Bridging the Gap between Chemical Flooding and Independent Oil Producers

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by

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Abstract

Geological characteristics and oil production mechanisms were used to classify reservoirs in Kansas that are applicable to chemical flooding. Information about chemical flooding and this research program was communicated to Kansas oil producers through a presentation, newsletters and personal contacts. Criteria were formulated to select specific oil leases that are considered to be the best candidates for chemical flooding. Laboratory work to formulate chemical formulations will be conducted on fluid and rock samples from the selected leases.

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Technical Results and Discussion

An initial task of this project is to identify reservoirs in Kansas that are the best candidates for application of chemical flooding. Geological characteristics and oil production mechanisms of the producing horizons were used to classify reservoir types. Interviews with engineers and geologists from several of the largest independent oil producers were conducted to verify reservoir types as well as specific reservoirs/leases that are candidates for chemical flooding. Through this process, it has become evident that the frequency of waterflooding application of a particular producing rock unit is the best indicator of favorable characteristics for chemical flooding. Criteria are being formulated for oil leases that will be selected for laboratory testing to generate effective chemical systems.

Geological Prospects of Chemical Floods in Kansas

Oil is produced in Kansas from rocks ranging from Proterozoic to Permian in age (Figure 1). Each productive horizon has one or more characteristic types of traps and drive mechanisms. For example, both limestone and dolomite of the Arbuckle Group, the most prolific unit, and chert or chert breccia of the Mississippian Osage, produce from high points on an overlying unconformity surface. Some such high points are faulted blocks, while others are residual highs on karsted unconformity surfaces. Strong water drive provides energy for production in most Arbuckle Group fields, whereas Mississippian reservoirs have weaker water drives. Both the Arbuckle and Mississippian are generally not good candidates for flooding processes.

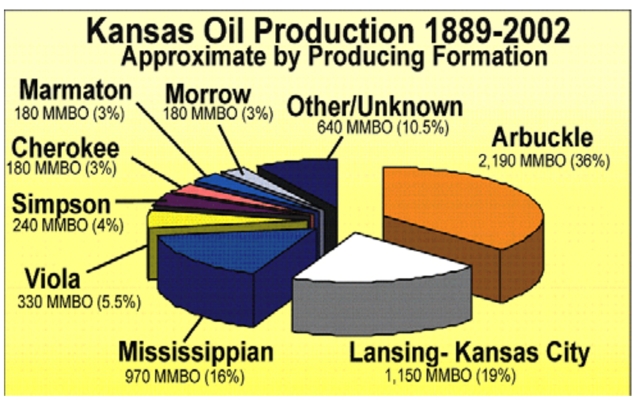

Figure 1. Oil production in Kansas by stratigraphic unit. (Kansas Geological Survey).

To the extent that the most likely targets for successful chemical floods are oilfields that waterflood well, a few characteristic combinations of lithology, trap and drive are most promising among those in Kansas. Among the sandstone producing units in Kansas, good waterfloods are common in Morrowan and Cherokee sandstones. However, productive Permian sandstone may also be a candidate; the 650 ft. thick sandstone in the El Dorado Field has been flooded (Van Horn, 1983). Cherokee reservoirs are concentrated in southeast Kansas, east of the Nemaha uplift. Most of the oil production comes from elongate sandstone bodies that probably fill valleys. Other pre-Marmaton, post-Atokan Pennsylvanian reservoirs on the margins of the Central Kansas Uplift are either assigned to the Cherokee Group or the informal Pennsylvanian basal conglomerate. Recently, development has occurred in channel-like sandstones of Cherokee age rocks in Ness County, first pointed out by Walters et al. (1979). The Pennsylvanian basal conglomerate is a discontinuous sheet of residual breccia, sandstone, and clay that thickens and thins over underlying irregularities in karsted Mississippian rocks.

Many grainstone reservoirs in the Lansing and Kansas City groups (Missourian), the Fort Scott Limestone and other Marmaton Group reservoirs (Desmoinesian), and the Topeka Limestone (Virgilian) have also waterflooded well. Oolitic grainstone is a common reservoir type in Lansing & Kansas City group reservoirs. Some such reservoirs are bending-fold anticlinal traps over faulted basement highs, perhaps with preferential development of oolites on the highs. Others are isolated oolite or other grainstone bodies.

