A New California Oil Boom?
Drilling the Monterey Shale

A Next Generation Series

Part 1: Distracted by Fracking?

How a little-known drilling technique could change California's oil industry

By Robert Collier

August 2013

Next Generation

Part 1: Distracted by Fracking?

Over the past few years, the United States has found itself in the midst of a major boom in oil and gas production. Rapid expansion in the use of a drilling technique called hydraulic fracturing, or "fracking," has opened up previously unreachable pockets of oil and gas, and returned the U.S. to its historic position as a major global producer of these fossil fuels.

And it seems the boom may be coming to California. Once a leading producer of oil in the U.S., California's production has fallen off dramatically over the years as oil fields age and are depleted. But could America's fracking-fueled oil resurgence breach the oil fields of California, particularly in the relatively untapped Monterey Shale? Could a fracking revolution once again make California a leading producer of domestic oil? And if so, what might this mean for the state's aggressive clean energy and climate goals?

Given the dramatic examples of North Dakota, Texas and Pennsylvania, where widespread use of fracking has helped oil and gas production soar, it might seem inevitable for California to be the next boom state. The Monterey Shale formation, which runs from north-central through southern California, has billions of barrels of oil locked away in its underground nooks and crannies. Petroleum geologists and engineers, always searching for the next strike, are feverishly seeking the technological fix to unlock those riches.

Politically, it's the same fight as elsewhere – environmental regulations have been drafted, legislation written and fought over, Hollywood films made, coalitions pro and con organized -- all focused on the potential benefits, and threats, of widespread fracking.

A "sleeper" oil field technology?

But in California, at least, the obsession with fracking may be misplaced. In recent months, policymakers have begun to realize that the debate about fracking may be a distraction from the technology that's the more likely candidate for tapping the Monterey Shale: A technique, already widely in use in the oil industry, known as "acidizing."

It's not widely discussed in publicly, but for some time oil companies have found acidizing more effective in the Monterey Shale than fracking.

Acidizing typically involves the injection of high volumes of hydrofluoric acid, a powerful solvent, (abbreviated as "HF") into the oil well to dissolve rock deep underground and allow oil to flow up through the well. Conventional fracking, in which water and other chemicals are pumped at high pressure to create fissures in the rocks, reportedly does not work well in many parts of the Monterey Shale – a rock formation that is typically folded and shattered by geological fault action, thus making fracking less effective.

A critical tool – but mistakes can be deadly

In the oil patch, hydrofluoric acid can therefore be a critical tool. But HF is also one of the most dangerous of all fluids used in oil production – and indeed in any industrial process. It is used in many oil refineries nationwide to help turn oil into gasoline and other products; while accidents are rare, they can be fatal.

Currently, large amounts of HF (precise volumes are an industry secret) are routinely trucked around California and mixed at oilfields. Critics call it a disaster waiting to happen. There have been minor HF leaks in other states, though no major catastrophes in the U.S. such as a recent HF tragedy in Korea.

Yet acidizing remains almost totally unregulated. State and federal rules currently being drafted in Sacramento and Washington, DC, make no mention of acidizing. An exception is legislation currently under debate in Sacramento, authored by Sen. Fran Pavley, D-Agoura Hills, who has spearheaded much of the state's climate laws in recent years.

What is acidizing?

There are two types of acid treatment: matrix acidizing and acid fracking.

A **matrix acid** job is performed when acid is pumped at low pressure into the oil well and into the texture of the reservoir rocks. The acids dissolve the sediments and mud solids that are inhibiting the permeability of the rock, enlarging the natural pores of the reservoir and stimulating the flow of oil.

Acid fracking involves pumping acid at moderately high pressure – though considerably lower pressures than conventional fracking. The acids physically fracture the reservoir rock and dissolve the sediments that are blocking the flow of oil.

Because HF is so successful at dissolving anything it touches, drilling companies add other substances to the mix to prevent the acid from dissolving the oil well's steel casings – which are intended to keep the oil and chemicals from leaching into the surrounding rocks and water table. After the acid job is performed, the used acid and oil well sediments are sucked out in a process called backflush.

A low-volume form of acidizing has long been used nationwide, including in California. This process typically occurs in aging oil wells during the final stages of production, as a means of coaxing out the last dregs of oil before the well is abandoned. In contrast, the tactic now being pioneered in California appears to involve much higher volumes of injected acid as a primary technique for new wells.

In past years, both HF and hydrochloric acid (HCl) were used, depending on the geology. However, the sandstones and silicates that are prevalent in the Monterey Shale lend themselves especially to HF use.[1]

In many cases, HF is created at the oilfield by mixing hydrochloric acid with ammonium fluoride and immediately injecting the mix down the well. Creating the HF on site is accepted as safer than offsite production, as it reduces the risk of transport accidents.

In other cases, however, HF is mixed at a remote location, trucked to the oilfield, mixed there and then pumped downhole.

Whether California regulates acidizing may have national and global implications. Although the state appears to be the first to do major experimentation with high-volume acidizing, the rapid expansion of unconventional oil technologies in shale formations in other states suggests that oil companies might try to export any successful California experiments to other locations.

Industry abuzz, but details are secret

Hydrofluoric acid is typically mixed with water and other chemicals, with HF concentration normally less than 9 percent. However, oil company executives have said they are experimenting in California with higher concentrations and pressures, testing the boundaries of geology, engineering – and safety.

Exactly how high those experimental concentrations and pressures are is a closely held secret. At a May 2013 industry conference in Bakersfield, executives in attendance speculated nervously about what their competitors were doing. Each company was clearly working on its own secret formula, trying to find its own recipe for success.

The buzz among conference attendees was about Occidental Petroleum, which had demonstrated much success with HF acidizing at its Elk Hills field.

