Hydraulic Fracturing

[From Wikipedia, the free encyclopedia]

Hydraulic fracturing is a method used to create fractures that extend from a borehole into rock formations, which are typically maintained by a proppant, a material such as grains of sand or other material which prevent the fractures from closing. The method is informally called fracing (pronounced "fracking") or hydrofracing.

The technique of hydraulic fracturing is used to increase or restore the rate which fluids, such as oil, gas or water, can be produced from the formation surrounding the borehole. By creating or restoring fractures, the reservoir surface area exposed to the borehole is increased and the fracture provides a conductive path connecting this reservoir surface area to the well, which effectively increases the rate that fluids can be produced from the reservoir formations.

The main industrial use of hydraulic fracturing is in stimulating production from oil and gas wells.[1][2][3] Hydraulic fracturing is also applied to stimulating groundwater wells,[4] preconditioning rock for caving or inducing rock to cave in mining,[5] as a means of enhancing waste remediation processes (usually hydrocarbon waste or spills), to dispose of waste by injection into suitable deep rock formations, and as a method to measure the stress in the earth. Volcanic dikes and sills are examples of natural hydraulic fractures. Hydraulic fracturing incorporates results from the disciplines of fracture mechanics, fluid mechanics, solid mechanics, and porous medium flow.

History

Hydraulic fracturing as used today in the oil and gas industry was first developed in the United States in 1948. It was first used commercially in 1949, and because of its success in increasing production from oil wells was quickly adopted, and is now used in thousands of oil and gas wells annually. The first industrial use of hydraulic fracturing was as early as 1903, according to Watson.[6] Before that date, hydraulic fracturing was used at Mt. Airy Quarry, near Mt Airy, North Carolina where it was (and still is) used to separate granite blocks from bedrock.

Method

When applied to stimulation of water injection wells, or oil/gas wells, the objective of hydraulic fracturing is to increase the amount of exposure a well has to the surrounding formation and to provide a conductive channel through which the fluid can flow easily to the well. A hydraulic fracture is formed by pumping a fracturing fluid into the well bore at a rate sufficient to increase the pressure downhole to a value in excess of the fracture gradient of the formation rock. The pressure then causes the formation to crack which allows the fracturing fluid to enter and extend the crack further into the formation. In order to keep this fracture open after the injection stops, a solid proppant is added to the fracture fluid. The proppant, which is commonly a sieved round sand, is carried into the fracture. This sand is chosen to be higher in permeability than the surrounding formation and the propped hydraulic fracture then becomes a high permeability conduit through which the formation fluids can be produced back to the well.

Drilling a borehole or well involves applying downward pressure to a rotating drill bit. This drilling action produces rock chips and fine rock particles that may enter cracks and pore space at the wellbore wall, resulting in damage to the permeability at and near the wellbore. The damage reduces flow into the borehole from the surrounding rock formation, and seals off

the borehole from the surrounding rock. Hydraulic fracturing can be used to bypass this damage.

The fracture fluid can be any number of fluids, ranging from water to gels, foams, nitrogen, carbon dioxide or even air in some cases. Various types of proppant are used, including sand, resin-coated sand, and man-made ceramics depending on the type of permeability or grain strength needed. Radioactive sand is sometimes used so that the fracture trace along the wellbore can be measured.

Hydraulic fracturing equipment used in the oil field usually consists of a Slurry Blender, series of Fracturing Pumps (Typically powerful triplex, or quintiplex pumps) and a monitoring unit. Associated equipment includes fracturing tanks, high pressure treating iron, low pressure pipes and gauges for flow rate, fluid density, and treating pressure. Fracturing equipment operates over a range of pressures and injection rates, and can reach up to 100 MPa (15,000 psi) and 265 L/s (100 barrels per minute).

