HYDRAULIC FRACTURING

Marcellus Shale

RANGE RESOURCES

Updated July, 2010

- **Hydraulic Fracturing is a proven technology and a key to unlocking our nation's growing 100-year supply of clean-burning natural gas.**
- **Fracturing fluids consist of 99.86-percent water and sand, the rest consists of highly diluted common chemicals that are contained and safely managed.**
- **More than 3 million pounds of fully cemented steel casing strings are utilized to fully protect freshwater aquifers.**
- **The fracturing process takes place more than one mile below the water aquifers.**

When our world demanded a clean, abundant, reliable, versatile, and secure source of energy – American natural gas producers like Range Resources delivered. Thanks to the application of proven technologies and American ingenuity, the United States now enjoys a growing 100-year supply of clean burning natural gas. Natural gas developed from shale rock formations found more than a mile below the surface have become global game changers for clean energy development.

With newfound attention on natural gas it's normal to want to learn more. The proven technologies employed today have been safely used since the 1940s including hydraulic fracturing. This technology is critical to developing America's abundant natural gas supplies.

History

Hydraulic fracturing was first used more than 100 years ago in 1903, but the first commercial fracturing treatment was performed in 1949. By some accounts it took more than 40 years for geologists and engineers to perfect the process, but since then, the pay-off has been extraordinary. Its efficacy in bringing new life to old oil and gas wells quickly made it an integral part of our nation's energy strategy, and by 1988, it had been applied more than one million times.

As technology improved, hydraulic fracture stimulation applications did, as well. Now, the technology is used not only to stimulate production in old wells, but to jump start the production process in unconventional formations like deep layers of shale. Energy producers now utilize this technology to safely complete more than 35,000 wells in the United States each year and thousands more internationally.

The Process

Hydraulic fracturing is used to stimulate production from new and existing wells by pumping a sand water mix at a pressure high enough to crack the rock. The small fracture network extends out from the wellbore and creates a pathway for the natural gas to flow from the shale to the well.

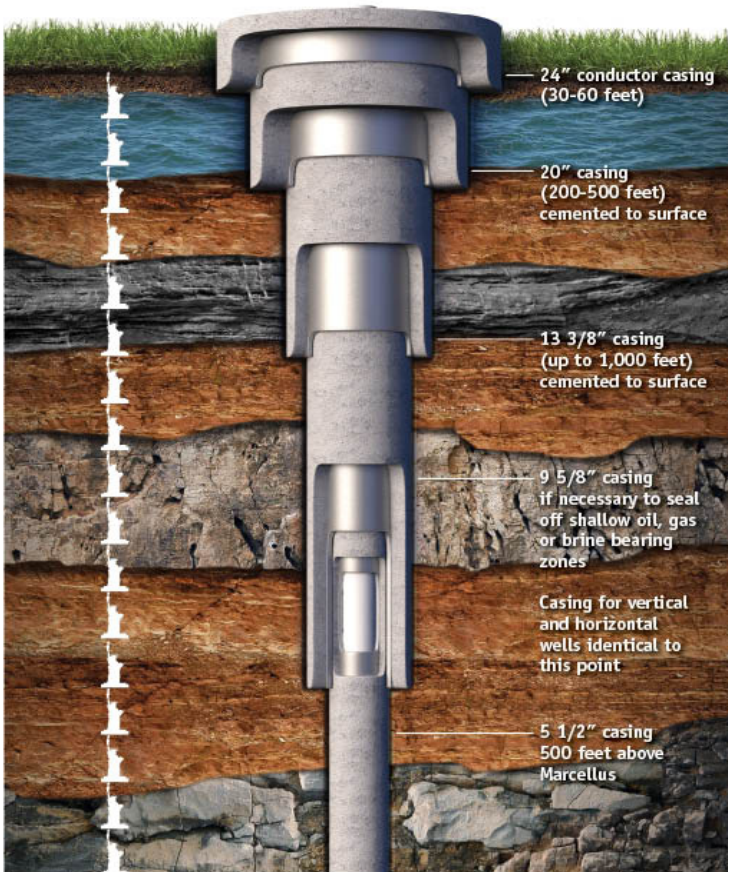
To fully isolate the wellbore, multiple heavy steel casings are inserted from the surface of the earth deep in the ground and fully cemented into the wellbore. The casing, cement specifications and cementing process are governed by state regulations as well as well developed industry standards. Once the cement has set, then the wellbore is continued from the bottom of the previously cemented steel casing to the next depth. This process is repeated using smaller diameter steel casings until the oil and gas bearing rock is reached. In a well stretching almost two miles, typically more than three million pounds of steel and cement are utilized to isolate a wellbore with several layers of casing strings cemented in place.

