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SECONDARY RECOVERY OPERATIONS IN KANSAS

During 1962



BY
THE KANSAS SECONDARY RECOVERY COMMITTEE

E.D. Goebel and M. C. Colt, Co-Chairmen

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SUMMARY OF SECONDARY RECOVERY OPERATIONS IN KANSAS DURING 1962

INTRODUCTION

Data contained in this survey have been assembled through the efforts of the Conservation Division of the Kansas Corporation Commission in cooperation with the Kansas Geological Survey. A state Secondary Recovery Committee appointed to assist in the accumulation and interpretation of information relative to secondary recovery projects in Kansas has the following membership:

E. D. Goebel, Co-Chairman Kansas Geological Survey The University of Kansas Lawrence, Kansas	Mack C. Colt, Co-Chairman Mack C. Colt, Inc. P. O. Box 427 Iola, Kansas	E. E. Funk Cities Service Oil Co. Cities Service Building Bartlesville, Oklahoma
Carl L. Pate Oilfield Research Lab. Chanute, Kansas	Carrol F. Mahoney Core Laboratories, Inc. 709 Petroleum Building Wichita, Kansas	John Roberts Oil and Gas Conserv. Div. Kansas Corp. Commission 500 Insurance Building Wichita, Kansas
V. W. McKnab P. O. Box 808 Winfield, Kansas	Gene Rowe Vance Rowe, Inc. 217 Midco Building Tulsa Oklahoma	Lester Wilkonson 409 Schweiter Building Wichita, Kansas
R. F. Ramsey Barbara Oil Company 322 Central Building Wichita, Kansas	C. R. Wallen Continental Oil Company P. O. Box 267 Great Bend, Kansas	Robert L. Dilts Kansas Geological Survey 4150 Monroe Street Wichita, Kansas
Tom L. Schwinn Kansas Independent Oil and Gas Association Union Center Building Wichita, Kansas		J. M. Penrod James A. Lewis Engineering, Inc. 1500 Wichita Plaza Building Wichita, Kansas

In recent years, secondary recovery projects in Kansas have contributed an increasingly larger proportion of the total crude oil produced in Kansas. This trend has been observed also in other oil-producing states. Because of the increasing importance of oil production from secondary recovery projects in each state's oil economy and in the interest of conservation, the Interstate Oil Compact Commission, through its Secondary Recovery and Pressure Maintenance Committee, has encouraged the collection and distribution of information pertaining thereto. The amount of oil attributable to secondary recovery or pressure maintenance methods can be determined only by the judgment of the individual operator. For this reason, it was necessary to survey all active projects and all operators holding secondary recovery permits in Kansas.

The committee wishes to thank the operators for the good response to the survey which is probably the most complete secondary recovery survey ever made for Kansas. Nevertheless, it is hoped that the response to questionnaires for 1963 will be even better, as the value of the survey to the petroleum industry improves with the completeness of the data available.

The organizational meeting of the Kansas Secondary Recovery Committee was held on May 28, 1963, at the Kansas Corporation Commission's Conservation Division offices in Wichita, Kansas. At that time Mack C. Colt and E. D. Goebel were elected Co-Chairmen. The questionnaire on secondary recovery operations in Kansas was prepared in accordance with the rules and regulations of the Kansas Corporation Commission by a pilot committee consisting of John Roberts, Lester Wilkonson, and E. D. Goebel, with help from a representative of the Interstate Oil Compact Commission, and was submitted to the committee for approval. The committee recommended that the data collected by way of the questionnaires from the operators should be placed on key-punch cards so that manipulation by modern computer methods could be possible. The Kansas Geological Survey acted for the committee as the agency for assembling the data into publication form after the questionnaires were completed by the individual operators and returned to the Kansas Corporation Commission's Conservation Division. In this way only one agency requested information from the petroleum industry on secondary recovery statistics in Kansas during 1962..

