U.S. Department of Energy • Office of Fossil Energy • National Energy Technology Laboratory

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DOE research helps put CO_2 EOR oil production on verge of explosive growth in U.S.

Technology advances, higher oil prices, reduced costs, and environmental needs have aligned to create a "perfect storm" of growth opportunity for a well-established method for enhancing oil recovery (EOR) in the U.S.: carbon dioxide (CO_2) flooding.

The U.S. Department of Energy is supporting critical research to help America's oil producers take full advantage of that growth opportunity (see table on p. 3). CO_2 flooding is the fastest-growing EOR technique in the U.S. While production volumes and the number of projects for thermal, chemical, and other EOR processes have fallen off sharply since 1980, the number of CO_2 projects has more than tripled, to more than 70 projects as of yearend 2004. Meanwhile, CO_2 production volumes have jumped twentyfold since the early 1980s (see chart on p. 2). The CO_2 share of U.S. crude oil production was estimated at almost 206,000 barrels per day in 2004, according to the Oil & Gas Journal's biennial EOR Survey, published April 12, 2004. That equals about 4% of the Nation's total.

With the proper incentives, CO_2 EOR output has the potential to double by 2010 and quadruple by 2020, according to an analysis by the National Energy Technology Laboratory (NETL).

Inside

Wider application

Commercial CO_2 flood projects in the U.S. largely have been limited to the prolific oil reservoirs of the Permian Basin of Texas and New Mexico that are especially amenable to this EOR process.

"I don't see any reason why CO_2 flooding can't work in any reservoir, as long as you can reach a reasonable minimum miscibility pressure. We've run CO_2 tests in just about every kind of rock."

— Jerry Casteel, Division Director of Technology Management for NETL's Office of Petroleum

However, a series of reports released in April 2005 by DOE's Office of Fossil Energy (FE) indicate significant growth potential for CO_2 flooding elsewhere in the U.S. The reports summarize the results of a series of basin-oriented CO_2 EOR assessments prepared by Advanced Resources International for FE.

Taken together, the assessments conclude that a broadly applied CO_2 flood campaign in large, favorable reservoirs in these other regions could yield another 43.3 billion barrels of incremental oil. That compares with the currently estimated 22 billion barrels of proven oil reserves in the U.S. The regions assessed were California, the Gulf Coast, Oklahoma, Illinois, Alaska, and the Louisiana offshore continental shelf (see table on p. 2).

There is no reason why CO_2 flooding wouldn't work in these other regions, according to Jerry Casteel, director of technology for NETL's Office of Petroleum. "I don't see any reason why CO_2 [flooding] can't work in any reservoir, as long as you can reach a reasonable MMP (minimum miscibility pressure)," he said. "We've run [CO_2] tests in just about every kind of rock."

As early as the 1970s, DOE-funded projects were assessing the basic fluid properties of CO_2 regarding pressure, temperature, and oil composition. A special focus was given to developing MMP correlations, which helped the oil industry to prioritize these properties in order to implement commercial CO_2 projects successfully.

During 1993-2003, DOE funded nearly half of the $100 million spent on Class Program CO_2 EOR field demonstration projects in six states, with a targeted incremental recovery of 23 million barrels of oil.

The FE regional assessments show the potential for technically and economically recovering crude oil from mature, domestic fields using available, state-of-the-art technologies in conjunction with CO_2 flooding. These technologies include horizontal wells for improved reservoir contact, 4-dimensional seismic to monitor the behavior of CO_2 floods, automated field monitoring systems for detecting problems, and injecting larger volumes of CO_2.

Emerging, advanced EOR technologies could even double the 43.3 billion barrels of technically recoverable oil identified by the regional assessments.

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The reports also assessed the performance of CO_2 EOR projects undertaken in these regions during the past 30 years, reviewing both successful and unsuccessful efforts.

FE concluded that a basin-oriented strategy underpinning widespread application of CO_2 flooding to the Nation's mature reservoirs could hike U.S. oil production by 2-3 million barrels per day by 2025. The benefits from such an effort would include a reduction in the Nation's trade deficit of over $1.7 trillion through reduced oil imports, over 500,000 high-paying domestic jobs from the direct and indirect economic effects of increased domestic oil production, and over $400 billion in added federal, state, and local revenues from royalties, production, and corporate income taxes.

