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Oil Companies Turning to Submarine Technology in Fracking



USS Wyoming

REBECCA REBARICH/U.S. NAVY

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HOUSTON — A gossamer-thin glass line threaded two miles underground is allowing oilfield engineers to listen to a new kind of music: the sounds of fracking.

Halliburton Co. and competing providers of drilling gear are adapting acoustic spy technology used by U.S. submarines to record sounds made deep in the earth that can guide engineers in finishing a well and predicting how much oil will flow.

The ability to hear inside a well enables producers to fine-tune hydraulic fracturing, or fracking, the process that blasts underground rock with water, sand and chemicals to free trapped oil and natural gas. The technology is targeted at an estimated \$31 billion that will be spent this year on fracking stages that yield less-than-optimal results, a majority of the work at 26,100 U.S. wells set to be pressure-pumped in 2013, according to PacWest Consulting Partners.

"We're creating a new science," said Magnus McEwen-King, managing director for OptaSense, a Qinetiq Group Inc unit that's one of the fiber-optics pioneers for the energy industry. "From an acoustic perspective, this is very much the start of what I think is going to be a revolutionary technology."

Fracking has helped U.S. oil production reach a 21-year high. Environmental groups have criticized the practice because of concerns it may affect drinking water supplies.

Energy companies are fueling the booming business of so-called distributed fiber-optic lines, where the cord itself is a sensor for sound and temperature throughout its entire length.

The U.S. market for such lines, used across industries from energy to military, will almost double to \$1.1 billion by 2016 from an estimated \$586 million this year, according to a study published by Information Gatekeepers and revised this month by Light Wave Venture, which helps develop new companies using fiber-optic technology.

The prospect of fine-tuning energy discovery has the world's largest oilfield service providers joining companies with ties to the defense industry including OptaSense and U.S. Seismic Systems Inc., a unit of Acorn Energy Inc., to develop ways to eavesdrop on wells. Royal Dutch Shell, Chevron and Statoil are among customers testing the technology.

"This market is evolving very, very aggressively," said Dave Krohn, a Connecticut-based materials engineer who wrote the market study. "Clearly the driver is oil and gas."

Halliburton, the world's largest provider of fracking services, is working on cataloging the combination of sounds that signal the perfect frack: an explosion, cracking rock, and eventually the gurgle of hydrocarbons seeping into the well bore, said Glenn McColpin, director of reservoir monitoring at Halliburton's Houston-based Pinnacle unit. A bad frack means the rock didn't crack as much as it could have.

When perfected, a computer will convert the sounds to a graph that will show how deeply and thoroughly cracks penetrate the rock surrounding the well, indicating the success of each frack stage. **The longer and more numerous the cracks, the more oil and gas will flow.**

One fracking stage can cost about \$100,000 and a typical well now will have about 15 stages, said Alex Robart, principal at PacWest. The effectiveness of each stage varies wildly. The industry generally subscribes to the 80-20 rule, meaning 80 percent of North American production comes from about 20 percent of the fracking stages, he said.

Finding out immediately which fracks were successful allows a company to repeat the process to improve flow.

"Our whole goal is to make the perfect frack every time," McColpin said. "You're spending millions of dollars pumping millions of gallons of fluid, and if you're only getting a third of the rock, you're getting a third of the production."

A fiber optic line consists of a stainless steel cable encasing one long, thin string of glass that vibrates when struck by sound waves. The sound waves are converted to light pulses reflected through the line, then converted by computer software back into sound that McColpin can monitor from his laptop.

"Bink, bank, boink" is what McColpin hears as a small metal ball rolls down the well bore and lands in a "ball seat" that triggers the rock's first fracture. **The fiber line captures the noise of the ball and the reverberating blast of the perforation gun firing into the rock.** Computer software converts those sounds into a colored graph on his laptop screen, etching a bright red fever line across a green background.

"Our whole goal is to make the earth transparent," McColpin said. "Now we've got a window into the well to see exactly what's happening."

The oil industry started experimenting with fiber optic lines' temperature-sensing abilities about a decade ago, and five years later started testing it with sounds.

