HYDRAULIC FRACTURING 101
WHAT IT IS;
WHY IT IS USED;
WHY ALL THE FUSS?
IS IT USED IN INDIANA?

Herschel McDivitt, Director
Indiana Division of Oil and Gas

Mission Statement: The Indiana Division of Oil and Gas is committed to encouraging the responsible development of Indiana’s oil and gas resources in a manner that will: prevent waste, encourage the greatest economic recovery of oil and gas, protect the correlative rights of owners, protect human health and safety, and protect the environment.

Our Commitment: To be **Firm** where we need to be; **Flexible** where we can; and **Fair** in everything we do.

This presentation was updated 10/15/2014
Can we ever stop using fossil fuels for energy needs?

The U.S. is poised to become world’s largest producer of crude oil in 2015.

U.S. natural gas production recently surpassed Russia to become largest producer of natural gas.

Within the last 5 years, U.S. has abandoned the construction of LNG import facilities and begun converting them to LNG export facilities.

Most of this growth is the result of increased use of:
- horizontal drilling; and
- high-volume, multi-stage hydraulic fracturing;
mostly in shale formations and on private lands.

Is “Peak Oil” a myth?
Coal, Oil, and Natural Gas Will Remain Indispensable

1980
288 QUADRILLION BTU

2004
445 QUADRILLION BTU

2030
678 QUADRILLION BTU

Source: IEA REFERENCE CASE

Global Oil and Gas Study
Well Drilling Methods

- Vertical
- Directional
- Horizontal (steerable bits)
Horizontal vs. Vertical Well
Conventional vs. Non-Conventional Resources

Conventional reservoirs:
- Younger, fractured sandstones and carbonates with higher permeabilities (100 to 1,000 millidarcy)
- Initial production usually “driven” by natural reservoir pressure

Non-conventional reservoirs:
- Typically older, compacted non-fractured formations having undergone cementation/recrystallization with very low permeabilities (microdarcies to 3 millidarcy)
- Shale gas and shale oil formations
- Coal bed methane
Major Shale Basins Worldwide
Major U.S. Shale Plays
Natural Gas Production Trends

U.S. dry natural gas production
trillion cubic feet

Natural Gas Supply Trends

U.S. Natural Gas Supply, 1990-2035

Source: EIA, Annual Energy Outlook 2011
Gas Production Trends by Basin

Sources: LCI Energy Insight gross withdrawal estimates as of September 2012 that are converted to dry production estimates with EIA-calculated average gross-to-dry shrinkage factors by state and/or shale play.
Two Primary Factors Influencing Shale Gas Development (and some types of oil)

- **Horizontal drilling technology**
  - Horizontal laterals extending 4,000’ to 10,000’
  - Often perpendicular to natural vertical fracture orientation

- **High volume, multi-stage hydraulic fracturing operations**
  - 6 to 12 frac “stages”
  - Cumulative frac fluid volume per well can be greater than 8 million gallons of water

The goal is to maximize reservoir contact by exposing vast quantities of surface area within the shale target by creating/interconnecting hydraulic and natural fractures.
History of Well Fracturing

- **1860’s** – Fracturing can be traced to the 1860’s when nitroglycerin was first used to stimulate shallow wells in Pennsylvania, New York, Kentucky, and West Virginia.

- **1947** - Stanolind Oil performed the first experimental treatment to “Hydrafrac” a well in Grant County, Kansas.

- **1949** – A patent was issued and an exclusive license was granted to HOWCO (Halliburton Oil Well Cementing Company) to pump the new Hydrafrac process.

- Early fracturing operations used approx. 750 gallons of fluid (gelled crude oil or kerosene) and 400 lbs of sand. Early fracturing employed only 10 to 15 hydraulic horsepower.

- **1950’s** – water increasingly became the primary fluid used.

- Hydraulic fracturing routinely used in oil and gas well completions since the mid-1950’s in Indiana and virtually every other oil and gas producing state.

- **Modern fracturing operations utilize >1,500 hydraulic horsepower and pump rates of more than 100 bbl/minute.**

- Specialized additives have been continuously developed to improve the effectiveness of the hydraulic fracturing operation.
What is HF and Why is it Used?