Virtually all CO_2 flooding targets light oil reservoirs deeper than 3,000 feet. However, some DOE-funded research has ascertained that its solvent effect also reduces oil viscosity in reservoirs with heavier crudes. Coupled with the increased oil saturation identified with CO_2-induced swelling, this points to the suitability of CO_2 flooding for a range of reservoirs not typically amenable to miscible displacement processes.

CO_2 EOR Technically Recoverable Resource Potential From Six Areas Assessed

Basin/Area	No. Large Favorable Reservoirs Assessed	All Reservoirs (Six Areas Assessed) OOIP* (Billion Barrels)	ROIP** (Billion Barrels)	Technically Recoverable (Billion Barrels)
California	88	83.3	57.3	5.2
Gulf Coast	205	60.8	36.4	10.1
Oklahoma	63	60.3	45.1	9.0
Illinois	46	9.4	5.8	0.7
Alaska	32	67.3	45.0	12.4
Louisiana Offshore (Shelf)	99	28.1	15.7	5.9
Total	533	309.2	205.3	43.3

* Original oil in place, in all reservoirs in basin/area.
** Remaining oil in place, in all reservoirs in basin/area.

Technology challenges

The major technical challenge isn't finding reservoirs amenable to CO_2 floods, Casteel noted: "The real problem we have is controlling proper mobility and proper sweep."

Most CO_2 floods entail injecting a large slug of CO_2 followed by injection of water—which drives the CO_2—to maximize sweep efficiency. Modifying CO_2 viscosity is critical because differences in CO_2 viscosity and density relative to the crude oil in place can set the stage for premature breakthrough of the gas. Such breakthrough results from a combination of gravity override and the CO_2 channeling through more-permeable zones. The end result is less oil ultimately recovered.

The response to this challenge entailed alternating injection of water and gas (WAG), which improved sweep efficiency. But this posed another problem: While sweep improves with WAG, displacement efficiency may decline because the water can shield the oil from the solvent-like nature of the gas. So DOE has funded much research on alternative ways to improve CO_2 sweep efficiency—with foams, chemical gels, and direct thickening agents.

At present, DOE is funding the only U.S. public research on improving reservoir sweep by modifying CO_2 viscosity.

CO_2 costs

Industry has been able to cut CO_2 operating costs by more than 50% since the early 1980s.

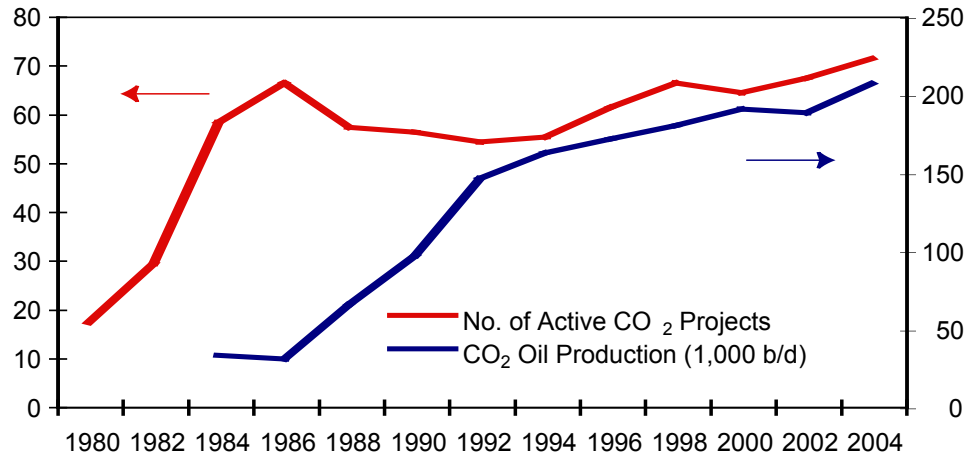
Kinder Morgan CO_2 Co. L.P. estimates that overall operating costs have plunged to less than half the $1 million per flood pattern seen in the 1980s.

Casteel concurred: "In the beginning, operators had to 'gold-plate' everything; all the pipe and fittings were stainless steel. The main boost [in the proliferation of projects] came in the mid-1990s, when a lot of papers were published on how to run an economical flood. Now, it's not 'gold-plated' like it used to be."

Meanwhile, CO_2 costs have fallen sharply as interest in the technology has grown. Kinder Morgan estimates that CO_2 prices have dropped by 40%. The company, the leading provider of CO_2 to EOR projects, estimates total operating expenses exclusive of CO_2 costs at $2-3 per barrel.