The data was key-punched onto cards and a program was written under the direction of Dr. Floyd Preston to be processed on an IBM 1620 Computer at The University of Kansas. Assisting the committee in gathering data, tabulation, key-punching, programming, and manuscript preparation were: Douglas Beene, S. S. Greider, Dean Lebetsky, and Robert L. Walters.

SECONDARY RECOVERY

In Kansas, many oil reservoirs are inefficiently produced by the primary sources of energy inherent to the reservoir, usually gas expansion, and a secondary means of furnishing energy to move the oil to the wellbore must be provided. In most oil reservoirs it is possible, when the natural energy for production has declined, to bring about increased oil production by injection of either gas or water into the reservoir. If such injection takes place while the reservoir pressure is high and the producing wells are in the flowing stage, the operation is classified as pressure maintenance. If it is started after the pressure has been substantially depleted and the field is in the pumping stage, it is classified as secondary recovery, repressuring, or water-flooding. Only the operators of an oil field can make the judgment as to when a field is in the secondary recovery stage.

The general rules and regulations for the conservation of crude oil and natural gas in Kansas issued by the State Corporation Commission have specific sections dealing with the application, approval, operation, and discontinuance of fluid repressuring and water-flooding of oil and gas properties in Kansas. Applications for permanent disposal of brines produced from Kansas oil and gas fields also comes under the jurisdiction of the Conservation Division. The permanent disposal of brines differs from water-flooding or

secondary recovery operations in that disposal is in other than the producing zones (oil and gas reservoirs).

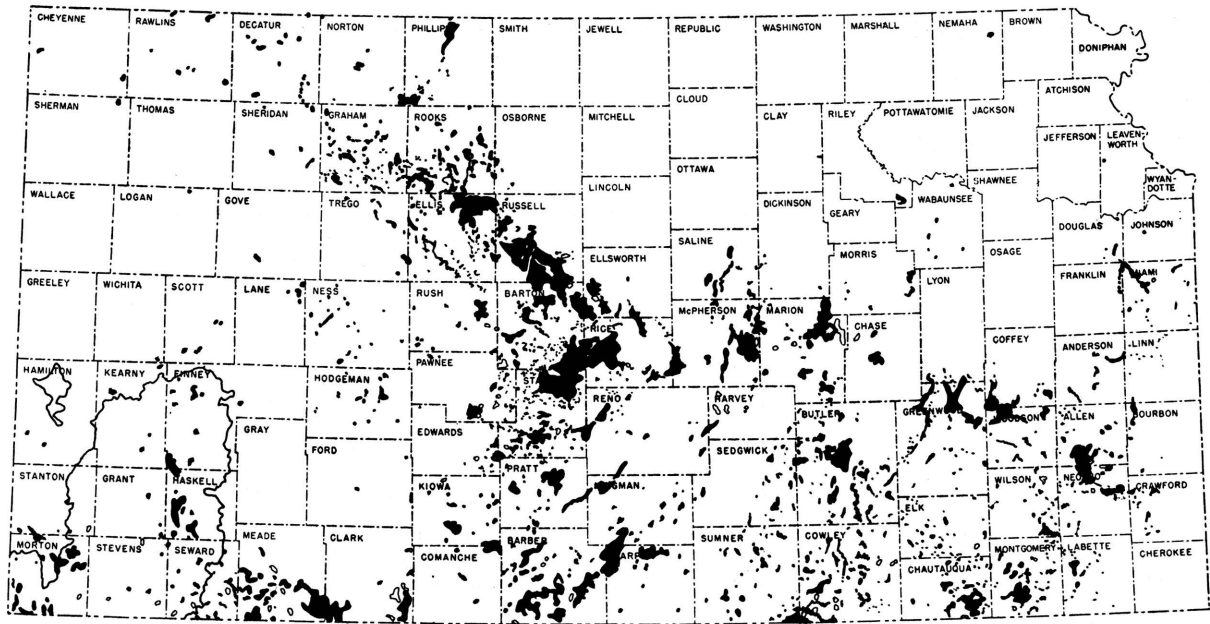
THE 1962 SECONDARY RECOVERY SURVEY

The data resulting from the 1962 survey of secondary recovery projects in Kansas are presented in Table 1 (in pocket). This is a direct "print-out" of information on the punch cards. A key to the various abbreviations and coding which appear in Table 1 is footnoted.

