Drilling a Horizontal Gas Well

1. Key Points

1.1. Well work is a series of complex, technical operations requiring specialized equipment and personnel that are typically conducted 24/7 – 365.

1.2. Drilling operations are designed by highly-trained professional engineers to achieve a subsurface target 1.5-2.0 miles from the surface location, relying on an integrated team of company employees and specialized service contractors.

1.3. Fracture stimulation using a frac fluid of primarily water and sand is employed to complete the well and allow the gas trapped in the shale to be produced to the surface.

1.4. A successfully drilled horizontal well will produce gas for 20-30 years, providing the energy required to fuel our homes and businesses.

2. General Operational Background

2.1. Well drilling operations are typically conducted around the clock, every day (24/7 – 365) once the drilling rig arrives on the location.

2.2. The drill site is an active operations area with access limited to the professionals and contractors supporting the drilling operation. At any given time, personnel at the drill site will likely include company operations supervisors, a company HES representative, the drilling rig crew and supervisor, specialized operational service contractor representatives, logistics personnel, and state regulatory representatives. Access to the drill site is limited to ensure a safe operation.

2.3. Throughout the course of the drilling operations, many different types of equipment will be traveling to and from the location. Construction equipment, such as bulldozers and graders, are used to build the location. Large trucks are used to move the equipment and materials required to support the operations, including water, diesel, and pipe, and other bulk materials.

2.4. Bluescape Resources ensures that of its operations meet all regulations related to operational, environmental, and safety requirements. Additionally, the company has instituted a series of safety, environmental, and operational best practices to further ensure protections.

3. Before the Rig Arrives

3.1. Activities before drilling operations occur are generally referred to as “pre-spud” activities. The phrase “spudding the well” typically refers to drilling the first foot of the well.

3.2. The initial set of activities begins in the office. Technical geoscience and engineering professionals develop a plan to drill a well and identify a proposed location based on the ideal subsurface location of the well.

3.3. Based on the initial plan, a well site location is determined. This site is chosen to ensure safe operations and environmental integrity while achieving the subsurface objectives of the well. Selection of the well site location considers many factors, including:

3.3.1. Existing structures, homes, or other improvements to the land;

3.3.2. Existing operations and other business activities;

3.3.3. Location of streams and other bodies of water;

3.3.4. Local habitat and identification of and environmental concerns;

3.3.5. Access to the site, including current roads, gates, and fences.

3.4. Once the well location is identified, the surface owner is contacted to discuss the use of the property for oil and gas operations and establish right-of-way for use. BRC endeavors to work with surface owners to minimize impacts of the operations and keep all parties informed as to expected operational activities.

3.5. Site preparation includes basic construction activities to build a working area that will facilitate safe and efficient operations. The basic activities are clearing and leveling the location and building containment ponds for water and drilling fluids. Finally, a conductor pipe is set to establish a foundation for the well control equipment and provide a conduit for “spudding the well.”

4. Drilling the Horizontal Well

4.1. Following site construction, the drilling rig moves on to the location. After rigging up and testing the drilling equipment, the drill bit is inserted into the conductor and begins drilling the well. At this point, the well is officially
Drilling a Horizontal Gas Well

4.2. The well is drilled vertically to a depth below the lowest known water zone, circulating a drilling fluid, either mud or air, during the drilling operation to cool and lubricate the drill bit and transport cuttings back to the surface. This drilling section is commonly referred to as the “surface casing interval.”

4.3. When the objective depth is achieved, a string of steel pipe, referred to as a casing string, is run into the well. Cement is circulated through the casing string and into the annulus between the pipe and the formation to create a hydraulic seal. Cementing the casing string across the water zone ensures that the water zone does not communicate with any other zones through the well bore.

4.4. Next, drilling continues from the bottom of the surface casing interval to approximately 500-1000 feet above the targeted formation. This depth is often referred to as the “kick-off point.” This is the point at which the operation converts from vertical drilling to horizontal drilling. For operations in the Marcellus shale, the kick-off point is typically between 6,000 and 7,000 feet.