In addition, once a flood is under way,

U.S. CO_2 EOR Growth



Source: Oil & Gas Journal

the produced CO_2 can be captured and recycled. This all adds up to a project that can yield a healthy profit even oil prices are as low as $18 per barrel, says Kinder Morgan.

Environmental benefits

The attractiveness of CO_2 EOR gains added luster when potential environmental benefits are factored in.

Utilizing an industrial source of CO_2 for EOR costs more than using natural sources, but this approach adds the benefit of capturing and sequestering CO_2 emissions. DOE is funding research related to this concept, a field demonstration project involving a CO_2 miscible flood in central Kansas that utilizes a CO_2 stream from a nearby ethanol plant. Because there are no natural sources of CO_2 available nearby, no one has attempted a commercial CO_2 flood in a Kansas oil field to date. Early results are promising, and if this approach can be applied to other Kansas fields, the incremental oil production resulting from CO_2 floods in that state ultimately could total 600 million barrels.

As pressures mount to reduce CO_2 emissions amid concerns over postulated human-induced climate change, future CO_2 sequestration efforts are likely to be met with fiscal incentives such as tax or emissions trading credits. That could help level the playing field between natural and industrial sources of CO_2. Broadening the use of industrial CO_2, in turn, could expand the applicability of CO_2 EOR to other areas of the U.S. while "closing the carbon cycle."

A widespread campaign of CO_2 EOR across the U.S. could ensue, "if it comes to where we can get CO_2 from power plants at a reasonable cost—and there are a lot of power plants in this country," Casteel noted.

Energy security, economic, and environmental benefits add up to a compelling case for championing the spread of CO_2 EOR technology across the Nation. And that dovetails neatly with DOE's oil and gas research mission.

NETL funded CO_2 EOR Projects

Performer	Project #	Title
4th Wave Imaging Corp	DE-FC26-03NT15417	Time-Lapse Seismic Modeling and Inversion of CO_2 Saturation for Sequestration and Enhanced Oil Recovery
Advanced Resources International	DE-FC26-04NT15514	Demonstration of a Novel, Integrated Multi-Scale Procedure for High-Resolution 3-D Reservoir Characterization & Improved CO_2-EOR/Sequestration Management, SACROC Unit/Breakout
Chevron USA Inc.	DE-FC22-95BC14938	Advanced Reservoir Characterization in the Antelope Shale to Establish the Viability of CO_2 Enhanced Oil Recovery in California's Monterey Formation Siliceous Shales – Class III
Electromagnetic Instruments Inc.	DE-FC26-00BC15307	Oil Reservoir Characterization and CO_2 Injection Monitoring in the Permian Basin with Crosswell Electromagnetic Imaging
Los Alamos National Laboratory	FEW03FE06-4	Technology Development and Demonstration of Microhole Oil Production at the Rocky Mountain Oilfield Test Center
Michigan Technological University	DE-FC26-02NT15441	Implementing a Novel Cyclic CO_2 Flood in Paleozoic Reefs
Petroleum Recovery Research Center New Mexico Tech	DE-FC26-01BC15364	Improving CO_2 Efficiency for Recovering Oil in Heterogeneous Reservoirs
University of Kansas	DE-FC26-00BC15124	Field Demonstration of CO_2 Miscible Flooding in the Lansing-Kansas City Formation, Central Kansas
University of Kansas Center for Research	DE-FC26-03NT15414	4-D High-Resolution Seismic Reflection Monitoring of Miscible CO_2 Injected into a Carbonate Reservoir
University of Pittsburgh	DE-FC26-01BC15315	Inexpensive CO_2-Thickening Agents for Improved Mobility Control of CO_2 Floods
University of Pittsburgh	DE-FC26-04NT15533	Synthesis and Evaluation of Inexpensive CO_2 Thickeners Designed by Molecular Modeling/Breakout

