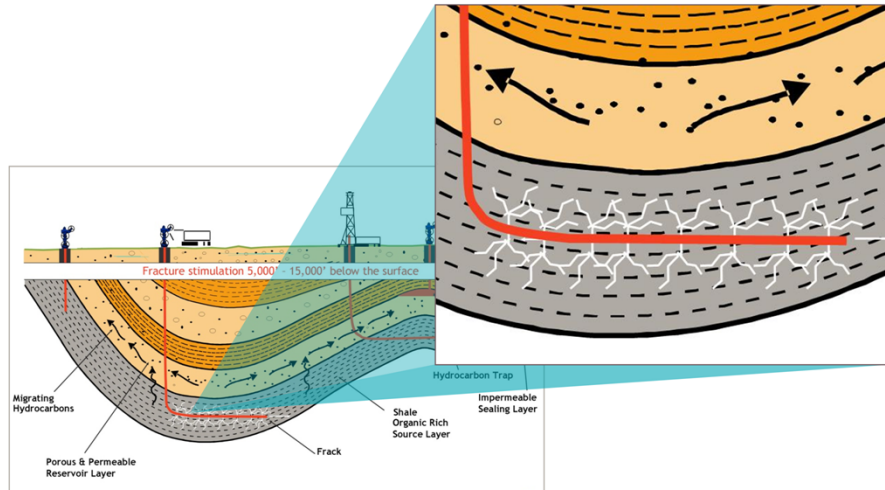


Hydraulic Fracturing

An Overview



Hydraulic fracturing



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page 11

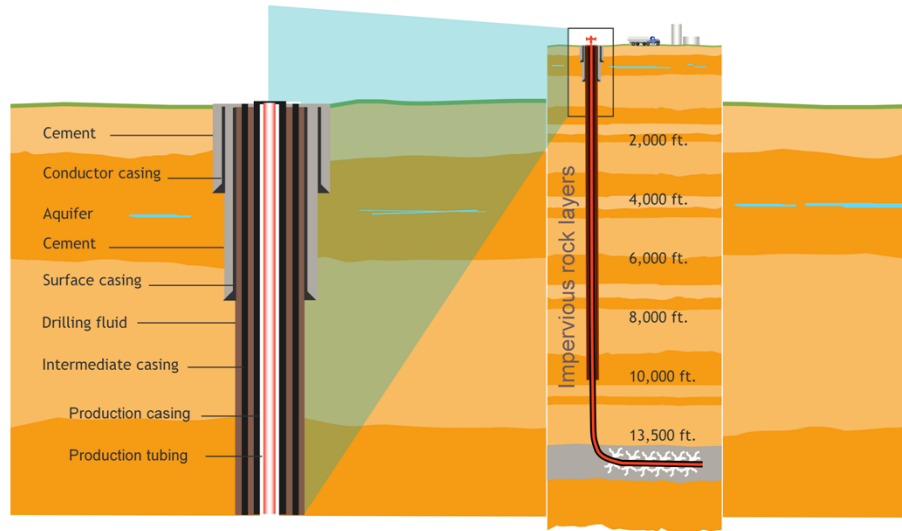


- As we saw earlier, the purpose of hydraulic fracturing is to capture natural gas directly from the source rock.
- Hydraulic fracturing is done in multiple stages, typically one to two miles below the earth's surface.
- The process allows for a greater amount of natural gas to flow into the wellbore.
- The process is rigorously regulated by state regulators.



- This cut-away demonstrates how horizontal drilling and hydraulic fracturing works.
- First the drill goes down vertically, and then it is taken horizontally through the source rock (shale).
- Once drilling is completed to the desired depth and the desired length of the well, the drilling rig is removed and replaced on site by frack job trucks.
- A perforation gun is inserted to the end of the well to make perforations in the shale.
- At that point, the frack fluid is pushed down the well at extremely high pressure to create fractures within the shale.
- It is important to note that these fractures extend no more than 200 feet from the wellbore.
- The fluid is extracted, and a plug is put into place.
- If further fracking stages are necessary, the same process is conducted, with a plug put in place after each stage.
- When we are ready to capture the gas, the plugs are removed.

Well construction



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page 13



- Fracking generally takes place several thousand feet deep.
- Often it is conducted as deep as 15,000 feet.
- Aquifers, on the other hand, typically are a few hundred feet deep.
- Between the aquifer and the source rock are layer after layer of impenetrable rock.
- Well construction is a key to the success of hydraulic fracturing.
- As you can see, the wellbore is surrounded by surface casing and then a layer of cement, then by conductor casing and another layer of cement.
- These sealing layers and steel casing are a primary reason that in the 60 years that hydraulic fracturing has been conducted, regulators have not found a single instance of groundwater contamination caused by fracking.

