

OIL AND GAS DOCKET NO. 8A-0240292

THE APPLICATION OF OCCIDENTAL PERMIAN, LTD. FOR AUTHORITY PURSUANT TO STATEWIDE RULE 50 TO TREAT SEISMIC STIMULATION AS AN ENHANCED RECOVERY TECHNIQUE, WASSON, SOUTH CLEARFORK UNIT, WASSON 72 FIELD, GAINES COUNTY, TEXAS

Heard by: Margaret Allen, Technical Examiner

Procedural history

Application received: September 24, 2004

Hearing held: October 14, 2004

Appearances

Richard E. Foppiano
Barry Alan Beresik

Representing
Occidental Permian, Ltd.

EXAMINERS' REPORT AND PROPOSAL FOR DECISION

STATEMENT OF THE CASE

Statewide Rule 50 allows operators to pay reduced severance taxes on oil from new enhanced oil recovery (EOR) projects, including those projects which change from secondary to tertiary projects. In order to be eligible for the recovered oil tax rate as provided in the Tax Code, §§202.052(b), an operator must obtain Commission approval of a new EOR project before commencing active operations. For a project to be approved the operator must prove that it qualifies as an EOR project and obtain Commission approval of its designation of the area that will be affected by the project.

Occidental Permian, Ltd., ("Oxy") plans to conduct seismic stimulation to increase oil recovery in a project area on its Wasson South Clearfork Unit in the Wasson 72 Field of Gaines County. In-situ seismic stimulation has not been previously qualified as an enhanced recovery technique under Statewide Rule 50.

DISCUSSION OF THE EVIDENCE

Since the 1950's, observers have noted correlations between water well levels and seismic activity due to earthquakes or trains. Similar effects were noted in oil wells due either to distant earthquakes or proximity to highways or trains. Oxy introduced production graphs from two reservoirs in its Elk Hills Field in California. The oil production rate increased 11.5% after a 6.5

magnitude earthquake, lasting 26 seconds on December 22, 2003, that was 140 miles away.

The first experiments to increase oil production were conducted in Russia. Interest in seismic stimulation has grown and several major oil companies, the Los Alamos National Laboratory, and the PTTC of the DOE¹ have conducted test projects. In situ seismic stimulation, at the level of the producing formation, appears to be much more effective than surface stimulation.

The mechanisms responsible for improved recovery are the subject of current research. The following mechanisms have been proposed to account for increased oil production:

- 1) changes in wettability, where the producing rock becomes more water-wet and less oil-wet;
- 2) coalescence and/or dispersion of oil drops, which causes tiny oil droplets to grow larger and thus flow more easily;
- 3) reduction in viscosity of the oil due to shaking;
- 4) reduction in surface tension due to differential shaking of the rock matrix and fluid, which tends to increase permeability; and
- 5) increases in permeability due to increased size of the pores that oil must flow through or to shaking lose fine material that has been plugging pore throats.

Seismic stimulation in a project in the Lost Hills Field of California was able to increase production by 10% to 30%. Projects do not have to increase oil production to be successful however, slowing the decline rate can also indicate incremental oil is being recovered. In 1998, Fina has tested in situ seismic stimulation on a 35 well project in San Andres dolomites of the Garza Field in Garza County, Texas. After the 1-1/2 month pilot project, the oil cut stopped decreasing and stabilized. Six months after stimulation, the oil cut was 23% better than expected.

Oxy has used seismic stimulation in one reservoir of its Elk Hills Field, near Bakersfield, California, and believes it successfully produced incremental oil. The Elk Hills Field produces low gravity oil (22° API) from a highly-faulted reservoir at 3000'. The field has a strong natural edge waterdrive. In Oxy's pilot seismic stimulation project, two wells within the field were equipped with in situ seismic tools.

ARS HydroImpact Tools were installed at producing depth in two idle wellbores in order to generate high energy, low frequency, elastic shock waves every 10 seconds traveling 1-1/2 miles per second. Pump jacks on the surface provide the energy. The tool at the base of the rod string contains upper and lower barrels and plungers, with a compression chamber between. At the bottom of the pump stroke, water is drawn into the tool, and then compressed between the plungers during the upstroke. At the top of the stroke, the lower plunger leaves the barrel and the compressed water is discharged, creating shock waves which carry a megawatt of energy at 3500 psi.