New, low-cost approach to 4-D imaging could bolster EOR economics

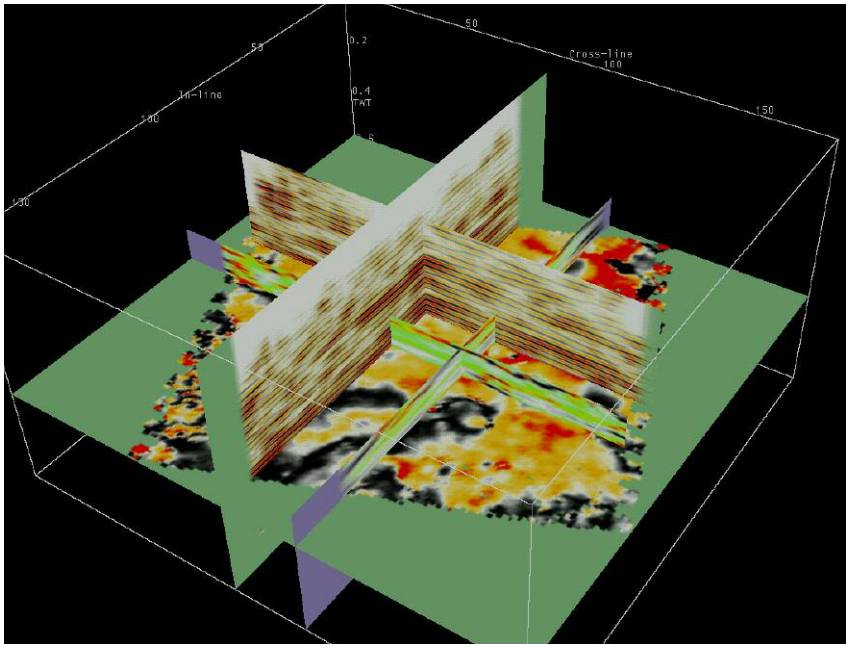
Advances in seismic imaging may help expand the application of enhanced oil recovery (EOR) to thousands of mature oil reservoirs across the U.S.

DOE-funded research could yield the technology keys to enabling that growth. About 30% of the original-oil-in-place (OOIP) in an oil reservoir is recoverable via primary (using natural reservoir drive) or secondary (usually waterflooding) means. EOR targets for recovery 30-40% of the OOIP that is trapped by waterflooding. The remaining 30% represents a tantalizing prospect for EOR when the thousands of mature oil fields in the U.S. are considered. And CO_2 flooding may have the broadest applicability to the majority of U.S. oil reservoirs of any EOR process (see cover story, pp. 1-3).

For CO_2 EOR to be commercialized on a broader scale requires the U.S. oil industry to gain more knowledge of how the CO_2 acts in a reservoir over time, especially through the use of high-resolution seismic imaging. But costly 3-D seismic surveys, especially implemented for a CO_2 flood in stages over time, or 4-D, are difficult to justify for most of the reservoirs that predominate in the U.S. Midcontinent.

And with more attention being paid to the potential for sequestration of the greenhouse gas CO_2 in abandoned oil and gas reservoirs, industry has even more reason to expand its understanding of subsurface CO_2 behavior. Refinements to high-resolution 3-D reflection imaging that result from the project could enable seismic to play a key role in providing assurances needed in sequestration of CO_2.

So a priority for DOE funding of CO_2 EOR research is to develop new approaches to adapting high-resolution seismic imaging in order for this advanced technology to become a cost-effective tool for monitoring CO_2 floods or disposal.



Vertical cross-line and in-line color wiggle trace displays intersected by the 2-D time slice from near the L-KC "C" interval. Correlating the time slice with reservoir tops as defined by well logs results in an excellent match between structure and amplitude. Reds are structurally higher than yellows, which are then higher than the blacks. Average instantaneous frequency in-line and cross-line sections (low is green and high is red) for a sub-volume around the target zone is shown.

4-D economics

One such DOE-funded research project in Kansas seeks to achieve that goal by implementing the world's first 4D seismic survey of a CO_2 flood and coupling that effort with carefully selective use of other advanced seismic technology.

During a 6-year span, a total of 12 3-D surveys, comprising the 4-D time lapse, will portray the movement of reservoir fluids and CO_2 injection in Hall-Gurney field, near Russell, KS. The baseline 3-D survey for the 4-D seismic monitoring project began Nov. 5 and concluded Nov. 20 in 2003. Four 3-D monitor surveys have been conducted since then. Project completion is scheduled for August 2009.

What marks the novelty of this project is its low-cost approach to implementing a valuable imaging tool that is usually too expensive to justify in monitoring subsurface fluid behavior and reservoir properties in the thin reservoirs prevalent in the U.S. Midcontinent.

UKCR researchers set up differential GPS tripod base prior to installation of satellite receiver and ground plane.

