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APPLICATION OF RESERVOIR CHARACTERIZATION AND ADVANCED TECHNOLOGY TO IMPROVE RECOVERY AND ECONOMICS IN A LOWER QUALITY SHALLOW SHELF SAN ANDRES RESERVOIR

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By
Archie R. Taylor
T. Scott Hickman
James L. Justice

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OXY USA, Inc.
Midland, Texas

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T. Scott Hickman
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Prepared for
U.S. Department of Energy
Assistant Secretary for Fossil Energy

Gary Walker, Project Manager
National Petroleum Technology Office
P.O. Box 3628
Tulsa, OK 74101

Prepared by
OXY USA Inc.
P.O. Box 50250
Midland, TX 79710-0250

T. Scott Hickman and Associates
550 West Texas St,, Ste. 950
Midland, TX 79701

Advanced Reservoir Technologies
P.O. Box 985
Addison, TX 75001-0985

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OBJECTIVES

The Class 2 Project at West Welch was designed to demonstrate the use of advanced technologies to enhance the economics of improved oil recovery (IOR) projects in lower quality Shallow Shelf Carbonate (SSC) reservoirs, resulting in recovery of additional oil that would otherwise be left in the reservoir at project abandonment. Accurate reservoir description is critical to the effective evaluation and efficient design of IOR projects in the heterogeneous SSC reservoirs. Therefore, the majority of Budget Period 1 was devoted to reservoir characterization. Technologies being demonstrated include:

1. Advanced petrophysics
2. Three-dimensional (3-D) seismic
3. Cross-well bore tomography
4. Advanced reservoir simulation
5. Carbon dioxide (CO_2) stimulation treatments
6. Hydraulic fracturing design and monitoring
7. Mobility control agents

SUMMARY OF TECHNICAL PROGRESS

West Welch Unit is one of four large waterflood units in the Welch Field in the northwestern portion of Dawson County, Texas. The Welch Field was discovered in the early 1940's and produces oil under a solution gas drive mechanism from the San Andres formation at approximately 4800 ft. The field has been under waterflood for 30 years and a significant portion has been infill-drilled on 20-ac density. A 1982-86 pilot CO_2 injection project in the offsetting South Welch Unit yielded positive results. Recent installation of a CO_2 pipeline near the field allowed the phased development of a miscible CO_2 injection project at the South Welch Unit.

The reservoir quality at the West Welch Unit is poorer than other San Andres reservoirs due to its relative position to sea level during deposition. Because of the proximity of a CO_2 source and the CO_2 operating experience that would be available from the South Welch Unit, West Welch Unit is an ideal location for demonstrating methods for enhancing economics of IOR projects in lower quality SSC reservoirs. This Class 2 project concentrates on the efficient design of a miscible CO_2 project based on detailed reservoir characterization from advanced petrophysics, 3-D seismic interpretations and cross wellbore tomography interpretations.

During this quarter, interpretation and integration of the crosswell seismic data continued, development of the south expansion area was completed and CO_2 injection was expanded into last row of injectors.

3-D SEISMIC INTEGRATION

Two new wells were completed in the project area based on the seismic guided mapping. Initial production from these two wells totaled 60 barrels of oil and 400 barrels of water per day. This completes the drilling of the additional wells identified by the seismic guided mapping. The total oil production from these wells is approximately 200 barrels of oil per day with estimated reserves of 300,000 barrels of oil.

CROSS WELL SEISMIC

Investigation of the shear velocity (V_p) versus compressional velocity (V_s) relationship for identifying rock type has continued. To facilitate the study, Advanced Reservoir Technologies is being provided access to Oxy's seismic interpretation system and the Stacked Curve system which allows the combining of wellbore data (log or core) for various analytical procedures. Much of the cross well seismic data can be reduced to a log trace format that can be integrated with other data in the Stacked Curve system and displayed as cross sections.

The cluster groups being identified from V_p versus V_s plots apparently represent lithologically-related units. Further work is being done to determine the spatial distribution of these units and to better understand their physical properties.

NUMERICAL SIMULATION

Actual injection rates continue to fall below predictions from the seismic enhanced model. However, the model had 17 wells on CO_2 injection while currently injection is only going into 11-12 wells due to various problems. There still has not been the significant increase in CO_2 production, which the base geologic model indicated would occur. Assuming the additional wells not on injection would perform similarly to the current injection wells, actual field performance to date would be following the seismic enhanced model. It will take 1-2 years of actual performance to establish the accuracy of the seismic enhanced model.

AREA PREPARATION AND CONSTRUCTION

CO_2 is currently going into 11 of the 17 projected wells in the project area. The CO_2 injection system was extended south to the last row of injectors. Injection into the #4817 and #4802 began April 30th. The #4809w was taken off CO_2 injection on April 30th due to a casing leak. The well was cement squeezed and is currently being monitored to be certain the squeeze was successful before continuing CO_2 injection. The #4837w was shut-in to allow pressure to dissipate from the wellbore prior to a workover to improve injectivity. By shutting the well in and allowing the pressure to dissipate we should avoid having to "mud up" for well control, thereby reducing the formation damage from workover fluids. Well #4812w stopped taking CO_2 in measurable volumes at the end of April.

Average CO_2 injection rates in the project area for the quarter were:

April	5444 mscfd	12 wells
May	4966 mscfd	11 wells
June	5172 mscfd	11 wells

Field construction of CO_2 handling facilities continues in anticipation of CO_2 breakthrough later this year. The production separator and test separators were set and are being piped up now. The 4 inch high pressure CO_2 return line from the Welch gas plant is being installed, with the 10 inch high pressure gathering line scheduled to be installed during the 3rd quarter.

TECHNOLOGY TRANSFER

A synopsis of the seismic integration methods[1], originally presented at the Permian Basin Oil and Gas Recovery Conference, March 23-26, 1998, was published in the SPE's Journal of Petroleum Technology.

REFERENCES

1. G. D. Hinterlong, A. R. Taylor, G.P. Watts, K.H. Kumar, "Improving Flow Simulator Performance with a Seismic Enhanced Geologic Model", paper SPE 39809 presented at the SPE Permian Basin Oil and Gas Recovery Conference in Midland, Tx, March 23-26, 1998