Before the Elk Hills project began, oil production from the 85 wells within a 1/2 mile radius around the pilot wells was 1800 BOPD. Oxy testified that this part of the reservoir was being depleted, though total daily oil production from these wells had not declined during the first half of 2003. Oxy believes the total production rate within this area was stable due only to numerous

¹ Petroleum Technology Transfer Council of the Department of Energy.

workovers, lift increases and new drilling during early 2003. Most of the wells within ½ mile of the two pilot wells did show decreased daily production in the two months prior to the pilot operation, indicating that enhanced recovery might be useful.

Seismic stimulation began at the end of August, 2003. By June 19, 2004, total daily production had increased 22%, to over 2220 BOPD, while daily water production declined. During this time period, there were no workovers or new wells drilled in the project area. Some of the north flank dewatering wells, used to improve the sweep efficiency of the edge waterdrive, changed from water wells to oil wells. The total daily oil rate of the seven dewatering wells went from a few barrels to over 250 barrels per day, while the total water cut decreased from 99-100% down to 93-94%.

The principal problem during the seven months the pilot program in the Elk Hills Field has been operating is tool failure, including rod parting. Tools have failed six times and the cost of restoring them to production, obviously increases the expense of the project. Oxy does plan to complete four more seismic stimulation wells in its Elk Hills Field.

Oxy believes that its Wasson South Clearfork Unit in the Wasson 72 Field is similar enough to the Elk Hills Field to be able to benefit from seismic stimulation. Factors which increase the odds of success in seismic stimulation include dense well spacing and reservoir heterogeneity such as are present on the Wasson South Clearfork Unit. Experiments by Los Alamos National Laboratory have showed that other factors influencing the success of seismic stimulation include oil density and gas content. The Clear Fork is a dolomite found between 6600' and 7800', containing oil with an API gravity of 35°. Extreme vertical and lateral reservoir heterogeneity has reduced total oil recovery on the Wasson South Clearfork Unit to only 22 to 26% of the original oil-in-place despite extensive enhanced recovery efforts.

The Wasson South Clearfork Unit is on the southwestern end of the Wasson 72 Field, located on the Northwest Shelf of the Permian Basin. There are numerous shallow-water platform reservoirs in rock of the same age around the Permian Basin with similar reservoir characteristics. The Wasson South Clearfork Unit currently has a mature secondary waterflood with residual CO₂ effects. Cumulative oil production from the unit has been 75 million barrels, while 332 million barrels of water have been injected.

Experiments conducted by Lawrence Berkeley National Laboratory showed that geophones could detect seismic stimulation energy as much as three quarters of a mile from the wellbore of origin, even across intervening faults. Oxy is therefor requesting that the designated area of its project in the Wasson South Clearfork Unit extend three quarters of a mile out from its wellbores.

The Wasson South Clearfork Unit was formed in 1980 and waterflood injection began on a nine-spot, 40-acre pattern. In 1985, Oxy began injecting CO₂ to augment the waterflood. By 1989, CO₂ injection was increased to a two:one alternating water:gas ratio. Infill drilling has reduced the actual well density to between 10 to 20 acres, and the injection pattern was changed to a five-spot. In 2001, Oxy discontinued CO₂ injection because it was no longer economic.

There are 74 active injection wells and 89 active producing wells on the unit as a whole.

Average daily production during August, 2004, was 2384 barrels of oil and 52,689 barrels of water, while an average of 59,000 barrels of water was injected every day. The project area has 67 of the producing wells and 55 of the injection wells. Average daily production from the project area during July, 2004, was 2211 barrels of oil. Oxy's projections show a 10% initial incremental production wedge which it expects will decline at a rate of 16.5%. Oxy will evaluate the results after 24 months, by which time it expects the project area to have produced 137,000 barrels of incremental oil. During this 24 month period, Oxy will maintain the water injection to move mobilized oil to the producing wells.

Oxy testified that both wells to be equipped with HydroImpact Tools have sufficient casing integrity to withstand the constant shaking of seismic stimulation. The tools will be set just above the existing perforations, with a cement plug in between. Hydraulic dampers will be installed above the tool and cement caps will be placed on top of the casing. Oxy expects that no motion will be felt at the surface farther than 30-40' distant from the wellhead.

