32-22-21E	....	do	28.1	33.73	17.53	11.93	[illegible]
327	3-24-17E	....	Mississippian	33.1	10.65	6.43	4.85	[illegible]
328	24-23-16E	....	"Squirrel"	....	....	....	....	[illegible]
329	28, 27-25-17E	....	do	27.5	24.0	14.0	12.0	[illegible]
330	26-24-21E	....	"Bartlesville"	31.0	16.84	9.52	6.94	[illegible]
331	22-23-21E	....	do	25.9	65.5	37.5	31.0	[illegible]
332	9-22-21E	....	do	30.2	21.88	12.07	8.75	[illegible]
333	14-21-22E	....	"Squirrel"	32.6	15.22	8.77	6.52	[illegible]
334	30,29,20,19-20-22E	....	do	29.1	26.10	12.88	9.63	[illegible]
335	10-20-23E	....	"Peru"	22.7	126	54	34	[illegible]
336	NW¼ 22-17-22E	....	do	30.4	20.09	11.36	7.94	[illegible]
337	SW¼ 10-17-22E	....	"Squirrel"	29.1	30.0	25.0	21.5	[illegible]
338	20-28-18E	800	"Bartlesville"	33.1	12.61	7.30	5.54	[illegible]
339	2-28-18E	800	do	29.5	17.58	....	7.49	[illegible]
340	2-29-16E	900	do	25.3	63.51	29.18	19.83	[illegible]
341	16-29-17E	950	do	27.9	19.84	10.95	8.06	[illegible]
342	24-29-16E	950	do	27.4	55.82	25.36	17.20	[illegible]
343	21,22-30-16E	800	do	30.4	6.96	4.45	3.60	[illegible]
344	28-30-16E	800	do	39.0	4.90	3.32	2.72	[illegible]
345	8-30-16E	800	do	36.3	8.76	5.29	4.37	[illegible]
346	7-30-16E	890-950	do	38.7	5.12	3.48	2.83	[illegible]
347	27-29-15E	1,050	"Burgess"	....	....	....	....	[illegible]
348	3-31-16E	950	"Bartlesville"	36.4	7.21	4.61	3.65	[illegible]
349	25-27-16E	900	do	31.5	11.23	6.83	5.41	[illegible]
350	24-27-16E	1,000	do	30.6	24.15	12.83	9.73	[illegible]
351	34-26-14E	950	do	29.3	35.29	17.87	13.27	[illegible]
352	23-26-14E	1,200	do	22.2	89	64	36	[illegible]

TABLE 1.—*Physical properties of eastern Kansas crude oils (continued)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises 70°F.	100°F.	120°F.	Interfacial tension, dynes/cm @ 60°F.
353	28-25-14E	1,450	"Bartlesville"	40.8	3.87	2.69	2.38	24.99
354	9-33-15E	1,150	do	37.2	5.90	3.97	3.11	24.38
355	2-34-15E	1,200	do	29.7	30.86	16.14	11.62	30.31
356	11-34-14E	650	"Wayside"	31.7	21.54	12.11	8.90	35.24
357	8-34-14E	650	do	31.0	26.3	18.0	15.5	....
