HYDRAULIC FRACTURING

FACT SHEET

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Hydraulic fracturing is a proven technological advancement which allows natural gas producers to safely recover natural gas from deep shale formations. This discovery has the potential to not only dramatically reduce our reliance on foreign fuel imports, but also to significantly reduce our national carbon dioxide (CO_2) emissions and to accelerate our transition to a carbon-light environment. Simply put, deep shale gas formation development is critical to America's energy needs and its economic renewal.

Experts have known for years that natural gas deposits existed in deep shale formations, but until recently the vast quantities of natural gas in these formations were not thought to be recoverable. Today, through the use of hydraulic fracturing, combined with sophisticated horizontal drilling, extraordinary amounts of natural gas from deep shale formations across the United States are being safely produced.

Hydraulic fracturing has been used by the oil and gas industry since the 1940s and has become a key element of natural gas development worldwide. In fact, this process is used in nearly all natural gas wells drilled in the U.S. today. Properly conducted modern hydraulic fracturing is a safe, sophisticated, highly engineered and controlled procedure.

Chesapeake's major deep shale play operating areas

KEY POINTS

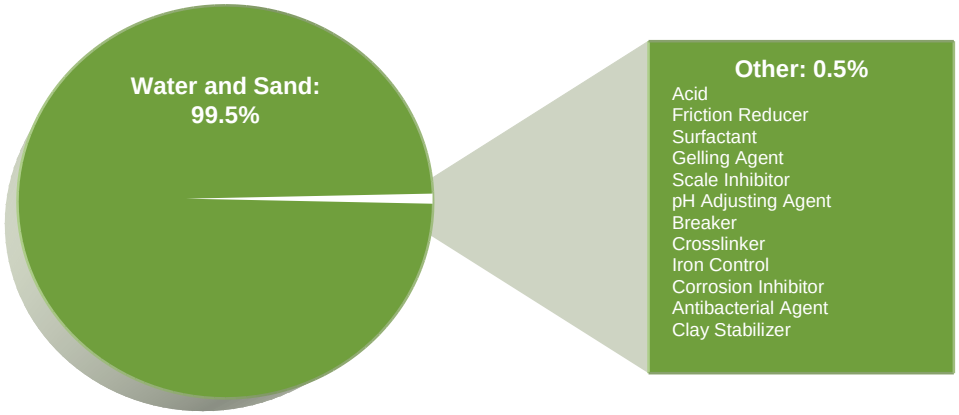
- Hydraulic fracturing is essential for the production of natural gas from shale formations.
- Fracturing fluids are comprised of more than 99% water and sand and are handled in self-contained systems.
- Freshwater aquifers are protected by multiple layers of protective steel casing surrounded by cement; this is administered and enforced under state regulations.
- Deep shale gas formations exist many thousands of feet underground.

What is hydraulic fracturing?

Hydraulic fracturing, commonly referred to as fracing, is the process of creating fissures, or fractures, in underground formations to allow natural gas to flow. In Chesapeake Energy Corporation's (Chesapeake's) deep shale gas plays, water, sand and other additives are pumped under high pressure into the formation to create fractures. The fluid is more than 99% water and sand, along with a small amount of special-purpose additives. The newly created fractures are "propped" open by the sand, which allows the natural gas to flow into the wellbore and be collected at the surface. Normally a hydraulic fracturing operation is only performed once in the life of a well. Variables such as rock formations and thickness of the targeted shale formation are studied by scientists before hydraulic fracturing is conducted. The result is a highly sophisticated process that optimizes the network of fractures and keeps them safely contained within the boundaries of the deep shale gas formation.

Fracturing Fluid Makeup

In addition to water and sand, other additives are used in fracturing fluids to allow fracturing to be performed in a safe and effective manner. Additives used in hydraulic fracturing fluids include a number of compounds found in common consumer products.



Example of Typical Deep Shale Fracturing Mixture Makeup

A representation showing the percent by volume composition of typical deep shale gas hydraulic fracture components (see graphic) reveals that more than 99% of the fracturing mixture is comprised of freshwater and sand. This mixture is injected into deep shale gas formations and is typically confined by many thousands of feet of rock layers.

FRACTURING FLUID ADDITIVES, MAIN COMPOUNDS AND COMMON USES

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
Antibacterial agent	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 in hair coloring, as a disinfectant, and in the manufacture of common household plastics
Corrosion inhibitor	Formamide	Prevents the corrosion of the well casing	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
Clay stabilizer	Potassium chloride	Creates a brine carrier fluid that prohibits fluid interaction with formation clays	Used in low-sodium table salt substitute, medicines and IV fluids
pH adjusting agent	Sodium or potassium carbonate	Maintains the effectiveness of other components, such as crosslinkers	Used in laundry detergents, soap, water softener and dishwasher 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 cleansers, de-icer, paints and caulk
Surfactant	Isopropanol	Used to reduce the surface tension of the fracturing fluids to improve liquid recovery from the well after the frac	Used in glass cleaner, multi-surface cleansers, antiperspirant, deodorants and hair color
Water	Water	Used to expand fracture and deliver proppant (sand)	Landscaping, manufacturing

Hydraulic Fracturing and Groundwater Protection

Unlike shallow natural gas projects, such as shallow coal bed methane (CBM), the producible portions of deep shale gas formations exist many thousands of feet below the surface. Across the U.S. the average depth of a Chesapeake well is more than 7,700 feet (almost one and one half miles below the Earth's surface and many thousands of feet below fresh water formations). This number varies depending on the development area. Chesapeake does not conduct any production or fracturing activities in fresh groundwater aquifers. In fact, across Chesapeake's deep shale gas operations, groundwater aquifers and producing natural gas formations are separated by thousands of feet of protective rock barriers.

How deep is 7,700 feet?

- Over **six Empire State Buildings** stacked end to end
- **1 ½ times deeper** than the deepest part of the **Grand Canyon**
- More than **25 football fields** laid out goal post to goal post

State oil and gas regulatory programs place great emphasis on protecting groundwater. Current well construction requirements consist of installing multiple layers of protective steel casing surrounded by cement that are specifically designed and installed to protect freshwater aquifers.

The measures required by state regulatory agencies in the exploration and production of deep shale gas formations have been very effective in protecting drinking water aquifers from contamination attributable to hydraulic fracturing. Based on reviews of state oil and gas agencies, there is not a documented case of drinking water contamination related to hydraulic fracturing of a deep shale gas well.

Furthermore, the Ground Water Protection Council (GWPC) issued a report in April of 2009 stating that the potential for hydraulic fracturing in deep shale gas wells to impact groundwater is extremely remote, as low as one in 200 million.

Information Sources

- U.S. Department of Energy (DOE)
- Ground Water Protection Council (GWPC)
- Dr. Michael Economides

About Chesapeake

Chesapeake Energy Corporation is the second largest producer of natural gas in the U.S Headquartered in Oklahoma City, the company's operations are focused on the development of onshore unconventional and conventional natural gas in the U.S. in the Barnett Shale, Haynesville Shale, Fayetteville Shale, Marcellus Shale, Anadarko Basin, Arkoma Basin, Appalachian Basin, Permian Basin, Delaware Basin, South Texas, Texas Gulf Coast and East Texas regions of the United States. If you have questions about hydraulic fracturing or other facets of our operations, visit www.chk.com or email us at info@askchesapeake.com.