The location of fracturing along the length of the borehole can be controlled by inserting tough inflatable plugs below and above the region to be fractured. This allows a borehole to be progressively fractured along the length of the bore, without leaking fracture fluid out through previously fractured regions. The plugs are inserted into the bore deflated, then expanded to seal off the borehole into a small working region. Piping through the upper plug admits fracturing fluid and proppant into the working region.

Environmental impact and regulation

Industry and environmental groups dispute whether hydraulic fracturing has a significant environmental impact, with arguments centered around the extent to which fracturing fluid could contaminate water supplies or impact rock shelf causing seismic events. There is concern that the process of fracing itself may destabilized bedrock and cause seismic activity. Reports of minor tremors of no greater than 2.8 on the Richter scale were reported recently as June, 2nd 2009 in Clemburne, TX - the first in the town's 140 year history. [7] Also the fluid or solids injected during hydraulic fracturing may have an impact. Indeed, one use of hydraulic fracturing is to remediate waste spills by injecting bacteria, air or other materials into a subsurface waste spill. In the United States, a 2004 Environmental Protection Agency (EPA) study concluded that the process was safe and didn't warrant further study, because there was "no unequivocal evidence" of health risks, and the fluids were neither necessarily hazardous nor able to travel far underground. The report did find uncertainties in knowledge of how fracturing fluid migrates through rocks, and upon its release service companies voluntarily agreed to stop using diesel fuel as a component of fracturing fluid, due to its potential as a source of benzene contamination. The Energy Policy Act of 2005 further strengthened the industry's regulatory position, specifically exempting hydraulic fracturing from federal regulation under the Safe Drinking Water Act.[8]

Periodic challenges to these conclusions have arisen. A 2008 investigation of benzene contamination in Colorado and Wyoming led some EPA officials to point towards hydraulic fracturing as a culprit, and later EPA statements have stressed that the 2004 report was not intended as a general study of hydraulic fracturing, but only of its use in coalbed methane deposits.[8] As of May 2009, a debate was ongoing in Congress over whether to repeal the 2005 regulatory exemption.[9]

Terminology

Fracture Gradient
: The pressure to fracture the formation at a particular depth divided by the depth. A fracture gradient of 18 kPa/m (0.8 psi/foot) implies that at a depth of 3 km (10,000 feet) a pressure of 54 MPa (8,000 psi) will extend a hydraulic fracture.

ISIP – Instantaneous Shut In Pressure
: The pressure measured immediately after injection stops. The ISIP provides a measure of the pressure in the fracture at the wellbore by removing contributions from fluid friction.

Leakoff
: loss of fracturing fluid from the fracture channel into the surrounding permeable rock.

Fracturing fluid
: The fluid used during a hydraulic fracture treatment of oil, gas or water wells. The fracturing fluid has two major functions 1) Open and extend the fracture; 2) Transport the proppant along the fracture length.