With those and other precautions taken, water and sand are pumped deep into the well at pressures sufficient to cause the reservoir rock to break or fracture. The fractures are then held open by the sand, carried by water. For shale gas development, all Range mixtures are comprised of more than 99-percent water and sand, with a small proportion of highly diluted common chemicals used to clean the wellbore, prevent scale formation and to prevent bacterial growth in the well which can generate H2S (a hazardous gas).

Once the rock has been fractured, fracturing fluids are flow back out of the well and in many cases recycled and reused or properly treated at permitted disposal facilities. Whatever small amounts of fluid is not immediately recovered return slowly over time through the isolated wellbore or remains trapped in the rock bed thousands of feet below the surface.

General Casing Design for a Marcellus Shale Well

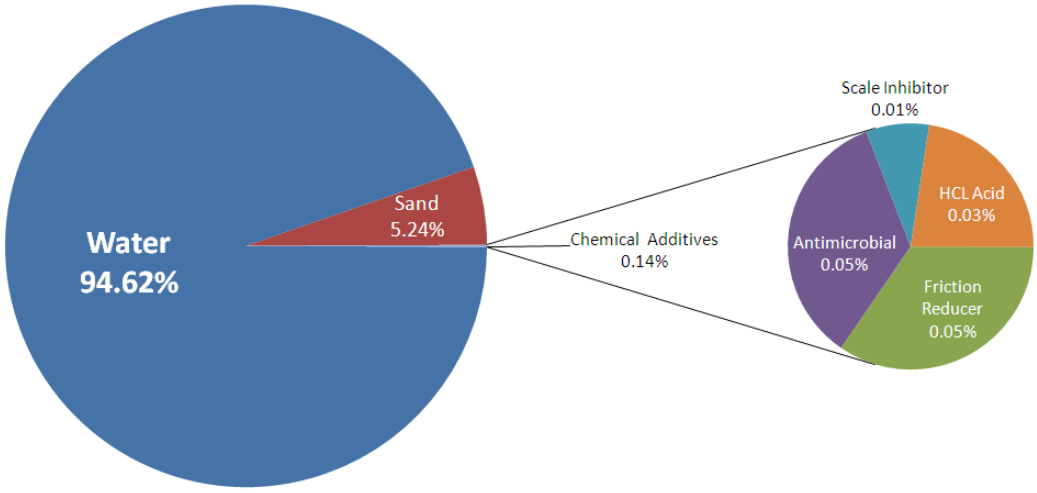
The Marcellus Shale is more than a mile below the Earth's surface.
It would take 17 Statues of Liberty on top of one another to reach the formation.



Completions Fluids

More than 30 state and federal regulatory agencies have studied our industry, including hydraulic fracturing, such as the U.S. Department of Energy, the Interstate Oil and Gas Compact Commission, the Groundwater Protection Council and others. These reports conclude that the technology is safe and well regulated. Roughly 99.9% of the fracturing fluid is water and sand, the rest is a blend of common chemicals that are a part of our everyday lives – or as the Groundwater Protection Council indicated essentially "soap." Listings of these additives are publicly available at several regulatory websites including the Pennsylvania Department of Environmental Protection and in the form of Material Safety Data Sheets at all work locations. The fluids are carefully managed and injected in a highly diluted blend through multiple layers of fully cemented steel casings to fully isolate the wellbore from ground water.

