KEYSTONE ENERGY FORUM

The Facts on Hydraulic Fracturing

The hydraulic fracturing process, also known as "well stimulation," is vital to extracting natural gas from the Marcellus Shale and other geological formations in Pennsylvania. Over the course of more than 60 years, well stimulation has been researched, advanced and used across the United States as a safe and effective method to create tiny cracks in the targeted formation that allow natural gas to flow freely into a wellbore and up to the earth's surface.

The Well Stimulation Process

Well developers begin the stimulation process once a well has been drilled to a desired vertical and horizontal depth, with a series of steel pipes, called casing strings, cemented in place along the length of the wellbore. The steel and cement isolates the well from the surrounding geology and groundwater zones found above. Groundwater sources are typically located a mile or more above the Marcellus Shale formation. A device known as a perforating gun is first lowered into the well to a designated location in the shale, and a charge is fired down the well from a wire at ground surface to perforate the steel casing, cement and the shale formation. This perforation stage creates small cracks, or fractures, in the rock.

A mixture of water, sand and chemicals is then injected into the wellbore under high pressure. The sand holds open the cracks in the rock to allow the well to produce natural gas. Water and sand make up about 99.5 percent of the fluid injected into the well, and the chemicals used in the process – both small in number and dilute in concentration – can be found in many household items (see summary box of common additives on second page).

Once the first zone of the well has been perforated and stimulated, a rubber plug is placed to isolate that area from the rest of the horizontal wellbore. The perforation and stimulation process then continues multiple times along the length of the formation to make the well as productive as possible. A bit is lowered into the well after the process is completed to drill out the rubber plugs and allow gas to flow to the surface.

Hydraulic fracturing technology has been used to produce oil and natural gas since 1949. The process involves pumping a mixture made up of 99.5 percent water and sand, along with a minimal amount of additives, into the ground under high pressure. The solution opens tiny fractures in the rock to allow a pathway for the oil and gas to enter the wellbore. It typically takes about a week of round-the clock activity to complete a hydraulic fracturing operation, at which point the equipment is removed to allow the well to enter the final completion and production stage.

Completing the Process and Recycling Technologies

At the completion of the stimulation process, approximately 20-30 percent of the water flows back up the wellbore, where it is collected and typically stored in tanks. A great majority of flowback water is now being recycled, a technology researched and developed in Pennsylvania with the recent increase in Marcellus Shale drilling activity. Water can be treated and conveyed to another well site through a temporary water line and pumping system, or put into trucks and transported to another well location awaiting well stimulation.

Water can also be stored on a drilling pad and used for multiple wells at that location. Over the productive life of the well, additional "produced" water slowly comes to the surface, where it is collected in on-site storage tanks and transported to permitted treatment facilities.

FAST FACTS

- A 2009 study by the Groundwater Protection Council, a non-profit organization of state groundwater regulators, found the chance for contamination of drinking water sources from the well stimulation process to be one in 200 million.
- Pennsylvania is leading the nation in the development of flowback water recycling technologies, with many producers achieving recycling rates close to 100 percent.
- The industry developed FracFocus.org to provide detailed information on hydraulic fracturing operations at wells across the country, including the capability to search for county-specific wells completed by individual natural gas operators.

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Water Treatment Regulations in Pennsylvania

The state Department of Environmental Protection developed the nation's most stringent wastewater treatment requirements for the oil and gas industry in 2011, requiring wastewater treated from Marcellus Shale drilling to meet drinking water standards at the point of discharge into a stream or river. This action resulted in a continuing investment by the industry in new treatment technologies and recycling processes that treat wastewater at "zero-discharge" facilities that return treated water to drilling locations in the trucks that originally transported wastewater for treatment.

Protecting Groundwater

Agencies in Pennsylvania enforce equally stringent regulations to protect groundwater during both the drilling and well stimulation processes.

Marcellus Shale wells require multiple, redundant layers of steel casing and cement as well as strict quality control procedures to protect groundwater sources.

State oil and gas regulatory agencies, including the Pennsylvania Department of Environmental Protection, have not documented a case of drinking water contamination related to the stimulation of an oil or natural gas well. In April 2009, the Ground Water Protection Council stated that the chances of groundwater contamination due to this process are as low as 1 in 200,000,000.

Regulation of Water Withdrawals

Water use in the well stimulation process is regulated in Pennsylvania either by the state DEP, or the federal Susquehanna or Delaware River Basin Commissions, with approval required for every withdrawal from streams or rivers. These withdrawals are limited to a fraction of a waterway's normal flow to protect aquatic life, and stream withdrawals can be halted in the event of low flow conditions. Water is either trucked or piped to drilling locations, where it is stored in secure, lined impoundments or tanks for use in the fracture process.

According to an analysis by the Susquehanna River Basin Commission, Marcellus Shale development at its anticipated peak levels of production in the Susquehanna River watershed would require the use of 60 million gallons of water a day. This amount is less than half of what is needed for recreational purposes, such as irrigating golf courses or making snow at ski resorts.

Continuing Development of New Technologies

The companies developing the Marcellus Shale are at the forefront of advancing well stimulation technologies and procedures, including research into using water impaired by acid mine drainage and other "lesser quality" water sources and developing "green" additives.

This involves research into additives that are biodegradable and do not bioaccumulate in the environment, including ingredients found in many foods. Guar gum, a thickener used in dairy products, baked goods and ketchup, is used as a friction reducer in the well stimulation process, while citric acid, used in the production of soft drinks and wine, is effective in controlling iron in a wellbore. Pennsylvania's winters have also led to the discovery of environmentally friendly additives required to prevent water from freezing during cold weather well stimulation, with the increased use of glycerin and potassium formate over material such as methanol, which is found in windshield cleaning solutions. Research continues to enhance recycling capabilities and identify effective biodegradable additives.

Common Well Stimulation Additives

Between five and ten additives are commonly used to stimulate a Marcellus Shale gas well, making up between .05 and .5 percent of the total injection into the well. The list below identifies many of them; the right column lists their common uses.

Chemical	Purpose	Common household product
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant; Sterilizer for medical and dental equipment
Sodium Chloride	Allows a delayed break down of the gel polymer chains	Table Salt
N, n-Dimethyl formamide	Prevents the corrosion of the pipe	Used in pharmaceuticals, acrylic fibers and plastics
Borate salts	Maintains fluid viscosity as temperature increases	Used in laundry detergents, hand soaps and cosmetics
Polyacrylamide	Minimizes friction between fluid and pipe	Water treatment, soil conditioner
Petroleum distillates	"Slicks" the water to minimize friction	Make-up remover, laxatives, and candy
Guar gum	Thickens the water to suspend the sand	Thickener used in cosmetics, baked goods, ice cream, toothpaste, sauces, and salad dressing
Citric Acid	Prevents precipitation of metal oxides	Food additive, food and beverages, lemon juice
Potassium chloride	Creates a brine carrier fluid	Low sodium table salt substitute
Ammonium bisulfite	Removes oxygen from the water to protect the pipe from corrosion	Cosmetics, food and beverage processing, water treatment
Sodium or potassium carbonate	Maintains the effectiveness of other components, such as crosslinkers	Washing soda, detergents, soap, water softener, glass and ceramics
Proppant	Allows the fissures to remain open so the gas can escape	Drinking water filtration, play sand
Ethylene glycol	Prevents scale deposits in the pipe	Automotive antifreeze, household cleansers, deicing, and caulk
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, and hair color