Identification of Chemical Flooding Prospect through Contacts with Oil Producers

Cooperation of independent oil producers is a key component of this project. A presentation on chemical flooding and the components of this project was given at the December meeting of the Wichita section of the Society of Petroleum Engineers. Similar information was contained in articles that were included in the January newsletters for the Kansas Geological Society and the Kansas Independent Oil and Gas Association (KIOGA). Although these presentations have initiated interest, personal contact with oil operators is the best method for generating greater interest and cooperation.

Personnel at 15 of the top 30 oil production companies in Kansas have been contacted by telephone and meetings with these companies are proceeding. The agenda items for these meetings are (1) describe and explain the chemical flooding process, (2) determine and confirm general chemical flooding prospects in Kansas from the company's waterflooding applications (3) inform company personnel about possible positive benefits from participating in this design project, and (4) identify their best performing waterfloods as prospects for design work.

The companies contacted to date represent oil production in central and western Kansas. Figure 2 is a stratigraphic chart showing the oil producing horizons in Kansas. Formations that are targeted for waterflood applications in central and western Kansas are highlighted in red. This chart will be updated as information is collected and the eastern Kansas production is investigated.

A well-performing waterflood that has good sweep efficiency implies favorable fluid flow characteristics that are required for the slug-type process of chemical flooding. A slug of a chemical mixture is injected and displaced through the reservoir by a polymer mobility buffer so that the slug will contact, mobilize and displace residual oil to production wells. Performance of the process relies on the integrity of the slug as it flows through the reservoir. Fluid-flow characteristics of the reservoir are the primary factors that influence slug integrity and thereby an important key to the success of a chemical flood.

Selection criteria for a demonstration or pilot chemical flood are being formulated based on discussions with engineers and geologists of the oil producing companies. Reservoir studies and simulations to determine fluid-flow characteristics are not common in Kansas. The primary method to determine the performance of a waterflood is to assess the oil recovery response

Era	System	Stage	Group	Producing Rock Units
Mesozic	Cretaceous		Colorado	Niabrara
Paleozoic	Permian	Guadalupian		
		Leonardian	Nippewalla	
			Sumner	Red Cave
		Wolfcampian	Chase	Herington, Krider, Winfield, Towanda, Fort Riley
			Council Grove	Neva, Cottonwood
		Virgilian	Admire	Indian Cave
			Wabaunsee	Langdon, Tarkio, Willard, White Cloud, Howard, Severy
	Pennsylvanian		Shawnee	Topeka, Elgin, Hoover, Toronto
			Douglas	Ireland, Stalnaker
		Missourian	***Lansing***	
			Kansas City	Layton, Perry Gas
			Pleasanton	Cleveland, Knobtown, Hepler
			Marmaton	New Albany, Wayside, Bandera, Weiser, Pawnee, Peru, Fort Scott, Oswego
			Cherokee	Mulky Coal, Prue, Bevier Coal, Squirrel, Cattleman, Bartlesville, Weir-Pittsburg, McClouth, Riverton Coal, Burgess
		Atokan		
		Morrowan	***Marrow***	
				Basal Pennsylvanian Conglomerate, Gorham
	Mississippian	Chesteran	***Chester***	
		Meramecian		Saint Genevieve, Saint Louis, Spergen, Warsaw
		Osagian		
		Kinderhookian		
	Devonian			Misener
	Silurian		Hunton	
	Ordovician			Maquoketa
				Viola
			Simpson	
			Arbuckle	
	Cambrian			
				Regan
				Granite Wash

Figure 2. Stratigraphic chart of oil producing formations in Kansas. Commonly waterflooded formations in central and western Kansas are highlighted.

through lease oil sales because individual well responses are not usually available. A significant and sustained oil recovery response during water injection indicates an efficient volumetric sweep of the reservoir and, thereby, a candidate for chemical flooding.

A second criterion is based on the age of the waterflood and the status of the wells. As waterfloods mature, it is common practice to plug the uneconomic wells. Leases where a majority of wells have been plugged are generally not considered for a demonstration or pilot project. Drilling new wells in central and western Kansas is considered cost prohibitive in that there are many leases where the additional costs of drilling are not required.

A third criterion is based on the containment of a chemical flood in the pilot area. Again, most information on reservoir flow is based on lease production rather than pattern or well production. A better assessment of a chemical flood can be made if the flood is contained within the specified pattern area. An effective way to satisfy this criterion is to use leases where containment is identified. We have identified several small reservoirs where the fluid containment is strongly indicated. These reservoirs appear to be representative of the larger resource of the same producing formation and are prime candidates for a demonstration project. Larger reservoirs are also considered if there is reservoir information, usually based on injection and production data, that a chemical flood could be contained in the targeted pattern.