One of these two wells was drilled in 1956 and converted to injection in 1987. It has surface casing cemented from 221' to the surface and intermediate casing cemented from 3121' to the surface. Its production casing is cemented from total depth at 7550' to 3650'. The other well was drilled in 1988 and converted to injection in 2001. It has surface casing cemented from 2125' to the surface and production casing cemented from total depth at 7650' to the surface.

Oxy believes this is a high risk project due to the costs associated with tool failure. Equipping a well initially costs about \$295,000 and costs obviously increase every time a tool fails and must be repaired. Oxy expects the tools will have to be replaced every four to six months. The decline rate in the project area over the last five years has been 7.89%, but after the cessation of CO₂ injection, the decline rate steepened to 10.5%. Oxy will not receive the reduced tax rate until the project area demonstrates increased oil production or a significantly reduced decline rate.

Oxy is requesting that this be considered a new EOR project because it meets the definition in Statewide Rule 50(c)(5):

Enhanced oil recovery project (EOR)—**The use of any process for the displacement of oil from the reservoir** other than primary recovery and includes the use of an immiscible, miscible, chemical, thermal or biological process. This term does not include pressure maintenance or water disposal projects. [emphasis added]

Oxy's project will utilize both water injection and seismic pulses to mobilize and displace previously unrecoverable oil from the reservoir and is not primary recovery, nor is it pressure maintenance or water disposal.

EXAMINERS' OPINION

The examiner believes that seismic stimulation meets the guidelines in Statewide Rule 50(c)(5), and that the project area proposed by Oxy will reasonably be affected by its new enhanced oil recovery project. None of the oil produced from the project area will receive the recovered oil tax

rate [as provided by the Tax Code §§202.052(b)] until the Railroad Commission certifies that there has been a positive production response. According to Rule 50(c)(12), this “occurs when the rate of oil production from the wells within the designated area affected by an EOR project is greater than the rate that would have occurred without the project.”

FINDINGS OF FACT

1. Notice of this application was issued to Occidental Permian, Ltd., the operator of the Wasson South Clearfork Unit, on September 30, 2004.
2. Occidental Permian, Ltd., plans to use both water injection and seismic pulses to mobilize and displace previously unrecoverable oil from the Wasson South Clearfork Unit in the Wasson 72 Field.
3. Seismic stimulation in projects in the Lost Hills Field and Elk Hills Field of California increased production by 10% to 30%.
4. Dense well spacing and reservoir heterogeneity, which are present on the Wasson South Clearfork Unit, are factors which increase the odds of success in seismic stimulation.
5. The Wasson South Clearfork Unit currently has a mature secondary waterflood with residual CO₂ effects.
6. ARS HydroImpact Tools will be installed at producing depth in two idle wellbores which will generate high energy, low frequency, elastic shock waves every 10 seconds traveling 1-1/2 miles per second.
7. Experiments conducted by Lawrence Berkeley National Laboratory showed that geophones could detect seismic stimulation energy as much as three quarters of a mile from the wellbore of origin, even across intervening faults.
8. The project area which will be affected by the seismic stimulation in two wells on the Wasson South Clearfork Unit extends three quarters of a mile around the two wells.
9. The project area produced a daily average of 2211 barrels of oil during July, 2004, from its 67 producers and 55 injection wells.
10. The recovered tax rate will not be effective until the applicant has shown a positive response within three years, either by increasing oil production or by slowing the decline rate.
11. The two wellbores to be used for seismic stimulation have adequate casing and seismic stimulation operations will not endanger groundwater.

CONCLUSIONS OF LAW

1. Proper notice was given to all necessary parties as required by applicable statutory and

regulatory provisions.

2. All things necessary to give the Commission jurisdiction to decide this matter have been performed or have occurred.
3. The seismic stimulation project proposed by Occidental Permian, Ltd. for the Wasson South Clearfork Unit qualifies as a new enhanced recovery project under the Tax Code, Title 2, Chapter 202, Subchapter B, Sections 202.052 and 202.054, and 16 T.A.C. §3.50 of the Railroad Commission of Texas.
4. The area within three quarters of a mile around the seismic stimulation wells on the Wasson South Clearfork Unit will reasonably be affected by the proposed seismic stimulation project.

EXAMINER'S RECOMMENDATION

The examiners recommends that this application of Occidental Permian, Ltd., for its seismic stimulation project in the Wasson South Clearfork Unit in the Wasson 72 Field, to be considered a new enhanced recovery project be **GRANTED**.

Respectfully submitted,

Margaret Allen
Technical Hearings Examiner