



Hydraulic Fracturing

The process of hydraulic fracturing (also known as “fracing” or “well stimulation”) is an essential part of extracting natural gas from virtually all gas reservoirs in the United States. Extracting natural gas trapped in formations like the Marcellus Shale in Pennsylvania requires the use of this technology.

Several thousands of frac jobs are successfully performed in Pennsylvania every year. Fracing has been used safely and effectively across the U.S. for over 60 years and in Pennsylvania since shortly after World War II. The goal of the fracing process is to create a “pathway” of man-made cracks in the rock that allow gas to flow from the shale into the wellbore. Without this technique, shale reservoirs would not produce natural gas.

State oil and gas regulatory programs place great emphasis on protecting groundwater. Current well construction regulations require the installation of multiple layers of protective steel casing and cement which are specifically designed and put in place to protect freshwater aquifers. State regulatory agencies have been very effective in protecting drinking water aquifers from contamination attributable to hydraulic fracturing.

According to information obtained from state oil and gas agencies, there is not one documented case of drinking water contamination related to the hydraulic fracturing of a deep shale gas well. Furthermore, the Ground Water Protection Council issued a report in April 2009 stating that the potential for groundwater contamination due to hydraulic fracturing is extremely remote: chances are as low as 1 in 200,000,000.

The amount of water needed to crack a rock formation sufficiently depends on the type of rock. The Marcellus Shale formation is a very “tight” rock which means gas cannot migrate through the formation naturally. Therefore, a rock formation like the Marcellus requires a greater amount of water to stimulate the fractures and enhance gas flow.

Fracing the Marcellus Shale requires more water than a traditional Pennsylvania shallow well. The water, typically between five-hundred thousand and several million gallons, is gathered and stored in a state-approved lined

pond or in tanks on the well site. Gas producers work closely with Pennsylvania regulators to ensure water withdrawals are done responsibly and do not pose a threat to aquatic life.

Pennsylvania has more surface water than any other state in the U.S. with the exception of Alaska. It receives four times the annual precipitation of Texas, where more than 10,000 deep gas wells have been drilled safely. Water is typically withdrawn during normal to high periods of rainfall. Because of timely withdrawals, Marcellus Shale development could even help reduce flooding. Some Pennsylvania natural gas producers purchase municipal water or reuse frac water from one well to another, while others use pre-treated abandoned mine drainage (AMD) in the fracing process.

According to the Pennsylvania Department of Environmental Protection (DEP) and the Susquehanna River Basin Commission, even if drilling increased to 20 times its current level, Marcellus Shale development would still consume less than half of what the state consumes for recreational uses such as golf course irrigation and snowmaking at ski resorts.

The Fracture Stimulation Process

Fracing a Marcellus Shale well takes place after the well has reached a desired vertical and/or horizontal depth and can last for several days. Once well casing is cemented in place

to protect the water aquifers and gas production zones, a charge is fired into the formation at the end of the wellbore. It perforates the steel casing, cement and shale formation to provide a pathway for the fresh water injection. The entire process is highly regulated and has a proven track record of safety.

Fluids pumped under pressure act as a wedge to crack the rock at depth during fracing. The fluid is over 99.5 percent water and sand, along with small amounts of special-purpose additives that are carefully and safely injected with the water-sand mix into the wellbore. The additives are mixed in self-contained systems where fluids are not exposed to the environment. The industry invests millions of dollars every year to improve these additives and formulate organically based mixtures.

As in any process, refinements are constantly being made by natural gas producers to improve the efficiency of fracture stimulation. Additives in fracing fluids are used in small quantities and diluted forms, with the specific mix based on geology, an individual company's preferences, the depth of the well, and a number of additional factors. Fracing a Marcellus Shale well commonly involves four to five classes of additives. The same chemicals can be found in grocery stores and pharmacies and have been safely used for generations in products applied to the skin or consumed by mouth.

Following the Completion of Fracture Stimulation

When the stimulation process is completed and the water pressure is relieved, about 20 percent of the fluid returns to the surface through the protective casing. It is highly monitored, collected and saved in tanks or lined pits on the well site for later transport to permitted disposal facilities. This

returned fluid, called “flowback,” can pick up heavy salts and minerals.

Additional amounts of water used in the fracing process remain in the shale formation nearly a mile below the Earth; some returns slowly over time at the well site and is redirected into collection tanks where it is removed and treated.

The fracing process is supported in a comprehensive, unbiased report completed by the U.S. Department of Energy and the Ground Water Protection

Council in 2009, entitled “Modern Shale Gas Development in the United States: A Primer.” According to the publication, fracing is a proven, safe and environmentally responsible way to extract clean-burning natural gas to meet our nation’s growing energy needs. In fact, the report estimates the use of natural gas will increase by more than 64 percent over the next 20 years.

In most situations, only four or five of the additives listed below are used to fracture Marcellus Shale gas wells, making up between .05 and .5 percent of the total injection into the well. A number of factors go into determining which are used. The typical uses for each component is provided in the right column.

Additive Type	Main Compound	Purpose	Common Use of Main Compound
Acid	Hydrochloric acid or muriatic acid	Helps dissolve minerals and initiate cracks in the rock	Swimming pool chemical and cleaner
Anti-bacterial agents	Glutaraldehyde	Eliminates bacteria in the water that produce corrosive by-products	Disinfectant; Sterilizer for medical and dental equipment
Breaker	Ammonium persulfate	Allows a delayed break down of the gel used to thicken the water in order to suspend the sand	Used in hair coloring, as a disinfectant, and in manufacture of common household plastics
Corrosion inhibitor	n,n-dimethylformamide	Prevents the corrosion of the pipe	Used in pharmaceuticals, acrylic fibers and plastics
Crosslinker	Borate salts	Maintains fluid viscosity as temperature increases	Used in laundry detergents, hand soaps and cosmetics
Friction reducer	Petroleum distillate	“Slicks” the water to minimize friction	Used in cosmetics including hair, make-up, nail and skin products
Gel	Guar gum or hydroxyethyl cellulose	Thickens the water in order to suspend the sand	Thickener used in cosmetics, baked goods, ice cream, toothpaste, sauces, and salad dressings
Iron control	Citric acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice ~7% citric acid
KCl	Potassium chloride	Creates a brine carrier fluid	Used in low-sodium table salt substitute, medicines and IV fluids
Oxygen scavenger	Ammonium bisulfite	Removes oxygen from the water to protect the pipe from corrosion	Used in cosmetics, food and beverage processing and water treatment
pH adjusting agent	Sodium or potassium carbonate	Maintains the effectiveness of other components, such as crosslinkers	Used in laundry detergents, soap, water softener and dish washer detergents
Proppant	Silica, quartz sand	Allows the fractures to remain open so the gas can escape	Drinking water filtration, play sand, concrete and brick mortar
Scale inhibitor	Ethylene glycol	Prevents scale deposits in the pipe	Used in household cleanser, de-icer, paint and caulk
Surfactant	Isopropanol	Used to increase the viscosity of the fracture fluid	Used in glass cleaner, multi-surface cleanser, antiperspirant, deodorant and hair coloring