"INCREASING WATERFLOOD RESERVES IN THE WILMINGTON OIL FIELD THROUGH IMPROVED RESERVOIR CHARACTERIZATION AND RESERVOIR MANAGEMENT"

Cooperative Agreement Number DE-FC22-95BC14934

Tidelands Oil Production Company (TOPKO), Long Beach, CA
City of Long Beach, Department of Oil Properties
Stanford University, Stanford, CA
Magnetic Pulse, Inc. (MPI), Houston, TX

Date of Report	October 21, 1997
Award Date	March 21, 1995
Anticipated Completion Date	March 20, 2000
Government Award	1996 $147,166
Principal Investigators	Roy Koerner, City of Long Beach Don Clarke, City of Long Beach Scott Walker, Tidelands Oil Production Co. Chris Phillips, Tidelands Oil Production Co. John Nguyen, Tidelands Oil Production Co. Dan Moos, Stanford University Kwasi Tagbor, MPI
Program Managers	Roy Koerner, City of Long Beach Don Clarke, City of Long Beach Scott Walker, Tidelands Oil Production Co.
Reporting Period	July 1, 1997 to September 30, 1997

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Objectives

The objectives of this quarterly report are to summarize the work conducted under each task during the reporting period July - September 1997 and to report all technical data and findings as specified in the "Federal Assistance Reporting Checklist".

The main objective of this project is the transfer of technologies, methodologies, and findings developed and applied in this project to other operators of Slope and Basin Clastic Reservoirs. This project will study methods to identify sands with high remaining oil saturation and to recomplete existing wells using advanced completion technology.

The identification of the sands with high remaining oil saturation will be accomplished by developing a deterministic three dimensional (3-D) geologic model and by using a state of the art reservoir management computer software. The wells identified by the geologic and reservoir engineering work as having the best potential will be logged with a pulsed acoustic cased-hole logging tool. The application of the logging tools will be optimized in the lab by developing a rock-log model. This rock-log model will allow us to convert shear wave velocity measured through casing into effective porosity and hydrocarbon saturation.

The wells that are shown to have the best oil production potential will be recompleted. The recompletions will be optimized by evaluating short radius and ultra-short radius lateral recompletions as well as other techniques.

Summary of Technical Progress

● Reservoir Characterization

The data system was updated to allow the collection of circumferential strain data which allows for a direct measurement of static Poisson's ratio. This data is now being collected on core samples from well 169-W. The results will provide a test of the Gassmann relations and of the relationship between the ultrasonic (pulse transmission) measurements of moduli and the static moduli. This new information will complete the data set proposed for collection at the start of the project and allow calibration of the acoustic saturation information from well logs. Results are confirming theoretical expectations.

Laboratory data from Wilmington samples were analyzed to evaluate the effects of burial, fluid withdrawal, and fluid injection. The lab results predict that waterflooding cannot be used for complete recovery of pore volume loss (subsidence). Results also found that simultaneous measurements of porosity and velocity could be used to infer pore pressure. This is important for the DOE work because it means that acoustically derived porosity is sensitive to pore pressure and will require a pore pressure correction. In the case of Wilmington results, this correction is less than a few porosity units.

The rock and fluid models developed under this DOE project were applied to acoustic velocity data collected through casing in the La Cira formation in Columbia South America. It successfully revealed bypassed oil behind casing which was recompleted and placed on production. In addition, previously productive intervals which are now poor producers were revealed to have sharply lower P-wave velocity due to elevated levels of free gas which decreased the relative permeability to oil. A study is under way to evaluate raising the reservoir pressure above the bubble point of the crude oil which would drive the gas back in solution and result in increasing the relative permeability to oil.

This is the first documented successful transfer of technology developed by this DOE project resulting in increased oil production in another oil field.

● **Reservoir Engineering**

Researchers continue to update and quality control the Fault Blocks 4 and 5 production and injection databases.

● **Deterministic 3-D Geologic Modeling**

No new modelling was attempted.

● **Pulsed Acoustic Logging**

No dipole logging took place.

● Recompletions

Recompletion candidate well Z-61 was perforated across the "F_1" and "F_o" sands of the Tar Zone in Fault Block V in March, 1997. The perforations were 0.74 cm (0.29") in size and spaced at one (1) per every other foot. Z-61 underwent the steam consolidation process by a portable steam generator during August, 1997. A thermal packer and thermal tubing were employed to minimize heat loss to the casing. There were problems keeping the portable generator online during start up due to the feed water pump. The feed water pump is a critical component which tends to be undersized by the vendors. Ensuring ample capacity of the feed water pump is pivotal.

An unfortunate result of the generator not running continuously was the well partially sanded up. During injection, the near wellbore area becomes pressurized and when the generator shuts down the well can flowback. In an unconsolidated formation this carries sand into the wellbore. A coiled tubing unit was used to clean out sand from the perforated interval and Z-61 stayed on continuous steam injection after repairs to the feed water pump. A total of 16,245 bcwe steam were injected into a total of 18 perforations for a ratio of 902 bcwe steam per perforation. The empirical guideline is 750 bcwe steam per 0.74 cm (0.29") perforation. Before shutting down the generator permanently, a sinker bar was run in the well to check that all perforations were open to steam injection. Sand was tagged below the bottom perforation. Z-61 will soak for a period of 3 weeks and then be placed on production.

Should this technique prove to be cost effective, other operators could contract out portable steam generators provided they have access to fresh water and fuel. Z-61 is a replacement for the ultra-short radius redrill.

Horizontal redrill candidate J-17 was started in early March. The first attempt to hit the target "Hx**o**" sand failed as the trajectory coming out of the window was too high and corrections could not be made before exiting the target sand. J-17 was then plugged back and successfully redrilled to the target interval. A significant achievement in drilling this well was turning it 90° while still in the target sand.

The liner was perforated with 0.74 cm (0.29") holes, 0° phased, and spaced one (1) hole per ten (10) foot interval from 1001 m (3285') to 1189 m (3900'). A string of thermal insulated tubing with a thermal packer on bottom were installed. The well is currently on steam injection.

● Technology Transfer

Researchers are working on a paper for the 1997 NIPER Workshop in Midland, TX titled: "Acoustic Logging to Detect Hydrocarbons Through Casing - DOE CLASS 3 Wilmington Waterflood Project".

Researchers submitted a paper "Identifying Patchy Saturation From Well Logs" Dvorkin et al. to the journal Geophysics.

Researchers submitted a paper "Relationships between Porosity, Pressure, and Velocity in Unconsolidated Sands" was submitted to a special Meeting on Pore Pressure to be held in Pau, France in Spring 1998; a manuscript is also in preparation for submittal to the journal Geophysics.

Researchers submitted a paper "Effects of Compaction and Pore Pressure on Velocity and Modulus in Unconsolidated Reservoir Rocks" was submitted to EUROCK Meeting to be held in Trondheim, Norway in early summer 1998. These results will also be presented at a workshop to be held after the 1997 Annual Meeting of the Society of Exploration Geophysicists in Dallas, TX on November 6, 1997.

Researchers had published a paper titled: "Locating and Producing Bypassed Oil: A U.S. DOE Project Update" in the September, 1997 issue of the Journal of Petroleum Technology magazine.

References and Publications

None