Institute for Regulatory Policy Studies Conference

Department of Economics at Illinois State University
April 26, 2012
Crowne Plaza Hotel, Springfield, Illinois
Hydrofracturing: Innovation in Regulation

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PHILLIPS MURRAH, P.C.
Shale Deposits Located in 32 U.S. States Creates Increasing Fuel Supply Certainty and Economic Growth

- 97% Supply is from N. America
- 85% Supply from U.S.

Natural gas producing states (32)
Non-producing state (18)
Natural Gas is now a hallmark of Oklahoma and United States energy production.

Today, Oklahoma is the nation’s 3rd largest natural gas producing state (behind Texas and Wyoming), and typically accounts for about one-tenth of U.S. production. In 2010, Oklahoma produced more than 1.8 trillion cubic feet, accounting for 80% of the state’s overall energy production.

More than a dozen of the 100 largest natural gas fields in the country are found in Oklahoma.
Historic natural gas price volatility
Technological game changers

Without horizontal drilling and hydraulic fracturing, shale gas production would not be economically feasible because the natural gas would not flow from the formation at high enough rates to justify the cost of drilling.
Discoveries in unconventional shale gas enhanced recovery techniques are drastically changing the American and global energy economy.

What is different about shale gas?

Shale gas resources form within the organic-rich shale source rock (formations with low permeability).
Hydrofracturing: General Overview

Hydraulic Fracturing Simply Stated

Hydraulic fracturing is a process used in nine out of 10 natural gas wells in the United States, where millions of gallons of water, sand and chemicals are pumped underground to break apart the rock and release the gas.

Source: National Geographic
The Process Explained

Hydraulic fracturing produces fractures in the rock formation that stimulate the flow of natural gas or oil, increasing the volumes that can be recovered. Wells may be drilled vertically hundreds to thousands of feet below the land surface and may include horizontal or directional sections extending thousands of feet.
Once the drilling rig leaves, hydraulic fracturing begins

Hydraulic fracturing is an advanced technology that allows the safe and economic removal of natural gas and oil from the deep shale formations

Fracking has been used by the natural gas and oil industry since the 1940s
The Process Explained

Fractures are created by pumping large quantities of fluids at high pressure down a wellbore and into the target rock formation. Hydraulic fracturing fluid commonly consists of water, proppant and chemical additives that open and enlarge fractures within the rock formation. These fractures can extend several hundred feet away from the wellbore. The proppants - sand, ceramic pellets or other small incompressible particles - hold open the newly created fractures.
Hydraulic Fracturing Process

- It is the process of “stimulating” natural gas from the impermeable shale by creating small fractures.
- Water mixed with sand and additives is pumped into the reservoir at high pressures.
- Fractures are “propped” open by the sand to allow the natural gas and oil to flow.
- The hydraulic fracturing process is completed in a matter of days.
The Process Explained

Once the injection process is completed, the internal pressure of the rock formation causes fluid to return to the surface through the wellbore. This fluid is known as both "flowback" and "produced water" and may contain the injected chemicals plus naturally occurring materials such as brines, metals, radionuclides, and hydrocarbons. The flowback and produced water is typically stored on site in tanks or pits before treatment, disposal or recycling. In many cases, it is injected underground for disposal. In areas where that is not an option, it may be treated and reused or processed by a wastewater treatment facility and then discharged to surface water.
What’s in the fluid?
An Industry & Oklahoma Example: Halliburton Oil

MATERIAL SAFETY DATA SHEET

Product Trade Name: BC-200 UC

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: BC-200 UC
Synonym: None
Chemical Family: Bland
Application: Crosslinker
Manufacturer/Supplier: Halliburton Energy Services, Inc.
P.O. Box 1431
Duncan, Oklahoma 73535-0431
Emergency Telephone: (817) 575-5000
Prepared By: Chemical Compliance
Telephone: 1-950-251-4335
e-mail: tlaunexxrelt@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances CAS Number PERCENT ACGIH TLV-TWA OSHA PEL-TWA

3. HAZARDS IDENTIFICATION

Hazard Overview: May cause eye, skin, and respiratory irritation. May be harmful if swallowed.

4. FIRST AID MEASURES

Inhalation: If inhaled, remove to fresh air. If not breathing give artificial respiration, preferably mouth-to-mouth. If breathing is difficult give oxygen. Get medical attention.

Skin: In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes. Get medical attention. Remove contaminated clothing and launder before reuse.