An index map showing the general location and extent of the Kansas oil and gas fields is presented as Figure 1. Detailed total production statistics for all Kansas oil and gas fields are given in Oil and Gas Developments in Kansas During 1962 (Bulletin 166, Kansas Geological Survey), as well as a map of Kansas (1"=500,000') on which the oil and gas fields are named and located. The locations of pipelines and allied petroleum industries in Kansas also are available in map form at the same scale (M-2, Kansas Geological Survey).

Of the 940 projects listed in Table 1, 146 reported no production attributable to secondary recovery during 1962 and no entry was made in that space of the questionnaire in 143 projects. Therefore, a total of 289 projects reported no oil production attributable to secondary production during 1962. It should, however, not be interpreted that all of these had no secondary recovery. In addition, 130 of the 940 entries represented Multiple Order Numbers (Conservation Division permits for project extensions). Therefore, from a total of 940 entries in Table 1, 521 projects had secondary recovery production specifically reported during the year. A total of 15,891,000 barrels of oil from 10,297 producing wells was reported from these 521 projects.

During 1962, the Conservation Division of the State Corporation Commission issued 144 permits for secondary recovery operations, two less than in 1961. Of these 144 permits issued, some were to new projects but some were to extension of former projects, and represent a portion of 146 projects for which no information on secondary recovery production was attributable during the year. The approximately 15.9 million barrels of oil reported as secondary recovery production for the year 1962 in Kansas represents only that which was reported on the questionnaires and is not necessarily an accurate figure. Assuming that 90 percent of the secondary recovery project operators in Kansas returned questionnaires, and also assuming that the 10 percent that did not return questionnaires actually produced oil that should have been added to the total of secondary recovery during 1962, and taking into consideration the factors discussed above, it is reasonable to assume that about 3 million more barrels of oil could be designated as secondary recovery oil.



□ GAS

■ OIL

Figure 1. Index map of Kansas oil and gas fields.

As an example of the incompleteness of the survey, about 511,000 barrels of oil is reported as attributable to secondary recovery projects from Allen County in 1962, yet the total amount of oil produced in the county during the year was approximately 900,000 barrels. A review of all operations in the county during 1962 would indicate that actually 85-90 percent of the county is under secondary recovery operations.

These factors should not negate the results from the survey but the results should be examined carefully and interpretations made with caution. The data presented on an individual project basis in Table 1 could be evaluated on a project basis as valid but a total of all projects would not represent the total secondary recovery oil in the state. It is anticipated that surveys similar to the one made in 1962 will be conducted annually by the Kansas Secondary Recovery Committee, aided by the Kansas Corporation Commission's Conservation Division and the Kansas Geological Survey. Attempts will be made to fill in those voids in information to the extent that future surveys will be more and more complete.

Table 2 presents a county summary of secondary recovery projects in Kansas during 1962. Included are county totals of secondary oil produced, number of producing wells, and number of acres. Data on the amount of water injected, number of injection wells

and the oil production to water injection ratio are presented. Water production and oil per acre are also listed. The oil production to water injection ratios are calculated on a project weighted basis.

Example:

Crawford County		
<u>M Bbls. Water Injected</u>	<u>M Bbls. Oil Produced</u>	<u>Calculations</u>
2	** (< 500 bbl; >1 bbl)	** ÷ 2 = .000
206	13	13 206 = .063
-1	-1 (no data)	none
-1	-1 (no data)	none
6	2	2 ÷ 6 = .333

$.000 + .063 + .333 = .396 \div 3$ (projects) = .132 oil produced/water injected ratio

The oil per acre figures are simple divisions of the two factors involved. Caution should be used here also to evaluate the completeness of the basic project data presented in Table 1.