Use of 4-D seismic surveying has grown in the past decade, proving to be an effective tool to assess the effectiveness of conventional EOR programs. But for such time-lapse monitoring of reservoir injection and production behavior to be effective, the operator must be able to secure consistent and repeatable 3-D data. That causes costs to mount rapidly. Accordingly, this approach to seismic monitoring has been deemed feasible only for the most prolific oil fields—those with the greatest potential for significant returns from recovering stranded oil reserves. And the costs add up even more with the introduction of technologies such as multi-component shear wave imaging, which can reveal unknown or unexpected properties within the reservoir because shear waves are unaffected by reservoir fluids. Conventional seismic employs reflected compressional acoustic waves that move fastest throught the earth and can help delineate the scope of a reservoir. Deploying multi-component seismic arrays, or increasing the number of geophones or other data receiver components, augments the value of seismic signal measurements.

Kansas project

The University of Kansas Center for Research (UKCR) designed a project that would combine time-lapse 3-D seismic surveys with 2-D, two-component (2-C) shear wave seismic data to observe changes in fluid characteristics in an oil reservoir before, during, and after a miscible CO_2 flood.

The seismic monitoring project is being implemented for a landmark CO_2 miscible flood pilot project under way in Hall-Gurney oil field. That pilot—the first CO_2 flood in Kansas—also is funded in part by DOE. Both projects are managed by the Office of Petroleum of DOE's National Energy Technology Laboratory.

The idea is to seismically delineate, essentially in real time, the nonlinear movement of a miscible CO_2 flood bank through

a thin carbonate reservoir with enough resolution to ascertain the heterogeneous aspects of the reservoir and thus determine their influence on the flood sweep's uniformity and efficiency.

Nearly real-time seismic monitoring data gleaned from this effort enabled the operator to dramatically improve injection and production schemes and thus improve the EOR program's efficiency and economics. CO_2 injection has been under way for about a year in Hall-Gurney field. High-resolution 3-D data gathered to date have highlighted changes consistent with expected CO_2 movement. The CO_2 front was shown breaking through completely around one well and trending toward a second as of June 2004. Thus the project has successfully demonstrated that it is possible to detect CO_2 movement in thin, relatively shallow, mature carbonate reservoirs.

The IVI Minivib2 vibrator seismic truck with GPS tracking and guidance system at work in Hall-Gurney field, KS.

Acquisition of the first 2-C, 2-D shear wave data got under way in December 2004. The current emphasis is on gauging the sensitivity of several seismic attributes to changes in fluid characteristics observed as the CO_2 moves across the reservoir. As of early this year, about 84% of the changes in seismic properties identified in the latest surveys resulted from CO_2 saturation, UKCR researchers reported to the Tertiary Oil Recovery Project conference in Wichita, KS, on Apr. 6, 2005. This further validates the effectiveness of this unconventional, low-cost approach to seismic monitoring of a CO_2 flood.

The project also will assess the best approaches to 4-D seismic monitoring to determine the minimum requirements needed for it to emerge as a cost-effective tool for routine monitoring of small, low-budget EOR projects.

Efficiently designing and implementing 4-D monitoring of EOR programs could significantly increase oil recovery in fields with marginally economic volumes of remaining oil. So it follows that getting a clearer, real-time image of the subsurface at a economically feasible cost could unlock billions of barrels of oil for the Nation's use.

Office of Petroleum E&P SNAPSHOTS

Ken Luff receiving IPAMS honor

Ken Luff, a Department of Energy research partner who developed innovative software tools with the help of DOE funding that resulted in the recovery of millions of barrels of additional oil in the Rocky Mountains, has been named "Wildcatter of the Year" by the Independent Petroleum Association of Mountain States (IPAMS).

Luff, owner of Luff Exploration Co., Denver, CO, received the IPAMS award at the organization's 24th annual Wildcatter of the Year Gala in Denver May 21. The award recognizes lifetime achievement for distinguished service to the oil and gas industry and the Rocky Mountain community. IPAMS is a regional, non-profit trade association representing more than 400 independent oil and gas producers and others in the 13 Intermountain West states. Luff Exploration is an independent oil and gas exploration firm that has operated throughout the Rocky Mountain region for 35 years.