4.5. The drill string is tripped out of the hole and a set of specialized tools referred to as measurement while drilling (MWD) tools are run back in the hole just above the drill bit. The MWD tools allow the well to be turned from vertical to horizontal. After the well is turned to the horizontal orientation, the well is drilled another 3,000-6,000 feet in the horizontal orientation.

4.6. When the objective depth is achieved, another casing string is run into the well. Cement is circulated through the casing string and into the annulus between the pipe and the formation to create a hydraulic seal. Cementing the casing string across the producing formation ensures that the produced fluids from the formation do not communicate with any other zones through the well bore.

4.7. At this point, the drilling operations are completed, and the rig is moved to the next well location.

5. Fracture Stimulation

5.1. After drilling is completed, the well must be completed to allow fluids from the formation to flow from the cemented casing string to the surface. For gas wells in shale formations, completion operations consist of multiple fracture stimulations throughout the length of the horizontal section of the wellbore.

5.2. The first step of the completion is perforating the casing string. A perforating gun is run through the casing string to the end of the horizontal section. Using and electrical signal, the perforating gun is fired, which triggers the explosion of the charges contained in the gun. Each of these charges penetrates the casing and passes into the formation a matter or inches. Thus, the well is now perforated.

5.3. Using large pumps on the surface, frac fluid is pumped at high rates and pressures into the perforated interval of the well. The frac fluid is a mixture of fresh water and sand with a small amount of highly diluted chemicals. In BRC operations, these chemicals are typically limited to a biocide (bleach) and a friction reducer (polymer). Such fracture stimulations using simple water and sand combinations are typically referred to as “slickwater fracs,” because these completions do not use many of the chemicals typically found in traditional fracture stimulations.

5.4. As the water is pumped into the formation, the pressure fractures the formation. By fracturing the formation, the completion allows the gas trapped in the formation to flow into the well.

5.5. After the first fracture stimulation is completed, a plug is set to isolate the completed interval of the well bore from the remainder of the well.

5.6. The process is completed as each subsequent section of the well is completed – perforate, frac, plug. The total number of fracture stimulations required in a well is dependent upon the characteristics of the formation and the design of the well bore. In Marcellus operations, fracture stimulations are typically executed every 300-500 feet in the horizontal section of the well.

5.7. After completion operations are finished, the plugs in the well bore are drilled out. At this point the fluids from the formation flow into the well bore and to the surface where they are processed to be sold.

6. Production and Marketing

6.1. After the well is drilled and completed, production equipment and tanks are installed at the location to process the produced fluids from the well. This equipment separates oil and water constituents from the produced gas. The gas is then treated using a dehydration unit to remove and condensed water from the gas stream.

6.2. The production equipment includes a set of safety and monitoring controls to ensure the safe operation of the equipment on the surface. These controls are designed to prevent failures in the processing equipment and the subsequent spills that could result in the event of an equipment failure.

6.3. The original well location is remediated, recovering 30-60% of the area originally used for drilling and completion.
activities. These remediation activities return the location to a more native condition. Finally, a fence is installed around the well location to limit access and ensure safety.

6.4. At this point, the well will produce gas for a life of approximately 20-30 years. The processed gas will be transported from the well location to the market through the natural gas pipeline system. The natural gas will be sold to customers who will use the gas to heat their homes, run their factories, or generate electricity.

6.5. BRC continuously monitors the wells to ensure that the operations are safe and pose no threat to the environment. Throughout the process BRC ensures compliance with all mandated safety and environmental regulations.
7. **Information Sources**

7.2. Unconventional Gas Center; http://www.chiefog.com/
7.3. Penn State University; http://extension.psu.edu/naturalgas
7.4. Chief Oil and Gas LLC company website; http://www.chiefog.com/
7.5. “Getting the Gas from the Well”, *The Columbus Dispatch*