Butler County had the most oil attributed to secondary recovery projects in 1962 with approximately 3,408,000 barrels from 1,198 wells. Greenwood County was second and Cowley and Russell were third and fourth. The total oil production reported in the survey amounted to 15,891,000 barrels from 10,297 wells. There were 6,428 active injection wells which accounted for 250,022,000 barrels of water. This represents approximately twice the volume of oil produced by all methods in Kansas during 1963, or about two barrels of water (mostly brine) for each barrel of oil produced by all methods in Kansas in 1962.

Table 3 presents information on a formation or "pay zone" basis. The "Bartlesville sand" yielded the most oil by secondary recovery methods, 5,058,000 barrels. The second most important zone was the Lansing with 2,531,000 barrels of oil. Of the pay zones accredited with more than 100,000 barrels of secondary recovery oil during 1962, the "Squirrel" had the highest ratio (.677) of average injection pressure (in p.s.i.) to average depth to top of pay zone.

TABLE 2. SUMMARY OF 1962 SECONDARY RECOVERY PROJECTS IN KANSAS, BY COUNTY

Counties	Oil Production, (Mbbbl)		No. Producing Wells,		Acreage,		Water Inject., (Mbbbl)		No. Injection Wells,		Oil-Water Ratio*	Water Production, (Mbbbl)	Oil Per Acre, (Bbls)
			Active	Inact.	Current	Add.			Active	Inact.			
Allen	511		1,085	141	4,971	1,156	8,931		732	159	.142	2,281	102
Anderson	350		1,062	38	3,203	518	5,656		830	39	.088	3,277	109
Barber	57		61	14	2,620	480	3,522		12	1	.126	45	21
Barton	143		169	26	4,819	770	4,435		70	13	.044	10,351	29
Bourbon	84		65	1	700	480	292		65	0	.309	119	120
Butler	3,408		1,198	108	18,804	2,489	59,521		930	36	.078	41,729	181
Chase	0		7	1	240	0	127		1	1	--	99	--
Chautauqua	24		176	19	1,801	350	633		103	10	.196	117	13
Clark	57		21	1	2,960	0	657		7	0	.105	20	19
Cowley	1,766		425	84	13,357	1,210	22,536		286	46	.103	11,725	132
Crawford	15		70	0	368	100	214		72	0	.132	69	40
Decatur	78		40	0	1,294	560	835		11	0	.138	593	60
Dickinson	0		3	1	160	160	0		3	1	--	0	0
Douglas	0		5	1	0	0	0		0	0	--	0	0
Edwards	11		5	0	140	0	191		2	0	.059	191	78
Elk	21		47	18	240	180	522		21	4	.117	390	87
Ellis	60		60	2	2,150	30	1,030		23	0	.081	813	27
Ellsworth	30		14	0	640	120	212		6	0	.066	25	46
Finney	0		5	0	240	480	144		2	1	.000	144	--
Franklin	214		355	27	1,575	590	3,976		389	37	.092	3,146	135
Graham	138		234	13	9,121	660	3,236		67	3	.278	1,288	15
Greenwood	2,057		1,003	221	17,755	1,745	42,222		654	203	.078	31,744	115
Harper	0		0	0	0	0	0		0	0	--	0	--
Harvey	0		0	0	0	0	0		0	0	--	0	--
Hodgeman	95		15	0	960	0	364		4	0	.260	107	98
Kingman	41		18	1	775	80	716		10	2	.032	432	52
Labette	49		109	66	755	570	512		47	20	.245	153	64
Linn	20		116	0	260	50	613		103	9	.038	422	76
Lyon	11		19	2	714	160	216		11	2	.087	63	15