- Creates numerous “pathways” or “conduits” through the producing formation to enhance the flow of oil or gas into the wellbore.
- Usually performed initially when the well is completed and equipped for initial production.
- *It increases the production of oil and gas from a well.* hydraulic fracturing has increased U.S. recoverable reserves of oil by at least 30% and of gas by 90%.
Fractured vs. Non-fractured Well

Figure 5—Illustration of a Fractured and a Nonfractured Well
High Volume Multi-Stage Frac
Horizontal Shale Gas Wells and “Multi-Stage” Fracs
What’s all the fuss?

The Movie: GASLAND

More Movies Since GasLand: TruthLand, Promised Land, Fracknation
People bring passion to this issue!
### Typical Frac Additives

<table>
<thead>
<tr>
<th>Additive Type</th>
<th>Description of Purpose</th>
<th>Examples of Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proppant</td>
<td>“Props” open fractures and allows gas / fluids to flow more freely to the well bore.</td>
<td>Sand [Sintered bauxite; zirconium oxide; ceramic beads]</td>
</tr>
<tr>
<td>Acid</td>
<td>Cleans up perforation intervals of cement and drilling mud prior to fracturing fluid injection, and provides accessible path to formation.</td>
<td>Hydrochloric acid (HCl, 3% to 28%)</td>
</tr>
<tr>
<td>Breaker</td>
<td>Reduces the viscosity of the fluid in order to release proppant into fractures and enhance the recovery of the fracturing fluid.</td>
<td>Peroxydisulfates</td>
</tr>
<tr>
<td>Bactericide / Biocide</td>
<td>Inhibits growth of organisms that could produce gases (particularly hydrogen sulfide) that could contaminate methane gas. Also prevents the growth of bacteria which can reduce the ability of the fluid to carry proppant into the fractures.</td>
<td>Gluteraldehyde; 2-Bromo-2-nitro-1,2-propanediol</td>
</tr>
<tr>
<td>Clay Stabilizer / Control</td>
<td>Prevents swelling and migration of formation clays which could block pore spaces thereby reducing permeability.</td>
<td>Salts (e.g., tetramethyl ammonium chloride) [Potassium chloride (KCl)]</td>
</tr>
<tr>
<td>Corrosion Inhibitor</td>
<td>Reduces rust formation on steel tubing, well casings, tools, and tanks (used only in fracturing fluids that contain acid).</td>
<td>Methanol</td>
</tr>
<tr>
<td>Crosslinker</td>
<td>The fluid viscosity is increased using phosphate esters combined with metals. The metals are referred to as crosslinking agents. The increased fracturing fluid viscosity allows the fluid to carry more proppant into the fractures.</td>
<td>Potassium hydroxide</td>
</tr>
<tr>
<td>Friction Reducer</td>
<td>Allows fracture fluids to be injected at optimum rates and pressures by minimizing friction.</td>
<td>Sodium acrylate-acrylamide copolymer; polyacrylamide (PAM)</td>
</tr>
<tr>
<td>Gelling Agent</td>
<td>Increases fracturing fluid viscosity, allowing the fluid to carry more proppant into the fractures.</td>
<td>Guar gum</td>
</tr>
<tr>
<td>Iron Control</td>
<td>Prevents the precipitation of metal oxides which could plug off the formation.</td>
<td>Citric acid; thioglycolic acid</td>
</tr>
<tr>
<td>Scale Inhibitor</td>
<td>Prevents the precipitation of carbonates and sulfates (calcium carbonate, calcium sulfate, barium sulfate) which could plug off the formation.</td>
<td>Ammonium chloride; ethylene glycol; polyacrylate</td>
</tr>
<tr>
<td>Surfactant</td>
<td>Reduces fracturing fluid surface tension thereby aiding fluid recovery.</td>
<td>Methanol; isopropanol</td>
</tr>
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</table>
Typical Composition of Hydraulic Fracturing Fluid

Water 88.340%

Sand 11.120%

Other 0.540%

Other Components

- Dilute Acid (15%), 0.123%
- Friction Reducer, 0.088%
- KCl, 0.060%
- Oxygen Scavenger, 0.060%
- Surfactant, 0.060%
- Gel, 0.056%
- Scale Inhibitor, 0.039%
- pH Adjusting Agent, 0.030%
- Breaker, 0.010%
- Crosslinker, 0.007%
- Iron Control, 0.004%
- Corrosion Inhibitor, 0.002%
- Biocide, 0.001%
Schematic of Horizontal Well & HF

Hydraulic Fracturing

Hydraulic fracturing, or “fracking,” involves the injection of more than a million gallons of water, sand and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes the rock layer, in this case the Marcellus Shale, to crack. These fissures are held open by the sand particles so that natural gas from the shale can flow up the well.
Again, “What’s all the fuss?”