In 2000 Luff Exploration received a cooperative grant from DOE to develop a set of tools for reservoir characterization from 3-D or 2-D seismic data and conventional well information. The tools comprised the Intelligent Computing System (ICS) software suite that uses computer clustering, artificial neural networks, and classic regression methods to combine seismic, geologic, and engineering data for predictions of reservoir potential. This set of software tools uses geologic, oil and gas production, drilling, and seismic data to create, in effect, a suite of reservoir maps. These maps predict the production rates and remaining oil and gas in any part of the reservoir, enabling the operator to choose the best drilling locations to maximize recovery of hydrocarbons.

Under the DOE grant, Luff used these tools to analyze carbonate reservoirs in the Williston Basin Red River formation in Bowman County, ND, and to locate optimum drilling targets. He validated the ICS concept by drilling or recompleting nine demonstration wells in the Williston Basin's South Amor oil field in North Dakota with the aid of ICS-generated maps during 2002. Using the ICS software greatly reduced the risks associated with drilling horizontal wells in the Red River formation. That paid off in terms of reduced exploitation costs, increased reserves discovered, and expanded production. As of July 2003, with the aid of ICS maps and horizontal drilling technology, Luff's field trials had increased its proved oil reserves by 3.25 million barrels and increased its oil production by 2,600 barrels per day. In announcing the Wildcatter of the Year award to Luff, IPAMS noted the contribution of the DOE cost-sharing grants to Luff's exploration and production successes in the past decade.

By using ICS to locate remaining bypassed pockets of oil and horizontal drilling techniques to cost-effectively recover this oil, Luff revitalized an oil field that after 20 years was nearing the end of its life.

The ICS software is not specific to any particular region or reservoir class. Using the same DOE software in tandem with their own databases and comparable advanced drilling technologies, operators could replicate such results throughout the U.S. ICS software is provided free along with a user's guide and tutorial on the DOE website at **www.netl.doe.gov**.

Dr. William F. Lawson, director of the Strategic Center for Natural Gas and Oil, delivered a speech, "R&D: Catalyst for the Next Stage of Seismic Industry Growth," at the Sercel Land Acquisition Forum on April 21, 2005, in Houston, TX. The speech has been posted on the SCNGO Reference Shelf at **www.netl.doe.gov/scngo/index.html**.

DOE project deems feasible miniaturization of key tools for microhole projects


Baker Hughes INTEQ

Baker Hughes Inteq's 2⅜-inch CoilTrak™ coiled tubing drilling assembly. A DOE-funded research project will develop a geosteering device and a resistivity module to add to this commercially available drilling assembly.

The Department of Energy continues to mark progress in advancing its "microhole" initiative, a revolutionary new approach to drilling America's oil and natural gas wells. The scale-down of two tools essential for the initiative has been deemed feasible under a DOE-funded project.

The new technology, which entails integrating a suite of high-tech tools with ultra-small diameter boreholes, promises to slash operators' costs, decrease drilling risks, and dramatically reduce the environmental impacts of oil and gas drilling.

Two such high-tech tools are a Rib Steering Device (RSD) and a Multiple Propagation Resistivity (MPR) device designed for 2-inch coiled tubing. RSD technology employs a downhole guidance system that continually adjusts the drill bit's course; it uses pads, or ribs, to steer while drilling continuously, enabling the operator to change drilling angles without interrupting the rotation of the drill pipe string. Resistivity measures a formation's resistance to electrical current, which is used to determine whether the formation holds hydrocarbons or water. MPR employs an array of antennas that propagate multiple electromagnetic signals at different frequencies. The technologies are intended to give the operator better control over drilling progress and better information about what the drillbit is encountering downhole.

A first-round Microhole Technology project, managed by DOE's National Energy Technology Laboratory, seeks to develop an RSD and an MPR device for coiled tubing that is only 2 inches in diameter. Baker Hughes INTEQ, through system concept development and a larger tool field survey, has determined that the appropriate technology is available and can be modified for microhole application.

For the RSD, the problem is primarily one of developing a 2⅜-inch tool that can maintain structural integrity. Modeling and drawing tasks have indicated that, at this stage of the project, construction of a 2⅜-inch RSD is feasible.

For the MPR device, the problems associated with scaling down the size are to maintain structural integrity and still achieve the fidelity of resistivity measurement of the larger tool sizes. The construction of a 2⅜-inch MPR device nevertheless appears to be feasible, according to project investigators. Several draft designs of these tools are undergoing evaluation to identify the optimum setup. In addition, Baker Hughes INTEQ has performed calculations to evaluate the maximum bending stresses that the new components may encounter when integrated into existing coiled tubing bottomhole assemblies.