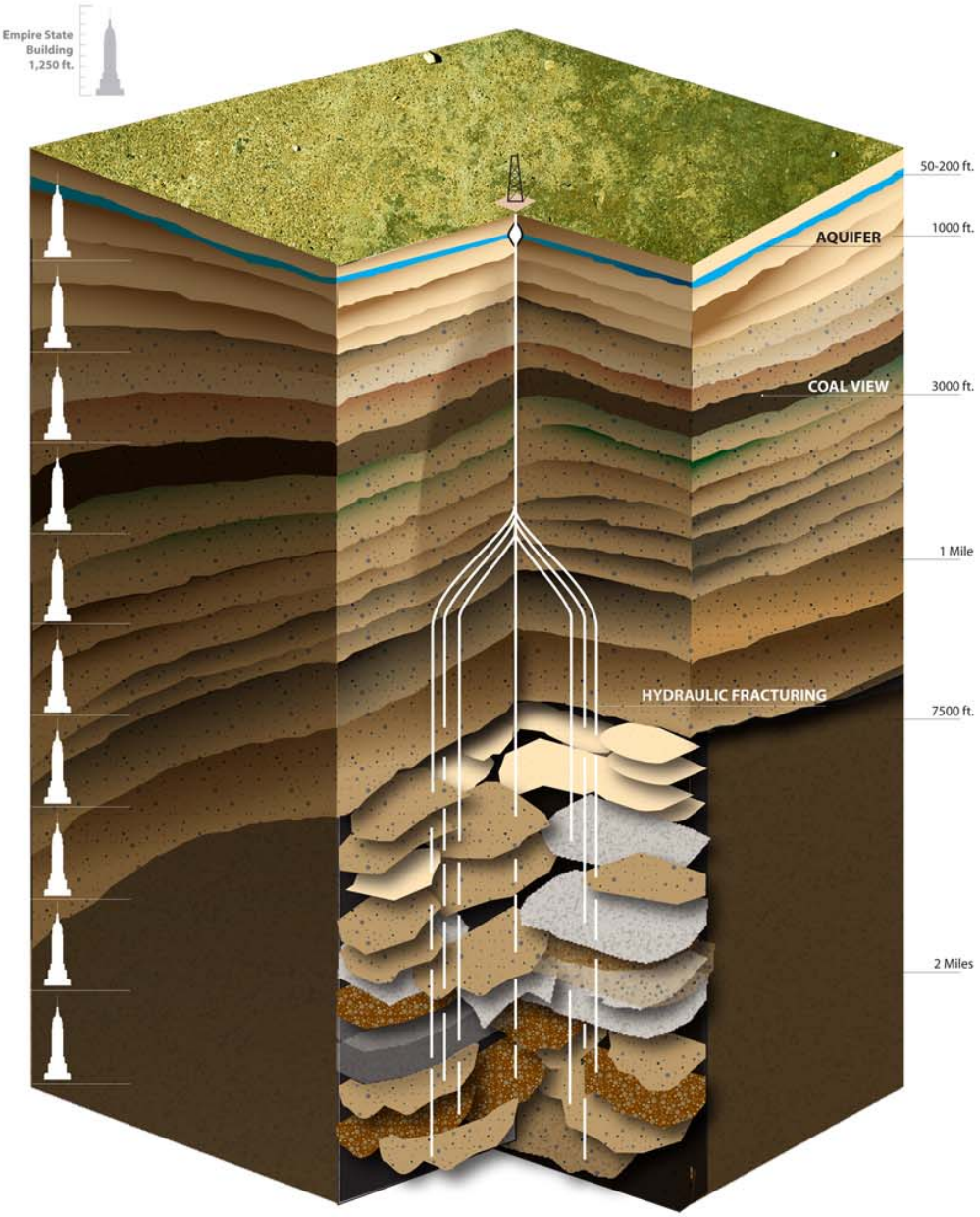
References

1. ^ Gidley, J.L. et al. (editors), Recent Advances in Hydraulic Fracturing, SPE Monograph, SPE, Richardson, Texas, 1989.
2. ^ Yew, C.H., Mechanics of Hydraulic Fracturing, Gulf Publishing Company, Houston, Texas, 1997.
3. ^ Economides, M.J. and K.G. Nolte (editors), Reservoir Stimulation, John Wiley & Sons, Ltd., New York, 2000.
4. ^ Banks, David; Odling, N.E., Skarphagen, H., and Rohr-Torp, E. (1996). "Permeability and stress in crystalline rocks". *Terra Nova* **8** (3): 223–235. doi:10.1111/j.1365-3121.1996.tb00751.x.
5. ^ Brown, E.T., Block Caving Geomechanics, JKMRC Monograph 3, JKMRC, Indooroopilly, Queensland, 2003.
6. ^ Watson, T.L., Granites of the southeastern Atlantic states, U.S. Geological Survey Bulletin 426, 1910.
7. ^ "Drilling Might Be Culprit Behind Texas Earthquakes". *AssociatePress*. June v12, 2009. http://hosted.ap.org/dynamic/stories/T/TEXAS_EARTHQUAKES_DRILLING?SITE=NYWNE&SECTION=HOME&TEMPLATE=DEFAULT.
8. ^ [a] [b] "Does Natural-Gas Drilling Endanger Water Supplies?". *BusinessWeek*. November 11, 2008. http://www.businessweek.com/magazine/content/08_47/b4109000334640.htm.
9. ^ "Industry campaign targets 'hydraulic fracturing' bill". *The New York Times*. May 7, 2009. http://www.nytimes.com/gwire/2009/05/07/07greenwire-industry-campaign-targets-hydraulic-fracturing-10572.html.