Mark Raffalo & Pete Seeger address lawmakers at NYS capital regarding moratorium, July 2010

Quebec protester “Shale gas a moratorium now” 8/30/10

NY EPA Scoping Meeting 9/13/10
Are we obsessed with HF?

- Our Obsession with HF, the new bellwether?
  - CSI Las Vegas vilifying hydraulic fracturing (Episode 8 of Season 11)?
  - Can you say Frac Daddy (2014 Kentucky Derby)?
- There’s a battle raging out there and everybody is weighing in. Very questionable management of the facts.
- The truth is that it isn’t all about HF, but it’s the convergence of issues involving competing interests and agendas.
- HF is the moniker that seems to have stuck.
- To resolve the issues, it’s important to understand some of those competing interests and the varying issues brought to the debate.
Common Issues — Local Communities

- Infrastructure Impacts
- Environmental Impacts
- Community and Quality of Life
- Jobs
Broader Social/Political Issues

- Jobs
- Tax Revenue
- Energy Security
- Private Property Rights
- Economic and Community Development
- Climate Change
- Environmental Protection
- Public Health and Safety
- Role of Government
- Activist Organizations and NGO's
- Political Base and Constituents
- Green Energy vs. Fossil Fuels
Steps in Operating a Well

- Data Gathering and Resource Assessment
- Leasing or Acquisition of Rights
- Permitting and Authorizations
- Well Planning and Design
- Scheduling and Contracting
- Site Preparation and Construction
- Drilling
- Well Completion
- Management of Fluids
- Management of Other Wastes
- Establishing Division of Interest
- Operation and Production of the Well
- Payment and Distribution of Royalties
- Gathering, Treatment, and Processing Facilities
- Management of Other Wastes
- Leasing or Acquisition of Rights
- Permits and Authorizations
- Payment and Distribution of Royalties
There are numerous steps in planning for and developing an oil or gas well. Any one of these steps could arouse concerns.
It’s Not Either/Or

Producing Oil and Natural Gas

or

Protecting the Environment and Public Health and Safety
Obstacles (Challenges or Opportunities)

- Our “sound bite” culture and shallow understanding of the issues.
- No Accountability in the world of Blogs, Facebook posts, and Tweets.
- It takes hard work to wade through the “fog” and get to the center of the issues.
- Passion is OK, but those who bring sound, factual information to the table are more effective.
How Is Hydraulic Fracturing Regulated?

- State Oil and Gas Conservation Laws have always regulated hydraulic fracturing.
- Most laws became effective in 1940’s.
- Hydraulic fracturing developed in the late 1940’s and gained popularity in 1950’s.
- Specific requirements can vary by state but all require detailed reporting of hydraulic fracturing operations such as volumes and types of fluids used and the nature and amounts of proppants.
- Information is reported on the Well Completion Report and made a part of the permanent well record.
- Not regulated under Safe Drinking Water Act (UIC Program) or any other federal regulatory program unless diesel fuel is used (extremely rare).
- States are responding to the new technology and public concerns over transparency by updating their requirements for reporting chemical additive information and making this information available to the public.
Chemical Disclosure Requirements

- Chemical Disclosure Required
- Chemical Disclosure Being Proposed
- States Using or Considering FracFocus
Hydraulic fracturing is indeed relevant to Indiana and has been since it began to be used in the early 1950’s.

- Indiana oil and gas operators continue to utilize hydraulic fracturing to complete wells when they believe the method will increase the productivity of a well. However, not every well is completed using this method.
  - Historically, on average, only about 24% of new oil wells are completed with the use of hydraulic fracturing. Recently we have seen an increase in the use of HF on certain types of oil wells.
  - Percentages for other well types are: 60% of coal bed methane wells, 9% of gas wells, and about 10% of enhanced recovery or disposal wells.
  - As a whole, only 16% of all wells completed in Indiana receive hydraulic fracturing treatments, but the trend is upward in some areas (100% in some limited cases).

The volumes of fluid used typically in Indiana are substantially less than those volumes reported for horizontal wells in other basins in the U.S.

