

# HYDRAULIC FRACTURING

## Overview

Hydraulic fracturing is an important and common practice that is used to stimulate production of hydrocarbons, particularly natural gas, from tight formations. SM Energy routinely utilizes hydraulic fracturing techniques in many of its reservoirs.

Hydraulic fracturing has recently received more attention as a result of increased hydraulic fracturing activity to develop shale rock formations closer to more populated areas of the United States, including concerns about whether hydraulic fracturing could affect ground water and potable water sources. SM Energy understands these concerns, and that the industry needs to take particular care in the utilization of hydraulic fracturing.

## History

Hydraulic fracturing has been safely used in the industry since the 1940s, and has been used in more than a million wells. While initially used to increase production in older wells, technological advances in the process have resulted in its use to access previously inaccessible natural gas and oil deposits in shale and other tightly compacted formations. The process has helped produce more than 600 trillion cubic feet of natural gas and 7 billion barrels of oil to date, and is currently used to complete more than 35,000 wells per year in the United States.

## The Process

The hydraulic fracturing process involves pumping a mixture of water, sand, and a relatively small proportion of special purpose chemical additives into a deep underground rock formation with enough pressure to create a network of fractures in the rock. This fracture network extends out from the wellbore and creates space that permits the natural gas or oil to flow from the shale or other tightly compacted formation to the well.

SM Energy typically drills wells to a depth of between 4,000 and 14,000 feet. Wells of this depth are far below groundwater aquifers, which generally occur at depths of less than 500 feet. In order to protect groundwater sources and in most cases fully isolate the wellbore, multiple heavy steel casings are typically inserted deep into the ground and fully cemented into the wellbore. The casings, cement and placement specifications, and cementing processes are governed by state regulations and well developed industry standards. The cement column must meet certain strength and quality criteria and extend from the depth of the casing

back to the surface. The steel casing protects aquifers from any material inside the wellbore, while the cement provides an additional protective barrier.

Once the surface casing is placed and cemented, the wellbore is established from the bottom of such casing through the use of an additional smaller diameter string of steel casing. In most cases, the casing string is cemented with a continuous column of cement the full depth of the well, with 100% circulation of the cement from the well depth to the surface. Where 100% circulation is not achieved, cement bond logs are utilized to evaluate the effectiveness of the cement job.

For various depths and pressure requirements, SM Energy designs and specifies the appropriate diameter, wall thickness and metallurgical properties of steel pipe casing that has an American Petroleum Institute (API) internal yield pressure rating in excess of planned exposure, and the actual hydraulic fracturing pressures utilized are held below the rating. Additionally, in its operations, SM Energy frequently will maintain the actual hydraulic fracturing pressures to a maximum of 80% of the applicable rating. Casings are pressure tested, and electrical instruments are inserted to log the wells and ensure cement placement and integrity. In addition, wells are typically equipped with pressure gauges that permit the monitoring of the structural integrity of the well.





Typically, once the well has been completed and reasonable safety precautions taken, water, sand, and a relatively small proportion of special purpose chemical additives are pumped into the well at pressures sufficient to cause the rock formation to fracture. The sand contained in this mixture is intended to hold the fractures open to allow natural gas or oil to flow to the wellbore. Once the rock has been fractured, water pumped into the well is intended to flow back out of the well. This flowback water is collected and then processed using one of the three techniques discussed below under the “Managing Flowback Water” heading. Any fracturing fluid that is not immediately recovered either returns to the surface slowly over time through the isolated wellbore or remains trapped in the rock bed thousands of feet below the surface.

## Fracturing Fluids

Much of the recent attention regarding hydraulic fracturing relates to the composition of fracturing fluids. More than 99% of the typical fracturing fluid mix is water and sand, with the rest a blend of highly diluted special purpose chemicals that are also frequently used in common consumer products and municipal water treatment plants. SM Energy believes that the chemicals used in hydraulic fracturing are safe when transported, stored, and handled properly, and used in appropriate amounts in compliance with applicable regulatory requirements.

The exact percentages and combinations of chemical additives in fracturing fluids may vary slightly based on the nature of the particular formation and the provider of such fluids, but the typical components of fracturing fluids are briefly described in the table below. Listings of typical additives are also publicly available at the websites of several regulatory agencies, including the Pennsylvania Department of Environmental Protection, and other industry participants.

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	94.52%	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	5.34%	Drinking water filtration, play sand, concrete and brick mortar
Diluted acid	Hydrochloric Acid	Helps to dissolve 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 cleaners
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	0.05%	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

Even though chemical additives to fracturing fluids are carefully managed, highly diluted, and injected through multiple cemented strings of steel casing to prevent migration to shallow groundwater aquifers, SM Energy also routinely works with its contractors to reduce chemical additives and utilize more environmentally friendly alternatives, and encourages contractors to use fluids with the lowest possible toxicity and amount of chemical additives that are both functional and cost effective.