ENERGYINDEPTH

Going Deep:

WELL STIMULATION TECHNOLOGY DEPLOYED
THOUSANDS OF FEET BELOW THE WATER TABLE.



Source: http://www.energyindepth.org/hydraulic-frac-graphic.jpg

Videos of how petroleum wells are completed are available at http://www.youtube.com/watch?v=lRDeWhJGn-4 and http://www.youtube.com/watch?v=AtyJbIOZjS8&NR=1

Oil and water don't mix, so lose loophole

By Susan Greene
Denver Post Columnist
The Denver Post, Wednesday 06/09/2009, page 1

"Trust us."

That's what oil-and-gas companies are demanding as Congress considers regulating the toxic brews they're pumping into our ground.

At issue are hydraulic fracturing fluids that the industry injects deep into wells. Dick Cheney's infamous 2005 Energy Policy Act exempted so-called "fracking juices" from the federal Safe Drinking Water Act, the law protecting water supplies.

It's known as the "Halliburton Loophole," after the fracking giant that Cheney, a former vice president, once headed.

U.S. Rep. Diana DeGette is pushing to lift the exemption and force companies to disclose the chemicals they use. "Our bill simply closes an unconscionable Bush-Cheney loophole by requiring the oil-and-gas industry to follow the same rules as everyone else," says the Denver Democrat.

Most wells in Colorado are blasted with fracking fluids, which are known to contain benzene and other carcinogens. Like the ozone hole, it's an issue that can freak you out. Especially, say, if you drink water.

The industry is hoping you won't give any thought to the poisonous gunk that most folks have never heard of.

Companies are making arguments on several fronts to those in D.C. asked to pay more attention.

One is that having to disclose chemicals would force them to reveal trade secrets.

"It is much like asking Coca-Cola to disclose the formula of Coke," a Halliburton exec testified contemptuously at a state hearing.

The industry also is attacking claims that fracking is a risk to water quality. Just in time for federal hearings, a front group called, ironically, the Groundwater Protection Council, published a report claiming the fluids cause no harm.

"When you have a process that's been used for 60 years and you don't have a single document of contamination, that's a compelling body of evidence," says Nate Strauch of the Colorado Oil and Gas Association.

Therein lies the trust issue.

Because fracking has gone virtually unregulated, "nobody has looked for the right things, and nobody has documented them," says Amy Mall of the Natural Resources Defense Council. In other words, there is no scientific smoking gun. Environmentalists rely only on the anecdotal evidence of people falling ill from exposure.

Geoffrey Thyne, a researcher at the University of Wyoming's Enhanced Oil Recovery Institute, contrasts the fracking exemption with laws requiring companies to disclose ingredients in food. Without such lists, consumers can't judge whether products are healthy.

"Without information about ingredients, we can't make judgments about whether a fluid would be safe if it got in an aquifer. That's where science gets stuck," he says.

Nine Colorado municipalities support DeGette's bill, including Pitkin and La Plata counties, where drilling is heavy and groundwater vital.

So far silent on the issue is Gov. Bill Ritter, who staked his own career partly on new state oil-and-gas rules. He has regulated fracking far more than most governors, raising the ire of an industry that has vowed to oust him. Still, environmentalists argue his rules don't go far enough.