In August 2009 OptaSense traveled to Alberta, Canada, to show off its acoustic fiber-optic line to Shell. Executives from both companies piled into an observation truck parked near the well site to oversee a fracking job while OptaSense's McEwen- King sat in his office back in England monitoring the real-time results on his computer.

As the perforation gun exploded, sound waves traveling along the fiber optic line were transformed into data that lit up his screen with a brightly colored graph illustrating the results.

"You guys just turned the lights on down there!" McEwen- King told his colleagues back in Canada. "The whole well-bore imaged instantaneously," he recalled in an interview earlier this month. Three years later, **OptaSense announced an agreement with Shell to provide global frack-monitoring services using the acoustic lines.**

Some of the world's largest oil producers are interested in the still-evolving technology, Joseph Elkhoury, general manager of microseismic services at Schlumberger.

"There's always this wide enthusiasm around a new technology," he said. Inevitably, that's followed months or years later by a drop in the adoption curve as customers realize the technology isn't everything they hoped it would be. Once the service companies fix some of the challenges, adoption picks up again, he said.

"We are in the wide-enthusiasm phase of acoustic sensing," Elkhoury said.

One of the biggest challenges for acoustic fiber in the oilfield is making the business case to use it onshore, Robart said. Installing the technology can cost as much as several hundred thousand dollars a well, meaning it doesn't pay off as easily on a \$6 million land well as it would on a \$50 million offshore well, he said.

To confirm how large a fracture was and where it went, companies still need to use a network of specific sensors called geophones to listen from a nearby monitoring well, measuring subtle earth movements from the rock cracking. Some service companies want to one day ditch these microseismic tools and get the same listening sensitivity from their one fiber optic line, helping bring costs down and becoming more efficient.

U.S. Seismic is using three acoustic fiber-optic lines to listen for sounds in place of traditional geophones. The technology provides a more accurate sense of how far the cracks penetrated the rock and in which direction, said Jim Andersen, chief executive officer of U.S. Seismic.

Contractors ranging from Halliburton to Exiuis have begun permanently installing fiber optic lines in U.S. wells. During completion of a just-drilled well, the fiber can listen for subtle noises that suggest sealing the well with cement didn't work properly.

Then the fiber can listen for good and bad fracking stages, and finally it'll be able to confirm if oil and gas is flowing. Eventually they'll be able to actually measure production flow based on sounds, McColpin said. He compares it to a flute: as different holes in the well's casing are open or clogged, the sound pitch of fluids flowing through the well are affected.

Programmers also are working on algorithms to detect the difference in sound for water versus oil flowing into the well from surrounding rock. Then valves for different areas in the well bore could be opened or closed as needed to minimize water incursion, which is a waste.

Scientists also want to beef up the listening capability of the fiber optic line during **seismic shoots** of the underground rock to capture better reservoir images for future exploration.

Submarines were among the first adopters of acoustic fiber- optic technology in the late 1990s. Some of OptaSense's technology expertise originates from its parent company, Qinetiq, a British defense contractor providing military services ranging from drones to cyber security.

Before moving to U.S. Seismic, Andersen previously ran the group at Litton Industries Inc. that sold about \$450 million worth of fiber-optic sensor technology to the U.S. Navy. Northrop Grumman Corp., a maker of surveillance drones, bought Litton in 2001 for about \$5 billion.

Outside of oil and gas production, fiber optic lines are being used on pipelines to detect leaks or foul play, for monitoring perimeter security along a property fence line and to measure the stress on infrastructure such as roads and bridges. The rebuilt Interstate 35 bridge in Minneapolis is now packed with 300 fiber-optic sensors after it collapsed in 2007, Krohn said.

One of the biggest challenges for the new technology is figuring out what to do with the mountains of data they're collecting. Halliburton has assembled engineers, scientists and former U.S. space program technicians in a Houston lab to comb through data that pores in fast enough to fill up a DVD every 28 seconds.

So far, companies are afraid to throw anything out, not knowing what might prove to be the crucial puzzle piece later, McColpin said.

"It's untenable," he said. "You can't collect 15 terrabytes a week continuously for 20 years on a well."