Eye: Immediately flush eyes with large amounts of water for at least 15 minutes. Get medical attention.
What’s in the fluid?
Tonkawa Foam Frac Formulation

Overall Percentage
- Water: 75.63%
- Nitrogen: 15.53%
- Proppant: 6.19%
- Fluid System: 0.65%

Liquid Gel Concentrate
- Crosslink Agent
- Foaming Agent
- Biocide
- Clay Stabilizer
- Breaker

Water provided by Operator
Typical Barnett Deep Shale Fracturing Products

Water and Sand: ~ 99%

Other: ~ 1%
- Acid
- Anti-bacterial Agent
- Breaker
- Clay Stabilizer
- Corrosion Inhibitor
- Iron Control
- Friction Reducer
- Gelling Agent
- Scale Inhibitor

For more information, visit HydraulicFracturing.com and FracFocus.org or see our fact sheet on Hydraulic Fracturing.
What Chemicals Are Generally Used?

The number of chemical additives used in a typical fracture treatment depends on the conditions of the specific well being fractured. A typical fracture treatment will use very low concentrations of between 3 and 12 additive chemicals, depending on the characteristics of the water and the shale formation being fractured.
Each component serves a specific, engineered purpose. For example, the predominant fluids currently being used for fracture treatments in the gas shale plays are water-based fracturing fluids mixed with friction-reducing additives (called slickwater).
The addition of friction reducers allows fracturing fluids and sand, or other solid materials called proppants, to be pumped to the target zone at a higher rate and reduced pressure than if water alone were used. In addition to friction reducers, other additives include: biocides to prevent microorganism growth and to reduce biofouling of the fractures; oxygen scavengers and other stabilizers to prevent corrosion of metal pipes; and acids that are used to remove drilling mud damage within the near-wellbore area.
FracFocus.org

The chart on the next slide is taken from Modern Shale Gas Development in the United States: A Primer demonstrates the volumetric percentages of additives that were used for a nine-state hydraulic fracturing treatment of a Fayetteville Shale horizontal well.
MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER

EXHIBIT 35: VOLUMETRIC COMPOSITION OF A FRAC TURE FLUID

Source: ALL Consulting based on data from a fracture operation in the Fayetteville Shale, 2008
What Chemicals Are Generally Used?

Hydrochloric acid (HCl) is the single largest liquid component used in a fracturing fluid aside from water; while the concentration of the acid may vary, a 15% HCl mix is a typical concentration.

A 15% HCl mix is composed of 85% water and 15% acid, therefore, the volume of acid is diluted by 85% with water in its stock solution before it is pumped into the formation during a fracturing treatment.
Once the entire stage of fracturing fluid has been injected, the total volume of acid in an example fracturing fluid from the Fayetteville shale was 0.123%, which indicates the fluid had been diluted by a factor of 122 times before it is pumped into the formation.

The concentration of this acid will only continue to be diluted as it is further dispersed in additional volumes of water that may be present in the subsurface.

Plus, if this acid comes into contact with carbonate minerals in the subsurface, it would be neutralized by chemical reaction with the carbonate minerals producing water and carbon dioxide as a byproduct of the reaction.
What about groundwater protection?
What about groundwater protection?

Studies by the Ground Water Protection Council (GWPC), an association of state regulators, and the Environmental Protection Agency (EPA) have clearly demonstrated the effectiveness of current state regulations in protecting water resources.
What about groundwater protection?

The ultimate goal of the well design is to ensure environmentally sound and safe production by containing the hydrocarbons inside the well, protecting groundwater resources, and insulating the productive formations.
What about groundwater protection?

The primary method used for protecting groundwater during drilling operations consists of drilling the wellbore through the groundwater aquifers, immediately installing a steel pipe (called casing), and cementing this steel pipe into place.
Multiple Layers of Protection

» Knowing where fresh water is located
  ▶ Established by state water protection agencies

» Protective well design
  ▶ Consist of multiple layers of steel casing
Groundwater Protection

- Marcellus Shale ~ 6,000 ft
- Cement
- Conductor Casing
- Cement
- Surface Casing
- Cement
- Intermediate Casing
- Drilling Mud/Cement
- Production Casing
- Production Tubing

Average distance from surface: 7,700 ft

Treatable Groundwater Aquifers

- Private Well
- Typical Municipal Water Well: < 1,000 ft.
- Additional steel casing and cement to protect groundwater
- Protective Steel Casing

*not to scale

Gas-bearing rock, usually shale

Typical Municipal Water Well: < 1,000 ft.

Private Well

Average distance from surface: 7,700 ft
What about groundwater protection?

All state drilling regulations specifically address groundwater protection, including requirements for the surface casing to be set below the lowest groundwater aquifer.
Usable Water vs. Target Depth

State water agencies determine the usable water level that drives the surface casing programs.
What about groundwater protection?