The next step will be to work through the detailed design process to reach a critical decision point: whether or not to enter into the manufacturing stage. That decision is expected in 2005. If that decision is a "go," then Baker Hughes INTEQ will manufacture two prototypes of each tool and test them in the lab, as well as in the field.

DOE-funded perforation-free 'Teleperfs' technology commercialized

A DOE-funded revolutionary well completion technology that promises lower oil field development costs and reduced environmental and safety risks has been commercialized.

Completion Concepts Inc., a small business based in Katy, TX, developed a method for cold production of heavy oil that eliminates the expense and risks of perforating and gravel packing wells. At the same time, this innovative approach constitutes a means to control sand while protecting well productivity and minimizing formation damage during well construction.

After receiving a Small Business Incentive Research grant from DOE, Completion Concepts developed a hydraulically telescoping, pre-formed perforation system with sand control media integrated into the system.

After a well casing is set and the well is drilled through the completion interval, telescoping, preformed devices, dubbed "Teleperfs," that contain a sand-control medium are arrayed around the outside of the well liner assembly.

Using only wellbore pressure, the Teleperfs are projected into the face of the formation, securing the well liner in place and providing entry ports for formation fluids. The well liner is then cemented into place. This new approach is an alternative to conventional jet perforations that are "exploded" into place. Conventional jet perfs often leave behind debris that can inhibit reservoir permeability, notably in unconsolidated sands. The Teleperfs are telescoped to as much as 1½ inches into place and can be installed as densely as 25 per foot.

In addition, the Teleperfs system dispenses with the costly and often inefficient practice of gravel packing. Gravel packs can be tricky to implement, as any gap in the pack coverage will allow the intrusion of sand. Because each Teleperf already is filled with sand control media during manufacture, gravel packs are unnecessary as part of a well completion in a sand-producing, heavy oil reservoir.

Each Teleperf also is coated with an organic, non-corrosive polymer/acid sealant that is released after exposure to downhole temperatures for a short time, removing a protective coating installed on the Teleperf face. This turns the Teleperf into a continuous pathway to the virgin producing formation.

The beauty of the system is that all of these steps can be accomplished in a single trip downhole. That's where significant savings come in. In comparing the Teleperfs system with a conventional well completion, equipment costs match up pretty evenly. But the one-trip approach of Teleperfs can result in considerable rig time and service personnel costs savings.

The Teleperfs system was developed under a joint industry project involving Completion Concepts, BP PLC, ChevronTexaco Corp., ENI SA, and Baker Hughes division Baker Oil Tools (BOT). Full-scale field testing of the Teleperfs devices was completed in a BOT test well at Bossier, City, LA, in spring 2004. Plans call for BP to conduct a "real-world" test of the Teleperfs system in an Alaska injection well this year.

Meanwhile, Baker Hughes has acquired a license to the technology and currently is offering Teleperfs services for sale in an aggressive marketing campaign in industry publications and conferences.

AEO project revives interest in SW Alaska exploration

Research funded by NETL through its Arctic Energy Office (AEO) could help revitalize oil and gas exploration in Alaska's remote southwestern region.

The geological field studies conducted under AEO auspices have yielded hints of what some oil explorationists suggest could be the next Prudhoe Bay in the Bristol Bay-Alaska Peninsula region. Prudhoe Bay is the largest oil field ever found in North America and remains the linchpin of Alaskan North Slope oil production.

Despite industry's interest in the area early in the previous century, the Bristol Bay-Alaska Peninsula area is one of the Nation's least explored regions for oil and natural gas.

The presence of oil seeps and other hydrocarbon indicators sparked a flurry of drilling in the region during the 1920s. However, a lack of success capped the ultimate tally of exploratory wells at a paltry 35 in an area described as two to three times the size of the Cook Inlet region, Alaska's other principal oil and gas producing area. Oil and gas discoveries in the Cook Inlet area and later on the North Slope helped redirect explorationists' interest toward those regions and away from southwestern Alaska. The last well drilled in the Bristol Bay-Alaska Peninsula region was spudded 2 decades ago, just before the oil price collapse of the 1980s.

Given declining oil production in the North Slope and Cook Inlet regions, it shouldn't be surprising that explorationists' interest once again is turning toward southwestern Alaska.