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http://www.huffingtonpost.com/2013/08/03/offshore-fracking_n_3700574.html?utm_hp_ref=green

HUFF NEWSLETTERS

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Offshore Fracking Off California Coast Under Review, Drawing Calls For Increased Regulation

AP | By JASON DEAREN and ALICIA CHANG

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SAN FRANCISCO (AP) — Companies prospecting for oil off California's coast have used hydraulic fracturing on at least a dozen occasions to force open cracks beneath the seabed, and now regulators are investigating whether the practice should require a separate permit and be subject to stricter environmental review.

While debate has raged over fracking on land, prompting efforts to ban or severely restrict it, offshore fracking has occurred with little attention in sensitive coastal waters where for decades new oil leases have been prohibited.

Hundreds of pages of federal documents released by the government to The Associated Press and advocacy groups through the Freedom of Information Act show regulators have permitted fracking in the Pacific Ocean at least 12 times since the late 1990s, and have recently approved a new project.

The targets are the vast oil fields in the Santa Barbara Channel, site of a 1969 spill that spewed more than 3 million gallons of crude oil into the ocean, spoiled miles of beaches and killed thousands of birds and other wildlife. The disaster prompted a moratorium on new drill leases and inspired federal clean water laws and the modern environmental movement.

Companies are doing the offshore fracking — which involves pumping hundreds of thousands of gallons of salt water, sand and chemicals into undersea shale and sand formations — to stimulate old existing wells into new oil production.

Federal regulators thus far have exempted the chemical fluids used in offshore fracking from the nation's clean water laws, allowing companies to release fracking fluid into the sea without filing a separate environmental impact report or statement looking at the possible effects. That exemption was affirmed this year by the U.S. Environmental Protection Agency, according to the internal emails reviewed by the AP.

Fracking fluids can comprise hundreds of chemicals — some known and others that aren't since they are protected as trade secrets. Some of these chemicals are toxins to fish larvae and crustaceans, bottom dwellers most at risk from drilling activities, according to government health disclosure documents detailing some of the fluids used off California's shore.

Marine scientists, petroleum engineers and regulatory officials interviewed by the AP could point to no studies that have been performed on the effects of fracking fluids on the marine

environment. Research regarding traditional offshore oil exploration has found that drilling fluids can cause reproductive harm to some marine creatures.

"This is a significant data gap, and we need to know what the impacts are before offshore fracking becomes widespread," said Samantha Joye, a marine scientist at the University of Georgia who studies the effects of oil spills in the ocean environment.

The EPA and the federal agency that oversees offshore drilling, the Bureau of Safety and Environmental Enforcement or BSEE, conduct some routine inspections during fracking projects, but **any spills or leaks are largely left to the oil companies to report.**

In a statement to the AP, the EPA defended its oversight of offshore fracking, saying its system ensures the practice does not pollute the environment in a way that would endanger human health. Oil companies must obtain permits for wastewater and storm water discharges from production platforms that "ensure all fluids used in the drilling and production process will not adversely impact water quality," the statement said.

Oil companies also maintain that much of the fracking fluid is treated before being discharged into the sea. Tupper Hull, spokesman for the Western States Petroleum Association, said fracking in general is safe and has "never been associated with any risk or harm to the environment" in over six decades in California.

California coastal regulators said they were unaware until recently that offshore fracking was even occurring, and are now asking oil companies proposing new offshore drilling projects if they will be fracking.

Because the area of concern is located more than three miles off the state's shoreline, federal regulators have jurisdiction over these offshore exploration efforts. However, the state can reject a permit in federal waters if the work endangers water quality.

"It wasn't on our radar before, and now it is," said Alison Dettmer, a deputy director at the California Coastal Commission.

Government documents including permits and internal emails from the BSEE reveal that fracking off the shores of California is more widespread than previously known. While new oil leases are banned, companies can still drill from 23 grandfathered-in platforms in waters where endangered blue and humpback whales and other marine mammals often congregate.

In March, a privately held oil and gas company received permission from the agency to frack some 10 miles off the Ventura County coast. The job by DCOR LLC involves using the existing wellbore of an old well to drill a new well. Three so-called "mini-fracks" will be done in an attempt to release oil locked within sand and rocks in the Upper Repetto formation.