This casing in combination with other steel casing and cement sheaths that are subsequently installed protects the groundwater with multiple layers of protection for the life of the well.
New rules approved by Oklahoma Corporation Commission will require disclosure of hydraulic fracturing chemicals in state

Oklahoma energy companies will have to disclose the chemicals they use in hydraulic fracturing at FracFocus.org or at the state Corporation Commission, if the Oklahoma Legislature gives final approval to new rules.

By Paul Monies | Published: March 21, 2012

Oklahoma energy companies will have to disclose the chemicals they use in hydraulic fracturing under new rules approved by the state Corporation Commission.

The rules give companies the option of reporting at a website called FracFocus.org or to the Corporation Commission. The rules now go to the Legislature for its approval.

Oklahoma would join six other states in requiring disclosure of the chemicals.

Hydraulic fracturing, or “fracking,” involves injecting water, sand and chemicals at high pressure to break apart
1. **Well Construction**

Today’s gas wells have redundant layers of cemented steel piping, called **casing**, to provide a shield between gas production and the environment. A typical gas well is constructed with three million pounds of **steel and cement**.

Each layer of steel casing is cemented into place to create a seal that is air tight. Drillers **monitor the pressure** in the wells to ensure the integrity of the seals.

Source: Groundwater Protection Council
Hydraulic Fracturing

Hydraulic fracturing is used to release gas trapped in rock pores that are sometimes **20,000 times thinner** than a human hair. Hydraulic fracturing fluid is forced down gas wells at high pressure to crack the rock and provide a pathway for the gas to escape into the well and rise to the surface for collection.

Fracturing fluid is made up from **90% water**, **9.5% sand** and **.5% chemicals**. These chemicals are largely found in common household products like cosmetics and cleaning supplies.

Source: Groundwater Protection Council
Because hydraulic fracturing typically takes place **a mile or more** below the surface, underground water supplies and fracturing operations are separated by thousands of feet of **impermeable rock**. Hydraulic fracturing fluid and natural gas cannot migrate through it.

This fluid is collected at the surface for proper disposal. See how above.
Backflow preventers

Drilling companies use backflow preventers as another means to protect groundwater supplies. Backflow preventers are essentially one way valves that only allow liquids to flow in one direction. They eliminate the threat of contaminated water from a gas well flowing into water wells used to supply drilling operations.
Lined impoundments & storage tanks

Drilling companies use lined impoundments or storage tanks to hold the waste water, drilling mud and rock fragments that are produced during drilling and well completion.

The lining of the impoundments is sealed and monitored to provide an impermeable barrier between waste water and top soil. After the well is completed and producing gas, the contents of these impoundments are removed for proper disposal and the site is reclaimed.

Storage tanks provide an alternative to waste water impoundments that allow companies to separate solids and liquids on site and streamline water recycling operations and proper waste disposal.
Water recycling, reuse & waste disposal

Natural gas wells produce waste water as well as the natural gas we use in our homes. This waste water is collected at the surface and then either treated in a mobile water recycling station, piped to a water recycling facility or trucked away to a water injection well for proper disposal under regulations in the Clean Water Act.

A majority of drillers in the Marcellus region now recycle the waste water that comes from gas wells.

This water can be used to provide the water needed for hydraulic fracturing in new wells or it can be further refined and returned to the water supply.
Separation of Hydraulic Fracturing from Freshwater Aquifer

Treatable Groundwater Aquifers

Approximately 7,700 feet deep

Municipal Water Well: < 1,000 ft.

Private Well

Source: Groundwater Protection Council
Hydraulic fracturing does not introduce new or unique environmental risks to exploration and production operations.

But concerns have been raised due to the potential scale of operations where this technology is applied. Many of these concerns are genuine and the oil and natural gas industry recognizes that there needs to be a bigger conversation about the development process and the steps being taken to ensure safe operations.
Access to Shale Gas has forever changed the U.S. Natural Gas outlook.

U.S. Natural Gas Supply, 1990-2035

Shale Gas is expected to account for 46% of U.S. supply in 2035 (up from 14% in 2009).

Source: EIA, Annual Energy Outlook 2011
Shale Production Economics Provide Substantial Cost Benefit to Broad Range of Consumers

Breakeven Henry Hub Price for Productive Capacity* of Analyzed Plays

Less than $3.00 per Mcf: 18.2 Bcf per Day
Less than $4.00 per Mcf: 70.5 Bcf per day
Less than $5.00 per Mcf: 74.1 Bcf per day
Less than $7.00 per Mcf: 108.6 Bcf per day

Dollars Per Mcf

Bcf Per Day

Source: IHS CERA 2010

* Forty years of plateau proved, possible, and potential productive capacity
"The environmental impacts of shale development are challenging but manageable."

MIT Study on the Future of Natural Gas
Thank You

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The Power of a Strategic Partner.

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