Composition of Hydraulic Fracture Fluid (by volume)



Range Resources Marcellus Shale Hydraulic Fracturing Completions Listing Individuals wells may vary slightly based on geologic and other conditions						
Additive Type	**Compounds**	**Purpose**	**Use and Dilution**	**Volume**	**Overall Makeup**	**Common Use**
Water	Water	To create fracture network in shale and carry proppant to the formation	Water is the primary constituent, consisting of about 4 million gallons per well	4 million gallons	94.69%	Water is the most abundant molecule on the Earth's surface
Sand	Sand	Allows the fractures to remain open so the gas can escape	Second most common constituent, about 1.5 million pounds	226,000 gallons	5.17%	Drinking water filtration, play sand
Diluted Acid	Hydrochloric Acid	Help to dissolve cement and minerals and initiate fractures	Diluted at one-quarter of one gallon per 1,000 gallons of water	1,338 gallons	0.03%	Swimming pool and household cleaner
Friction reducer	Polyacrylamide	Reduces friction between fluid and pipe	Diluted at one-half gallon per 1,000 gallons of water	2,040 gallons	0.05%	Water treatment; soil conditioner; some children's toys
Antimicrobial Agent	Glutaraldehyde, ethanol, and methanol	Eliminates bacteria in the water that produce corrosive byproducts	Diluted at one-half gallon per 1,000 gallons of water	2,040 gallons	0.06%	Water treatment, disinfectant; sterilize medical and dental equipment and surfaces
Scale inhibitor	Ethylene glycol, alcohol , and sodium hydroxide	Prevents scale deposit in the pipe	Diluted at one-tenth gallon per 1,000 gallons of water	490 gallons	0.01%	Water treatment, household cleaners, de-icing agent

HYDRAULIC FRACTURING

Unlocking America's vast natural gas resources, with state-of-the-art technology

RANGE RESOURCES

Environmental Commitment

Even though chemical additives are carefully managed, highly diluted and injected through multiple cemented strings of steel casing to prevent migration to shallow groundwater aquifers, Range encourages all vendors to utilize the most environmentally friendly additives whenever technically possible. For instance, we do not use diesel fuel in hydraulic fracturing fluids. Range and many of our service companies are studying ways to utilize ultraviolet light to eliminate bacteria, which can help to reduce the amount of antibacterial agents needed to maintain a clean wellbore. All of these things will take time, but we're working on them every day.

Other examples can be found in the environmentally friendly drilling fluids that we utilize, including a defoamer that flushes a wellbore and breaks down the soaps used in the process. This defoamer also promotes a stronger cement casing by fully removing soaps and eliminating annular spaces that can impact cementing.

Additional security and supervision

Range is constantly pursuing advancements in our safety and security programs. For instance we maintain a series of onsite preventative technologies, such as absorbent materials to soak up a spill and accessible water to flush and eliminate spills. We maintain a staff of our own field inspectors that look for the same things a regulatory inspector would watch for. This is on top of the dozens of field inspectors state regulatory agencies already employ. All of our active locations are staffed 24-7 by a security guard. We've also utilized motion-activated security cameras.

Regulation and Best Practices

Natural gas development is highly regulated. Before a well is even drilled, thousands of pages of documentation are typically filed and submitted to state regulators for review and approval. Many aspects must be stamped by a Professional Engineer. Often times there are other state regulatory agencies involved. For instance in Pennsylvania in addition to the Pennsylvania Department of Environmental Protection, the Susquehanna River Basin Commission, the Delaware River Basin Commission, and the Pennsylvania Fish and Boat Commission also have various levels of regulatory oversight.

In addition to state laws, various aspects of natural gas development either directly with Range or our various service companies are subject to, the Federal Emergency Planning and Community Right-to-Know Act, the Federal Worker's Right to Know Act, the Federal Dam Safety Law, and others through state regulatory statutes. All of our locations are regularly inspected by industry and regulatory officials.

Above and beyond our commitment to complete regulatory compliance, Range's technical team works closely with state and federal regulatory agencies and industry organizations to develop best practice standards.

The opportunity for our nation is too important and we simply must get this right. That's why in many cases Range goes above and beyond required regulation, we often overlap inspections, we pioneered water recycling and reuse in the Marcellus Shale, and Range has helped make various aspects of our industry accessible to anyone interested in learning more about the technology utilized in our industry.