Only a month before the application was approved, however, an official with the BSEE voiced concerns about the company's proposed frack and whether the operation would discharge chemicals into the ocean.

"We have an operator proposing to use 'hydraulic stimulation' (which has not been done very often here) and I'm trying to run through the list of potential concerns," Kenneth Seeley, the BSEE's regional environmental officer for the Pacific, wrote in a Feb. 12 email to colleagues. "The operator says their produced water is Superclean! but the way they responded to my questions kind of made me think this was worth following up on."

BSEE officials approved DCOR's application on March 7. The agency told the AP that DCOR's job would use far less fracking fluid than an onshore operation.

"For comparison, well stimulation offshore typically uses 2 percent of the liquids and 7 percent of the sand that is used routinely for onshore hydraulic fracturing," the BSEE said in a statement.

Oil industry estimates show that at least half of the chemical-laced water used in fracking remains in the environment after an operation. Environmental groups say as much as 80 percent of the fluids can be left behind. The rest gets pumped back up to the oil platform, and is piped or barged back to shore for treatment. Companies can also pump the fluids into an old well reservoir to discard it.

DCOR, which did not respond to requests for comment, is not the first company to try to tap more oil from California's offshore reserves, nor is the project the most extensive offshore frack here in recent years.

In January 2010, oil and gas company Venoco Inc. set out to improve the production of one of its old wells with what federal drilling records show was the largest offshore fracking operation attempted in federal waters off California's coast. The target: the Monterey Shale, a vast formation that extends from California's Central Valley farmlands to offshore and could ultimately comprise two-thirds of the nation's shale oil reserves.

Six different fracks were completed during the project, during which engineers funneled a mix of about 300,000 pounds of fracking fluids, sand and seawater 4,500 feet beneath the seabed, according to BSEE documents.

Venoco's attempt only mildly increased production, according to the documents. Venoco declined to comment.

Despite greenlighting offshore fracking projects for years, federal and state regulators now are trying to learn more about the extent of fracking in the Pacific even as officials and marine scientists scramble to weigh the environmental effects.

In January, Jaron Ming, the Pacific regional director of the BSEE, told employees in an email that there had been heightened interest in offshore fracking from within the agency and the public.

"For that reason, I am asking you to pay close attention to any (drilling applications) that we receive and let me know if you believe any of them would be considered a 'frac job.'"

That same month, BSEE estimated in internal emails that only two such jobs had occurred off California in the past two decades. But weeks later, as the agency worked to respond to public requests about fracking offshore, emails show it had found 12 such instances of offshore fracking.

BSEE said it cannot be sure just how often fracking has been allowed without going through every single well file.

Brian Segee, a staff attorney at the Environmental Defense Center, said the uncertainty makes him skeptical about the actual number of offshore fracks. The Santa Barbara-based environmental law firm, which formed in the wake of the 1969 oil spill, is calling for a moratorium on future fracking in the Pacific until the potential environmental effects are studied.

Most fracking efforts off California have yielded mixed results. The first time Venoco fracked offshore in the 1990s, it had limited success. Chevron's one try failed. Out of Nuevo Energy's nine attempts, only one was considered very successful, according to company and BSEE records.

The practice has been more fruitful in the North Sea and the Gulf of Mexico, where it's more common and the porous nature of the geologic formation makes it easier to extract oil, according to regulators and oil industry experts. Still, oil companies surveyed by federal regulators said they haven't ruled out fracking projects in the Pacific in the future.

As fracking technology evolves and companies seek to wring production from old offshore wells, drilling experts caution that strict safety precautions and planning are needed.

Working in the open ocean, "you have to be a lot more careful to avoid any spillage," said Mukul Sharma, a professor of petroleum engineering at The University of Texas at Austin.

David Pritchard, a Texas petroleum engineer who has been working in offshore drilling for 45 years, said offshore fracking "no doubt adds complexity and risk."

One concern is that the high pressure fracking mixture in some jobs might break the rock seal around an old well bore, allowing oil to escape, added another expert, Tulane University petroleum engineering professor Eric Smith.

"I'd say it (offshore fracking) is safe," Smith said, "but nothing's a sure thing in this world."

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