PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Petroleum Exploration and Production

06/2004

REACTIVATION OF AN IDLE LEASE TO INCREASE HEAVY OIL RECOVERY

Rethinking conventional steam drive technology

PARTNERS

University of Utah
Salt Lake City, UT

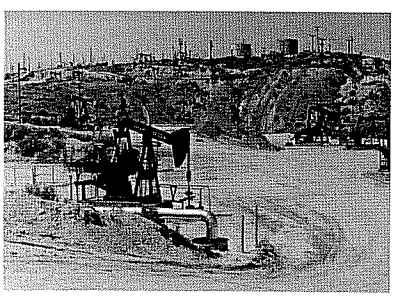
AERA Energy
Bakersfield, CA

ARCO Western
Bakersfield, CA

MAIN SITE

Midway-Sunset Field
Pru Fee Lease
Kern County, CA

DE-FC-95BC14937



Pru Fee Lease, Midway-Sunset field, Kern County, California.

Background/Problem

The Pru Fee Lease in California's Midway-Sunset field was a significant producer when first brought on line in 1906, but the lease had declined by the 1960 s, and was shut down in 1985. University of Utah oil researchers believed that the lease, located in such a prolific heavy oil area, could be revived. Awarded a DOE Class III project in 1994, University researchers persuaded lease operator ARCO Western to test using detailed knowledge of the reservoir to guide application of innovative steamflood technologies that could increase recovery efficiency. Initial studies identified producibility problems in the 200- to 300-foot-thick Miocene Monarch Sand reservoir: shallow dip of the strata that inhibited gravity drainage, lack of effective steam barriers to keep the steam confined within the pay interval, and a thick water-saturated transition zone above the oil-water contact.

Project Description/Accomplishments

ARCO Western started revitalizing the property in October 1995, renovating old wells and cyclic steam production facilities, and drilling two new wells. Analysis of seismic data and cores, well logs and surface outcrops provided detailed descriptions of the oil-bearing strata. Reservoir simulation using that information, along with infill drilling, guided the design and location of optimal injector- and producer-well patterns in the pilot project. Several of the old wells were put into production to evaluate the feasibility of cyclic steamflooding — alternate steaming and "soaking" cycles. Production reached 70 barrels of oil per day (bopd) in the early months, but dropped off rapidly after two cycles. In January 1997 an eight-acre four-pattern steamflood pilot was started in the marginal, low-dip portions of the reservoir to demonstrate the effectiveness of continuous steamflooding, which generally gives a steady increase in production. After 16 months production had risen to 320 bopd.

A common-sense approach guided the successful strategy for perforating the injector well casing to inject steam at the most efficient level. Water saturation was 80-90% in the lower 125 feet and the uppermost 30 feet of the reservoir, but only 30% or less in the intervening 150-foot span. After perforations at several levels in the pilot injectors proved less than satisfactory, the combination of operator experience and detailed reservoir information led to placing six perforations per well in a 60- to 80-foot interval of the middle zone, where the oil saturation was greater than 50%. Confining the steam injection to this section of the oil column prevented water coning (excess water flooding the oil zone) and avoided undue loss of heat to water.

Reactivation of an Idle Lease to Increase Heavy Oil Recovery

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In 1998, the perforation strategy was extended throughout the entire 40-acre Pru lease. Thirty-seven additional wells in the 32 acres surrounding the steamflood pilot were put on line, and by mid-1999 these wells were producing 381 bopd, providing an additional 129,700 barrels in just a year. All of the cyclic wells were converted to continuous steamfloods in four 9-spot patterns.

Benefits/Impacts

The oil rate for the entire 40-acre Pru lease increased from about 10 BOPD when the property was shut-in in 1985 as "depleted" to over 1,500 BOPD in the second half of 2000. As of January 2001, after nearly five years of renovating the Pru fee property, production from the Monarch Sands was over 1,300 BOPD (cumulative - 965,611 barrels), with additional production from the Tulare formation totaling more than 200 BOPD (cumulative - 125,507 barrels). In 1988, Hart's Publications, a leading trade journal publisher, recognized ARCO with its Award for Best Advanced Recovery Project in the Pacific Section. And today, after five years of operation, the project operators are confident enough in its promise to have invested, over and above their cost-share contribution, in 37 wells external to the steam flood pilot, increasing the number of steam flood patterns from 4 to 14, with 54 new producers external to the Pru lease, and additional wells anticipated in future development.

By project end in February 2001 daily production exceeded 1,500 barrels, and cumulative production was over one million barrels. The researchers have conducted an aggressive technology transfer program, including publications, technical presentations and a highly successful, well-attended public workshop in Bakersfield, CA, on Feb. 20, 2001. This industry outreach has conveyed to other producers in the area and in similar California properties the benefits of recovery process simulation, using reservoir-architecture information developed from outcrop and subsurface data, in designing geologically optimized injector- and producer-well strategies. Application of these methods in only one-half of the 26 currently shut-in Midway-Sunset properties could add an estimated 80 million barrels of oil to the ultimate production of the field, a potential yield in Federal taxes of over $10 million, more than five times the total government cost share for the Pru Fee project.

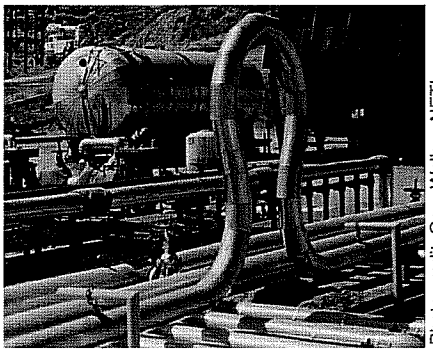

Photo credit: Gary Walker, NETL

Steam injection facilities at Pru Fee Lease.

July 2003 production results from the California Dept. of Conservation, Division of Oil, Gas, & Geothermal Resources database indicated that production was starting to show a slight natural decline. This is five years later than the decline curve predicted following inception of the steamflood, showing extended reservoir life in the once abandoned lease. As of June 2004 Monarch well production rates are holding up better than expected, and more have been shut-in. Cumulative production has passed the 2 million barrel mark (2.52 million bbl as of Mar. 31, 2004). The steamflood technology has spread to three adjoining leases in the Midway-Sunset field.

Midway04

CONTACT POINTS

Steve Schamel
Principal Investigator
University of Utah
Phone: (801) 581-5299
E-mail: schamel@egi.utah.edu

Roy Long
Technology Manager
U.S. DOE
Phone (918) 699-2017
E-mail: roy.long@netl.doe.gov

Gary D. Walker
Project Manager
U.S. DOE
Phone: (918) 699-2083
E-mail: gary.walker@netl.doe.gov

TOTAL ESTIMATED COST

$5.8 million

COST SHARING

DOE	- $2.2 million
Non-DOE	- $3.6 million

WEBSITE

www.netl.doe.gov