Waterfloods are frequently applied in wells that are open to multiple zones, either initially or where additional zones have been opened as the previous open intervals were watered out. This is often the case in waterfloods applied to the Lansing-Kansas City group. Generally, waterfloods that target multiple zones are not good candidates for chemical flooding unless the zones can be isolated. Control of the volume of chemical slug that is injected into each zone is difficult if the zones have different permeabilities and integrity of the chemical slug is questionable if there if communication between the zones occurs in the reservoir.

An example that conforms to the above criteria is the Trembley Lease in the Trembley Field in Reno County. The boundaries of the reservoir are defined and are enclosed by the lease. Discovery and development for primary production occurred 1978-79. One ten-foot thick zone of oolitic and dolomitic limestone in the Kansas City Group was targeted. Lease oil production is shown in Figure 3. Primary production peaked in 1979 followed by production decline through 1996. A waterflood was implemented in early 1995 and the initial oil production response occurred in 1997. This type of waterflood response indicates good reservoir sweep through the targeted zone. The field/lease has three water injection wells and three production wells.

We will continue to make contacts and have meetings with the remainder of the top 30 production companies in Kansas which represent 41% of Kansas oil production. Most of the oil production of the top 30 producers is from central and western Kansas and thus there is little representation of production in eastern Kansas. We are identifying the larger producers in eastern Kansas and will contact and meet with them so that prospective reservoirs will not be bypassed in the Pennsylvanian Cherokee formations.

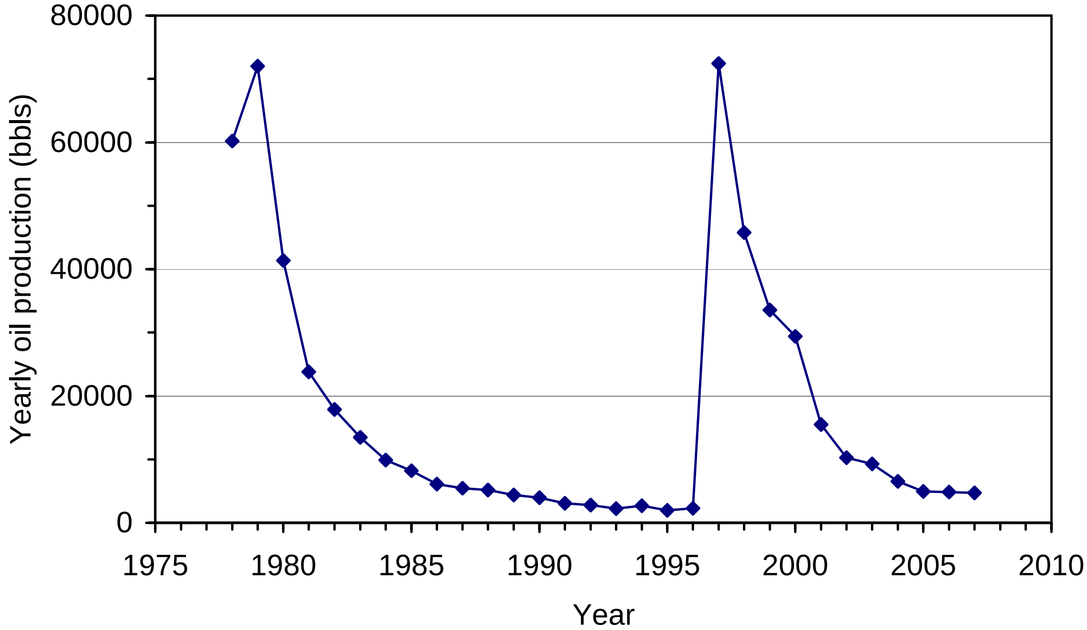

Figure 3. Yearly oil production of the Trembely Lease in Reno County.

Milestone Log

The following list of milestones have been completed.

- Project Management Plan Updated [12/31/2008].

References

Van Horn, L.E., 1983, An evaluation of the El Dorado micellar-polymer demonstration project: Proceedings of the 5th Tertiary Oil Recovery Conference, Tertiary Oil Recovery Project, Lawrence, Kansas, p. 40-48.

Walters, R.F., Gutru, R.J., James, III, A., 1979, Channel sandstone oil reservoirs of Pennsylvanian age in Northwestern Ness County, Kansas: in Hyne, N.M., ed., Pennsylvanian Sandstones of the Midcontinent: Tulsa Geological Society, Special Publication No. 1.