"As you have seen here, companies are experimenting widely with acidizing," said Maysam Pournik, a geology professor at the University of Oklahoma who spoke at the event.[2] "Nobody is saying exactly what they are doing, because the Monterey Shale is extremely complex, and companies need to try new methods at the limits."

Some executives said they believe their competitors were experimenting with HF concentrations as high as 30 percent. But others downplayed such talk.

"If you use that much HF, you will melt your well casings," said Paul Gagnon, senior vice president of Central Resources, a Denver-based oil firm. "It's not doable."[3] Left unsaid was the environmental danger – that HF could breach the double or triple steel walls of the well casings and enter the surrounding water table, putting local water supplies at risk.

A recognized human hazard

HF is commonly used in oil refineries, where it serves as a catalyst to produce high-octane gasoline. It is one of the most hazardous industrial chemicals in use, according to the U.S. Centers for Disease Control. HF can cause severe burns to skin and eyes, and can damage lungs in ways that may not be immediately painful or visible. Overexposure causes painful, deep-seated and slow-healing burns and ulcers. If absorbed through the skin in even minute amounts and left untreated, HF may cause death.

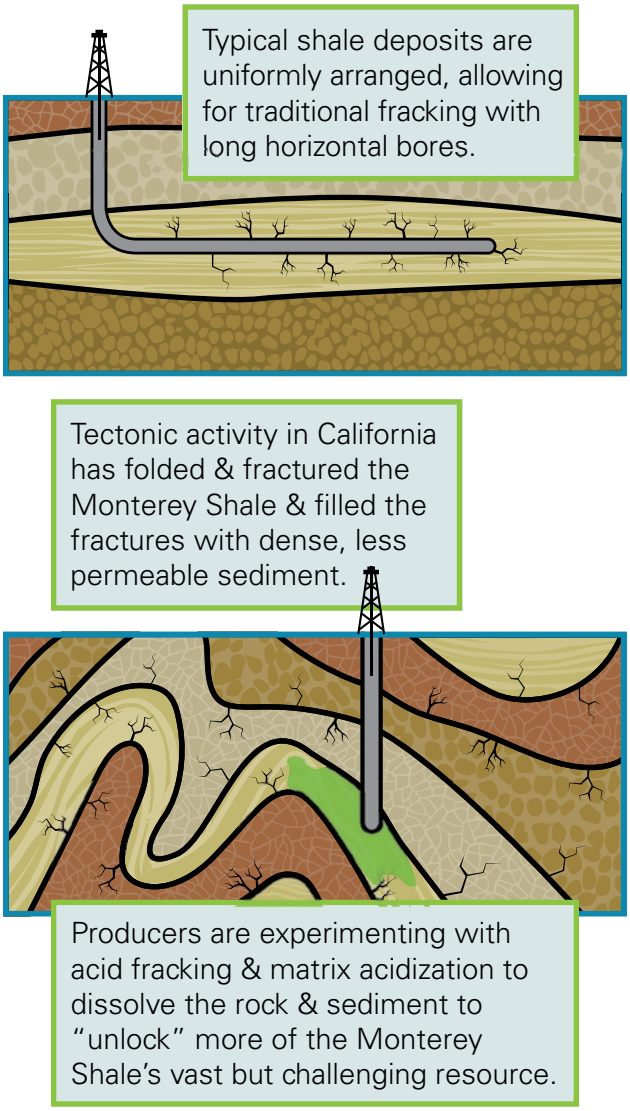
The dangers of HF are compounded by its extreme volatility at relatively low temperatures. If temperatures are cool, HF is a liquid. But at 67.1 degrees F, HF boils into a dense vapor cloud that, if released into the open, does not dissipate, hovers near the ground and can travel great distances – meaning the risks of a spill to nearby population centers are significant.

The National Fire Protection Association system rates hydrofluoric acid in the most dangerous category of hazardous materials. Hydrofluoric acid also is recognized on the Superfund list of Extremely Hazardous Substances. As a powerful corrosive, it dissolves nearly anything – research on matrix acidizing lists "corrosion" as one of the primary challenges.[4]

There appears to be no research or other publicly available information about HF's use in oil and gas production or its potential effects on groundwater supplies. But the risks are clear.

Monterey Shale Geology

The unique geology of California's Monterey Shale renders conventional fracking methods less effective.



Source: Steve Hargreaves, CNN Money

Next in the series: The most dangerous chemical you've never heard of

1 In addition to the primary acid components, other chemicals used include surfactants, solvents, corrosion inhibitors and oxidizers. The acid solution may also be applied in other forms such as foams, gels or emulsions. The volume injected is typically low, such as 5 gallons per well foot, but there are reports that higher volumes of as much as 250 gallons per foot are being used.

2 Interview with author at "Tight Oil R Source: Steve Hargreaves, CNN MoneyProducers are experimenting with acid fracking & matrix acidization to dissolve the rock & sediment to "unlock" more of the Monterey Shale's vast but challenging resource.Tectonic activity in California has folded & fractured the Monterey Shale & filled the fractures with dense, less permeable sediment.Typical shale deposits are uniformly arranged, allowing for tradional fracking with long horizontal bores.The unique geology of California's Monterey Shale renders conventional fracking methods less effective. eservoirs California" conference, Bakersfield, May 30, 2013.

3 Interview with author at "Tight Oil Reservoirs California" conference, Bakersfield, May 29, 2013.

4 http://www.jmaterenvironsci.com/Document/vol3/vol3_N5/87-JMES-234-2012-Puthalath-review.pdf
http://www.onepetro.org/mslib/servlet/onepetropreview?id=NACE-03121
http://www.onepetro.org/mslib/servlet/onepetropreview?id=00038594