## Managing Flowback Water

Once the hydraulic fracturing process has been completed and the applied pressure is released through the surface equipment, fracturing fluids typically flow back through the well to the surface. The amount of fracturing fluid that ultimately flows back up the well depends on the characteristics and amount of injected fluid, and the characteristics of the reservoir and shale or other tightly compressed formation.

There are three primary methods for managing flowback water:

- flowback water may be recycled and reused in another fracturing operation, through both on-site and off-site treatment and processing. SM Energy typically reuses approximately 20-40 percent of the flowback water produced by its wells, depending on the level and proximity of well drilling activity in the particular field or region;
- flowback water may be evaporated at a water treatment storage facility. These storage facilities typically utilize earthen pits with a protective liner (in Pennsylvania SM Energy installs a 30-mil liner on top of a felt pad and a 12 inch sand bed, exceeding regulations that require only the instillation of a 30-mil liner). Regardless of the storage method, the flowback water is treated so as to adhere to strict air emission and water quality standards, including the removal of hydrocarbon and solids. SM Energy flowback operations are monitored 24 hours a day, 7 days a week with redundant on-site supervision; and
- flowback water may be injected underground in formations that are separated from groundwater aquifers by thousands of feet and impermeable layers of rock, in compliance with applicable rules and regulations.

## Regulation and Best Practices

Almost every aspect of oil and natural gas exploration, development, and production is highly regulated under a comprehensive set of federal, state, and local government rules, regulations, and land use codes. Before a well is even drilled, hundreds of pages of documentation are typically filed with state regulators for review and approval. Rigorous compliance with all applicable rules and regulations is paramount at SM Energy. All SM Energy well locations are regularly inspected by industry and regulatory officials, and SM Energy employees and consultants with responsibility for monitoring and implementing relevant laws and regulations work closely

with operations personnel. SM Energy also works closely with its contractors to ensure compliance with applicable laws, regulations and codes.

Examples of the regulatory oversight framework that directly address various aspects of the hydraulic fracturing process include:

- State Oil and Gas Regulatory Agencies, Department of the Interior - Bureau of Land Management – these agencies have general operating rules with guidelines for ensuring the mechanical integrity of the wellbore design and the protection of aquifers;
- Occupational Safety and Health Administration (OSHA), Department of Transportation, State Regulatory Agencies – these agencies have requirements ensuring worksite safety compliance, including the handling and storage of potentially hazardous chemicals. Some states require inventories of all chemicals present on location and volumes pumped into the wellbore during the hydraulic fracturing process. OSHA and the Toxic Substances Control Act have chemical recordkeeping rules, including requirements to maintain Material Safety Data Sheets (MSDS) at the well site where hydraulic fracturing chemicals are being used. These forms describe the composition of the chemical products present on location, as well as guidelines for proper and safe handling and first aid measures;
- Clean Water Act (CWA) – the CWA includes rules to regulate surface water use and storm water runoff. These rules require an element of secondary containment in the event of any spills associated with the storage or handling of the fluids used in the hydraulic fracturing process; and
- Environmental Protection Agency (EPA) – the EPA administers a very comprehensive set of regulations related to water management and disposal (including the Underground Injection Control (UIC) Program), air emissions, and many other health and safety related measures to mitigate the environmental impact of oil and natural gas activities. The EPA has delegated regulation under the Safe Drinking Water Act of underground injection well control, which applies primarily to disposal wells, to most states.

SM Energy is committed to working with regulatory authorities, contractors and others to meet or exceed all regulatory standards and best management practices applicable to hydraulic fracturing. These standards and practices include those for well design, construction, and

monitoring; minimization of potential toxicity of fluids used; flowback water storage, management, monitoring, reuse, treatment, and disposal; overall groundwater and surface water protection; water withdrawals and water quality monitoring (pre- and post-drilling, where appropriate); transportation and onsite storage, handling, and management of chemicals and other materials; tracking and disposal of wastes; and control of air emissions.

### **Additional Safety and Security Programs**

SM Energy is constantly pursuing advancements in its safety and security programs. For example, SM Energy maintains a series of onsite preventative technologies, such as absorbent materials to soak up spills and accessible water to flush and limit the scope of spills. In addition to the many field inspectors typically employed by state regulatory agencies, SM Energy maintains a staff of its own field inspectors to monitor and respond to the same issues of concern. All of SM Energy's active locations are monitored by SM Energy field personnel.