The state in October 2005 will hold an areawide oil and gas lease sale of offshore and onshore acreage in the southwestern peninsular region. Bidders at that sale will be armed with some of the preliminary findings coming out of the project managed by AEO, which is housed at the University of Alaska-Fairbanks in Fairbanks, AK.

The 3-year program is designed to apply contemporary exploration science to the available repository of geological knowledge and well data from the area. A team of state, university, and private consulting geologists led by Alaska's Division of Geological and Geophysical Surveys (DGGS) is undertaking the project field geology work, reservoir characterization, and hydrocarbon-potential analysis. DGGS, the state's Division of Oil and Gas, and Bristol Bay Native Corp. also are contributing funds to the project.

Gas seep at the hot springs pool in Herendeen Bay on the Alaska Peninsula's Bristol Bay coast yielded samples with a methane content of more than 99%.

Regional geology

The first phase of the project entailed spring 2004 field work in the Puale Bay and Wide Bay areas of the northeastern Alaska Peninsula to study source rock potential and stratigraphy of the Jurassic and Triassic section and to sample oil seeps for geochemical characterization.

The second phase called for summer 2004 field work in the Port Moller, Herendeen Bay, and Bear Lake areas along Bristol Bay to assess Tertiary reservoir potential, particularly the Miocene Bear Lake and Pliocene Milky River. The researchers also will be taking another look at seismic and well log data from the area as well as testing samples.

In essence, the project is intended to develop a working concept of how a petroleum system may have formed in the region.

The project pinpointed some good-quality source rock in the Triassic Kamishak and the Middle Jurassic Kialagvik formations. The Kamishak yielded a total organic carbon (TOC) level of 2.4%, and the Upper Jurassic Naknek formation registered a 2.9% TOC. The Lower Naknek showed porosity of 2-8% and permeability of 0.005-300 millidarcies and featured tens of meters of oil-charged outcrop. A seep at Oil Creek produces 0.5 barrel of 18 degree gravity oil per day and natural gas with a methane content of 91% from the Jurassic Shelikof.

Along the eastern side of the Alaska Peninsula, the Bear Lake and Milky River formations can be as thick as 1,000 meters, and the Bear Lake has produced oil shows offshore. Especially noteworthy is an angular unconformity that defines the contact between the steeply dipping and locally tightly folded Bear Lake and the gently dipping Milky River.

More field work is scheduled this year as DOE-funded research takes a second look at a still-promising area of America's Last Frontier.

Calendar of Events/2005

Aug. 24-25
NAPE, *North American Prospect Expo,* Houston, TX. Contact: www.napeonline.com/snape/index.html.

Sep. 10-13
AAPG, *Mid-Continent Section Meeting,* Oklahoma City, OK. Contact: www.aapg.org.

Sep. 18-20
IOGCC, *2005 Annual Meeting,* Jackson Hole, WY. Contact: www.iogcc.state.ok.us.

Sep. 18-20
AAPG, *Eastern Meeting- Mountains of Opportunity,* Morgantown, WV. Contact: www.aapg.org.

Sep. 25-27
AAPG, *Gulf Coast Association of Geological Societies 55th Annual Convention,* New Orleans, LA. Contact: www.gcgas2005.com.

Nov. 6-11
SEG, *International Exposition & 75th Annual Meeting,* Houston, TX. Contact: meetings@seg.org.

Nov. 30-Dec. 1
IADC, *Drilling Gulf of Mexico Conference & Exhibition,* Houston, TX. Contact: www.iadc.org.

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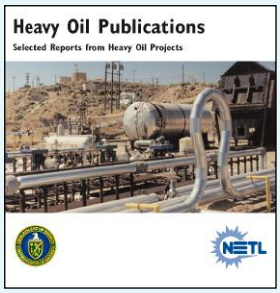

This CD contains selected DOE reports and analysis on resource and recovery technologies for U.S. heavy oil. They cover DOE-funded heavy oil R&D involving laboratory work, numerical simulator development, and various thermal and non-thermal field tests of heavy oil recovery processes. Included are an Excel spreadsheet of more than 500 of the largest heavy oil reservoirs (a subset of 1,025 analyzed) and publications on heavy oil resources in selected basins.

Please request the CD via NETL's CD-ROM Ordering System at **http://www.netl.doe.gov/scngo/index.html**, listed under the SCNGO Reference Shelf.

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