358	3-35-14E	1,280	"Bartlesville"	35.7	21.08	5.18	4.01	23.74
359	4-35-15E	1,160	do	30.3	16.98	9.06	6.79	29.87
360	21,22,13-34-15E	380-500	"Wayside"	31.4	19.86	11.21	8.50	29.65
361	13-34-14E	630	do	29.8	27.87	14.42	11.05	26.13
362	24-34-15E	630	do	33.6	105.85	39.32	11.46	36.55
363	1-34-15E	1,550	Arbuckle	24.5	112.0	50.0	33.0	32.38
364	1-34-15E	840	....	33.3	17.68	9.95	7.28	35.42
365	17-25-17E	1,200	....	24.2	79.89	32.71	20.84	27.52
366	36-35-20E	850	....	....	....	....	....	23.76
367	30-34-17E	850	"Bartlesville"	31.2	21.63	11.72	8.53	34.03
368	7-34-17E	350	"Peru"	31.4	21.05	11.78	8.42	29.98
369	10-34-17E	325	do	27.1	59.0	34.0	25.0	25.93
370	12-33-16E	1,370	Arbuckle	26.9	48.59	22.16	15.06	33.81
371	3-33-16E	900	Hays	24.9	70.0	50.0	35.0	42.91
372	1-32-16E	900	"Bartlesville"	33.5	11.43	6.93	5.41	30.91
373	6-32-17E	590	"Peru"	29.5	30.68	16.16	11.94	32.11
374	33-31-17E	....	....	33.1	12.54	7.18	5.52	34.06
375	10-32-17E	725	"Bartlesville"	31.3	18.66	10.20	7.57	25.55
376	11-31-17E	675	do	26.7	48.80	23.17	15.94	37.06
377	25-32-17E	680	"U. Bartlesville"	22.5	120.0	67.0	42	31.31
378	23-32-18E	700	"Bartlesville"	29.4	27.78	14.23	10.06	29.24
379	8-33-18E	600	do	31.5	18.68	10.60	7.42	29.42
380	23-32-17E	1,100	do	31.3	16.21	9.10	6.82	31.37
381	12-35-16E	280	"Peru"	31.7	19.46	10.87	8.64	32.33
382	6-35-17E	580	"Squirrel"	30.8	20.23	11.13	8.14	16.66
383	12-31-16E	900	"Bartlesville"	36.6	6.59	4.26	3.43	26.66
384	30-31-16E	500	"Wayside"	33.9	11.74	6.96	5.34	44.39
385	5-32-16E	1,000	"Bartlesville"	32.4	15.06	8.52	6.48	28.08
386	15-34-13E	760	"Wayside"	32.6	14.65	8.51	6.43	29.05
387	22-34-12E	1,000	"Peru"	35.2	9.03	5.92	4.49	29.54
388	19-34-12E	1,000	do	33.7	11.88	7.11	5.42	33.71
389	15-34-11E	1,175	do	35.9	8.70	5.59	4.42	37.58
390	3-34-11E	1,000	do	34.0	15.0	12.0	10.5	34.49
391	36-33-11E	1,300	do	36.8	7.87	4.85	3.90	23.28
392	14-33-10E	1,225	do	34.4	11.53	7.95	5.42	36.72
393	32-33-11E	1,320	do	31.1	20.16	11.08	8.27	34.36
394	27-33-11E	1,200	do	33.5	12.71	7.55	5.97	33.03
395	26-33-11E	1,180	do	34.2	11.96	6.89	5.26	33.69
396	32-33-12E	1,000	do	33.6	10.74	6.56	5.12	30.98

TABLE 1.—*Physical properties of eastern Kansas crude oils (continued)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises 70°F.	100°F.	120°F.	[illegible]
397	27-33-12E	1,000	"Peru"	35.1	9.71	6.31	4.68	[illegible]
398	5-33-16E	1,340	Arbuckle	23.4	158.0	80.0	42.0	[illegible]
399	20-32-16E	475-495	Pink limestone 100 ft. above Oswego	32.0	20.06	11.17	8.43	[illegible]
400	36-32-13E	900-1,000	"Peru"	30.7	24.24	12.98	9.48	[illegible]
401	11-33-14E	1,200	"Bartlesville"	29.8	33.77	18.24	12.90	[illegible]
402	3-32-15E	1,000	do	37.5	5.52	3.64	2.95	[illegible]
403	4-27-18E	713-729	do	28.8	27.40	14.36	9.78	[illegible]
404	1-35-11E	1,000	"Peru"	33.8	11.54	6.81	5.33	[illegible]
405	13-35-11E	1,000	do	35.4	8.58	5.33	4.39	[illegible]
406	5-35-13E	700	"Red sand"	35.4	9.95	6.26	4.89	[illegible]