Marion	35	43	1	1,460	400	975	19	0	.022	903	23
McPherson	412	193	82	5,910	420	13,347	79	21	.089	13,524	69
Meade	341	21	4	1,839	0	1,233	10	0	.276	271	185
Miami	254	495	21	1,486	810	3,438	472	52	.107	1,607	170
Montgomery	22	176	27	610	910	437	35	53	.052	50	36
Neosho	189	452	33	2,798	1,996	2,110	290	43	.216	148	67
Ness	34	17	0	500	80	387	5	0	.087	387	68
Pawnee	54	28	3	859	640	788	21	1	.024	371	62
Phillips	353	125	2	7,765	580	2,473	47	0	.127	942	45
Pratt	390	126	23	3,600	1,250	4,006	33	6	.121	1,908	108
Reno	127	37	11	2,630	320	3,976	14	1	.034	1,576	48
Rice	366	185	4	5,506	250	3,909	48	2	.068	1,939	66
Rooks	120	89	5	3,210	1,040	1,645	29	1	.312	1,327	37
Rush	33	29	1	550	80	1,526	8	3	.008	307	60
Russell	1,297	519	25	17,520	1,900	15,990	269	3	.091	8,667	74
Saline	66	54	5	2,294	0	650	18	3	.140	638	28
Sedgwick	595	181	4	2,391	0	9,059	56	0	.076	2,628	248
Sheridan	57	51	2	1,466	0	1,271	12	3	.087	396	38
Stafford	269	98	18	4,178	13	1,782	42	6	.194	690	64
Sumner	741	149	27	4,413	0	8,123	78	10	.075	3,014	167
Trego	49	21	3	1,060	0	772	8	0	.145	148	46
Wilson	217	256	97	1,219	2,560	1,716	134	47	.124	174	178
Woodson	258	356	91	4,438	592	2,979	153	28	.094	1,090	58
Allen & Neosho	70	39	2	175	80	180	18	1	.388	100	400
Barton & Rice	10	18	0	370	0	195	7	0	.051	147	27
Ellis & Rooks	55	31	2	337	327	800	10	2	.067	487	163
Ellis & Russell	56	14	0	450	0	347	3	1	.161	291	124
Kingman & Pratt	56	29	8	1,100	0	1,613	22	2	.034	501	50
Kingman & Sedgwick	72	34	11	445	530	1,738	19	0	.041	827	161
McPherson & Harvey	46	11	3	350	0	522	2	1	.088	522	131
Rice & McPherson	0	9	0	100	0	49	1	1	--	43	--
Trego & Graham	7	13	1	320	340	483	2	0	.014	0	21
Woodson & Coffey	0	11	0	140	180	190	3	0	--	156	--

*Oil-water injected ratio calculated on project weighted averages.

TABLE 3. SECONDARY RECOVERY OIL PRODUCTION AND RATIOS OF INJECTION PRESSURES TO DEPTHS OF THE PRODUCING ZONES DURING 1962 IN KANSAS

Producing Zone	Oil Production (Mbbl)	Average Injection Pressure (p.s.i.)/ Average Depth	Producing Zone	Oil Production (Mbbl)	Average Injection Pressure (p.s.i.)/ Average Depth
"Bartlesville"	5,058	.274	Morrowan	57	.179
Lansing	2,531	.063	Maquoketa	56	.002
Mississippian	1,666	.047	Reagan	40	.007
Simpson	1,327	.034	"Redd"	23	.343
"Shallow El Dorado"	1,307	.208	"Wayside"	20	.833
"Squirrel"	865	.677	Admire	20	.941
Kansas City	635	.084	Pennsylvanian	19	.030
Marmaton	466	.061	Kinderhookian	17	.305
"Hunton"	392	.040	Topeka	16	.035
Tarkio	293	.166	Hoover	14	.144
Viola	211	.013	Indian Cave	14	.742
"Cattlemen"	156	.101	"Gorham"	13	.042
"Peru"	142	.446	Arbuckle	12	.013
Douglas	108	.132	"Dodge"	10	.102
"Tucker"	82	----	Toronto	10	----
"Layton"	67	.086	"Conglomerate"	10	.108