"No wonder he's sitting out this fight," says Bruce Baizel of the Durango-based Oil and Gas Accountability Project. "I see that he announced he's up for re-election."

Trust is tough when we're talking about an industry that, like Cheney himself, wages war on anyone who tries keep it in check. In my book, no loophole named after Halliburton is worth keeping.

Susan Greene writes Sundays, Tuesdays and Thursdays. Reach her at 303-954-1989 or greene@denverpost.com.

Fracking scare tactics

By Vincent Carroll
Denver Post Columnist
The Denver Post, Wednesday 07/01/2009, page 13B

Want to give the federal government more power to regulate an industry? Start by telling scare stories to alarm the public and set the industry on its heels.

U.S. Rep. Jared Polis, a Boulder Democrat, proved a quick study this month when he joined several colleagues, including Colorado's Diana DeGette, in introducing the "FRAC Act" — the Fracturing Responsibility and Awareness of Chemicals Act — which would add a layer of regulation over a technology used to boost natural gas production.

"Families, communities, and local governments are upset that the safety of their water has been compromised by a special interest exemption . . .," Polis declared. "It is irresponsible to stand by while innocent people are getting sick because of an industry exemption that Dick Cheney snuck in to our nation's energy policy."

Oh, my. Another malevolent plot by Dick Cheney, is it? And innocent sick people? That sounds bad, too. This hydraulic fracturing process, in which high-pressure fluid (mostly water but also various chemical compounds) is injected into rock formations containing natural gas, must be a menace.

So just how many times *has* fracking been linked to the contamination of drinking water because of migrating chemicals? Would you believe zero — despite its use in literally hundreds of thousands of gas wells, including nearly all in Colorado?

This is not merely what energy drillers say; it's what state regulators confirm as well. The Interstate Oil and Gas Compact Commission, to which energy-producing states belong, has surveyed its members twice this decade. The unanimous verdict in 2002 and again this year: There are no documented cases of groundwater contamination caused by fracking.

From time to time, of course, regulatory agencies have been known to become cozy with industry. Is it really likely, however, that *every* state's regulators are industry apologists? Is it possible that David Neslin and his staff at the Colorado Oil and Gas Conservation Commission, which spent much of the past two years butting heads with industry officials over drilling rules, have fallen under the sway of industry propaganda?

I asked Neslin about allegations that fracking has polluted drinking water. "We have no verified example of fracking contaminating groundwater in Colorado," he replied.

And no wonder. The fracking liquids would typically have had to migrate thousands of feet through layers of impervious shale to reach groundwater.

Critics of fracking claim that regulators can't tell whether contamination has occurred because they don't always know the full list of chemicals being used. But this is misleading on several counts. In Colorado, for example, energy companies must now maintain an inventory of chemicals used on site and provide it to relevant officials in the event of a threat to "public health, safety, welfare, or the environment." Moreover, regulators don't need to know every chemical in a well to detect contamination elsewhere because tests *would* detect other compounds associated with fracking, such as potassium chloride.

Even so, you might argue, why begrudge the Environmental Protection Agency a role in supervising fracking under the Safe Drinking Water Act? "I don't know why [industry officials] are so opposed to it if the fluid is so safe," DeGette said after a hearing this month on Capitol Hill.

They're opposed to it because they have no way of knowing what it will mean in terms of added expenses, delays and bureaucratic roadblocks.

Would each well require a new fracking permit? Would the permitting be delegated to the states?

As the commissioner of the Alaska Oil and Gas Conservation Commission noted in comments to the interstate commission, the EPA will "likely set redundant construction guidelines and testing standards that will merely create duplicate reporting and testing requirements with no benefit to the environment. Additional government employees will be required to monitor the programs . . . . "

Yet for what purpose? To satisfy the purveyors of scare stories? Surely Congress, in these fragile economic times, can find better things to do.

E-mail Vincent Carroll at vcarroll@denverpost.com