407	18-35-10E	1,600	"Peru"	....	....	....	....	[illegible]
408	1-32-10E	1,500-1,600	Arbuckle	37.8	7.15	4.42	3.54	[illegible]
409	18-32-10E	2,300	do	....	....	....	....	[illegible]
410	8-32-11E	2,200	....	35.1	6.84	4.24	3.37	[illegible]
411	1-32-10E	2,300	Arbuckle	32.4	13.67	7.34	5.53	[illegible]
412	4-29-13E	600-650	"Wayside"	32.0	16.33	9.19	6.81	[illegible]
413	14-31-13E	1,645	Kansas City	34.6	9.16	5.66	4.42	[illegible]
414	34-29-10E	1,327	do	35.9	6.65	4.29	3.61	[illegible]
415	12-29-8E	2,000	do	37.8	5.26	3.22	2.59	[illegible]
416	2-28-11E	1,197	do	24.7	9.82	5.78	4.57	[illegible]
417	34-29-10E	1,987	Mississippian	34.3	14.48	6.38	5.06	[illegible]
418	5-35-12E	1,150	"Peru"	33.6	13.14	7.62	5.78	[illegible]
419	26-34-10E	1,400	do	37.8	6.03	4.03	3.20	[illegible]
420	4-36-12E	....	....	34.6	10.59	6.45	5.03	[illegible]
421	31-34-12E	1,100	"Peru"	36.2	10.37	6.23	4.90	[illegible]
422	20-33-12E	935	do	37.5	11.46	7.27	5.86	[illegible]
423	8-32-10E	1,700	"Chat"	37.7	12.76	7.59	5.80	[illegible]
424	23-32-10E	1,900	Mississippian	32.4	11.98	6.94	5.30	[illegible]
426	30-30-11E	1,300-1,400	Kansas City	33.1	10.99	6.20	4.74	[illegible]
428	7-24-14E	1,725	Mississippian	37.2	5.56	3.62	2.89	[illegible]
429	14-24-12E	1,600	"Bartlesville"	38.3	4.09	2.83	2.38	[illegible]
430	21-23-11E	1,900	do	40.2	3.84	2.65	2.18	[illegible]
431	6-24-12E	1,750	do	40.0	3.90	2.72	2.22	[illegible]
432	11-23-13E	1,600	do	38.7	4.71	3.16	2.53	[illegible]
433	15-22-13E	1,800	Mississippian	38.7	4.75	3.19	2.61	[illegible]
434	35-22-16E	950	"Squirrel"	24.0	142.0	69.0	45.0	[illegible]
435	36-35-10E	2,000	Mississippian	32.8	9.34	5.62	4.25	[illegible]
437	27-25-15E	1,480	do	31.2	13.55	7.67	6.04	[illegible]
438	5-24-15E	1,570	do	22.0	381.0	173.5	106.5	[illegible]
439	2-24-15E	1,520	do	30.5	16.10	8.94	6.88	[illegible]
440	31-23-15E	1,570	do	43.6	4.31	2.92	2.38	[illegible]
441	12-23-14E	1,540	do	42.0	4.24	2.93	2.46	[illegible]

TABLE 1.—*Physical properties of eastern Kansas crude oils (concluded)*

Sample no.	Location	Depth, feet	Formation	Gravity, A.P.I. corrected @ 60°F.	Viscosity, centipoises 70°F.	100°F.	120°F.	Interfacial tension, dynes/cm @ 60°F.
442	4-24-14E	1,550	Mississippian	38.8	4.63	3.25	2.66	20.95
443	16-23-15E	1,540	do	35.3	7.59	4.82	3.83	21.99
444	18-30-9E	2,580	do	34.9	8.84	5.42	4.31	34.77
445	12-31-12E	580	"Wayside"	32.1	17.22	9.84	7.38	33.39
446	23-31-10E	1,960-1,980	"Mississippi lime"	31.1	13.45	7.66	5.94	36.21
447	34-31-12E	700	"Wayside"	31.3	20.82	11.77	8.41	34.89
448	33-31-12E	480	"Stray sand"	25.8	63.63	28.13	19.00	34.74
449	34-29-9E	2,303	Mississippian	34.8	9.13	5.24	4.15	41.22
450	13-31-9E	2,270	do	33.6	11.18	6.50	5.10	12.26
451	3-31-8E	1,975-1,985	Kansas City	33.6	10.39	6.28	4.88	33.58
452	21-31-9E	2,300	Mississippian	37.2	5.73	3.71	3.06	31.34
453	23-30-8E	2,000	Kansas City	32.0	15.01	8.58	6.19	37.81