- Historically, the average volume of a HF treatment in Indiana has been between 7,000 to less than 20,000 gallons. Other basins are seeing HF operations which utilize more than 10 million gallons per treatment.
- High volume, multi-stage hydraulic fracturing operations have not been widely used yet in Indiana because they have not been shown to increase the productivity of most wells.
- A few operators have begun using higher volume fracture treatments in some oil wells in extreme southwestern Indiana. These treatments have resulted in increased productivity and are likely to continue so long as these increases are seen.
  - Volumes of 150,000 to 2,000,000 gallons of water per well are being used with some success.
Comparison of Hydraulic Fracturing Fluid Volumes
2005 to 2013
Indiana Wells vs. Other Shale Wells*

Frac Volume (gals.)

Frac volumes for other shale wells reflect calculations of the average volume data obtained from FracFocus by a random sampling of horizontal wells completed in these basins in 2013. (www.fracfocus.org)
Indiana Hydraulic Fracturing Trends

Well Completions and Wells Fraced By Year

Annual Total Frac Volumes - Oil Wells

Percent of Wells Fraced By Year

Annual Total Frac Volumes - Gas, CBM, and Oil Wells
DNR Website: DOG Home Page
### Well Records Search

**NOTE:** If the "Scan Count" is 0, this file has not yet been scanned. If you are interested in receiving this information, please email or fax the request with your name, company name, and attachment (Excel form) to the email address to receive a scanned copy.

Clicking on the "View File" hyperlinks allows you to view the well and its information. Once there, you will see a list of all available documents for that specific well.

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HF Product MSDS Sheets
Division of Oil and Gas Web map
Indiana Geological Survey - PDMS
The path forward

- Dialogue should continue in order to inform those who are interested in a better understanding of the issues and to shape reasonable policy on the use of hydraulic fracturing.
- Getting the right people around the right tables and engaging in the sharing of accurate, reliable information and avoiding hidden agendas.
- Remember that drilling is drilling, well construction is well construction, surface spills are surface spills, producing is producing, and fracking is fracking, each with their own unique characteristics, risks, and solutions.
- Identifying the most effective means of guarding against adverse impacts to public health and safety and to the environment and whether those should be at local, state, or federal level.
- **Ensuring the protection and preservation of private property rights.**
- **Promoting the responsible development of oil and natural gas.**
- Fix what needs fixed and **avoid one-size fits all solutions** - outcomes can and should vary by state and region and must reflect those issues that are relevant considering state and local variables.
- **States are in the best position to address the regulation of the actual practice of hydraulic fracturing and its related processes given their role (and responsibility) as primary regulators of oil and gas drilling and production and their familiarity of the geology and hydrology within their state.**
- Be transparent and remain flexible and ready to adapt to evolving technologies and management practices.
Key HVMSHF Issues

- **Things at the surface:**
  - Impacts upon water availability.
  - Storage of HF fluids and additives.
  - Storage of “flowback” fluids and solids.
  - Proper management and disposal of HF wastes.
  - Impacts of disposal practices.

- **Things going on underground:**
  - Protection of groundwater and other underground resources.
  - Well design, construction, and integrity.
  - Potential fluid migration pathways.
  - Physical isolation and containment of fluids.

- **Matters of oversight, accountability, and management systems:**
  - The rule of law and differing roles of government jurisdictions.
  - Degree and nature of regulatory oversight, inspections, and reporting of activities.
  - Transparency, “right to know”, and information/education.
  - Permanent records retention and public availability.
  - Monitoring systems to detect failures or compromises to integrity.
  - Contingency plans including protective and remedial measures to be taken when failures occur.
  - Encourage reduction, reuse, and recycling.
Just Saying

President Barack Obama

"We should strengthen our position as the top natural gas producer ... It not only can provide safe, cheap power, but it can also help reduce our carbon emissions."

"We produce more natural gas than ever before -- and nearly everyone’s energy bill is lower because of it. The natural gas boom has led to cleaner power and greater energy independence. We need to encourage that."

Gina McCarthy
Current EPA Administrator

Lisa Jackson
Former EPA Administrator

"There's nothing inherently dangerous in fracking that sound engineering practices can't accomplish."

Ernest Moniz
Current Secretary of Energy

"I'm not aware of any proven case where the fracking process itself has affected water."

Steven Chu
Former Secretary of Energy

"Fracking has been done safely for many, many years."

Sally Jewell
Current Secretary of Interior

"This [hydraulic fracturing] is something you can do in a safe way."

Ken Salazar
Former Secretary of Interior

"There's a lot of hysteria that takes place right now with respect to hydraulic fracting. My point of view, based on my own study of hydraulic fracturing, is that it can be done safely and has been done safely hundreds of thousands of times."
Questions?

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