Hydraulic fracturing

3-7 day process

- Each horizontal well is initially fractured in 6-8 stages
- Represents 90% of total water requirement for a Barnett Shale well
- Approximately 4 million gallons of fresh water are required per well, which equals the amount used:
 - By a golf course every two weeks
 - By New York City every six minutes
 - Through irrigation to produce 5,100 gallons of ethanol



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page 14



- In the Barnett Shale, each well requires about 4 million gallons of water for hydraulic fracturing.
- That's roughly the same as the amount required every two weeks to water a Texas golf course, based on annual water use totals.
- It's also the same amount needed to fill six Olympic-size swimming pools.
- New York City uses roughly the same amount every six minutes.
- And finally, according to the USDA, it takes about the same amount of irrigated water to produce 5,100 gallons of ethanol as it takes to complete a natural gas well capable of producing 3 billion cubic feet or more of natural gas.

Frack fluid components And their purposes

Ingredient	Percentage	Purpose
Water	95%	Creates necessary force to create tiny fractures within the formation
Sand	4.5%	Keeps fractures open, allowing natural gas to be collected in the well
Additives	0.5%	Gelling agents carry the sand through water. Others break down gel when natural gas is ready to be collected. Proppants keep fractures open so gas can flow to the wellbore. Ingredient lists for specific wells available at www.fracfocus.com .

Source: EIA, Annual Energy Outlook 2011

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page 15



- News accounts typically state that hydraulic fracturing is conducted using water, sand and additives.
- What often is omitted from those stories is that water and sand make up 99.5 percent of the mixture.
- The remainder consists of additives needed for specific purposes depending on each individual well.
- There has been some mystery regarding the hydraulic fracturing mixture.
- That mystery has led to public concerns and a desire for more information.
- Devon shares the desire for more transparency, and that is why we have worked with two groups of regulators to provide an internet database where the public can see what additives are used in each well – and in what quantities.

Fracfocus.org

Hydraulic fracturing fluid composition

Trade Name	Supplier	Purpose	Ingredients	Chemical Abstract Service Number (CAS #)	Maximum Ingredient Concentration in Additive (% by mass)**	Maximum Ingredient Concentration in HF Fluid (% by mass)**
Water	Operator	Carrier	Water	7732-18-5	100.00%	94.46100%
Frac Sand (All Meshes) [CWT]	BHI	Proppant	Crystalline Silica (Quartz)	14808-60-7	100.00%	5.11899%
Hydrochloric Acid, 10.1-15%	BHI	Acidizing	Hydrochloric Acid	7647-01-0	15.00%	0.05582%
			Water	7732-18-5	85.00%	0.31633%
FRW-15A	BHI	Friction Reducer	Copolymer of Acrylamide and Sodium Acrylate	25987-30-8	40.00%	0.01879%
			Hydrotreated Light Distillate	64742-47-8	30.00%	0.01409%
			Nonyl Phenol Ethoxylate	127087-87-0	5.00%	0.00235%
			Sorbitan Monooleate	1338-43-8	5.00%	0.00235%
Ferrotrol 300L	BHI	Iron Control	Citric Acid	77-92-9	70.00%	0.00283%
NE-940	BHI	Non-emulsifier	Methanol	67-56-1	60.00%	0.00017%
			Isopropanol	67-63-0	10.00%	0.00033%
			2-Ethyl Hexanol	104-76-7	10.00%	0.00033%
			Polyoxyethylene Glycols	25322-68-3	5.00%	0.00001%
			Solvent naphtha (Petroleum) ^h Heavy Arom.	64742-94-5	5.00%	0.00001%
			Ethoxylated Alcohol ^h Branched	78330-19-5	5.00%	0.00001%
			Ethoxylated Alcohol ^h Branched	78330-20-8	5.00%	0.00001%
			Naphthalene	91-20-3	1.00%	0.00000%
1 ^h 2 ^h 4-Trimethyl Benzene	95-63-6	1.00%	0.00000%			

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page 16



- This is snapshot of one such well that you can see at that website, www.fracfocus.org.
- The website was developed by the Ground Water Protection Council – which is composed of state environmental and oil and gas regulators – and the Interstate Oil and Gas Compact Commission.
- This example is a Devon well in Denton County, Texas, which was fracked on March 22, 2011, at a depth of about 8,200 feet.
- Water and sand make up a little more than 99.5 percent of the total volume.
- This database went live about a month ago.
- To date, about 450 wells are available for the public to inspect.
- That number will continue to expand.
- This database should remove any mystery about these additives and their purpose in the hydraulic fracturing process.

Hydraulic fracturing

Key to the revolution

- Excellent environmental record over decades
- Regulated by states
- Fracfocus.com offers public database
- Continually improving well construction
- Steel and cement protection of aquifers
- Incident control, containment and clean-up plans

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page 17



- Hydraulic fracturing has been conducted safely and without a singled documented case of water contamination since the late 1940s.
- The states are rigorous in their regulatory duties regarding the process.
- Internet database of individual frack fluid compositions now available to the public.
- Well construction is continuously improving.
- Aquifers are protected not only by steel and cement casing, but also the sheer distance and the layers of impermeable rock that separate fresh water supplies and the depth where fracking occurs.
- And finally, our industry is required to have provide a detailed plan of action in the event of any incident.

Thank you

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- I realize that this has provided just a brief overview of hydraulic fracturing.
- I'll be happy to take any questions.