Environmental Concerns About Shale Gas Production

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SERC

- The Ohio State University has created a Subsurface Energy Resource Center (SERC)
- An interdisciplinary university center to serve as an “honest broker” to interface between industry, government agencies, and NGOs
- At its beginning, SERC is a virtual center serving a coordinating function
- To provide outreach to the legal community and serve as a resource to regulators and policy-makers.

Disclaimer

- The opinions and remarks contained in this presentation are my own and do not necessarily reflect those of The Ohio State University, its Subsurface Energy Resource Center, nor the Ohio State University Alumni Association.

North American shale plays
(as of May 2011)
Muskwa-Otter Park, Evie-Klua
Lower Besa River
Muskwa-Otter Park
Montney
Doig Phosphate
Colorado Group
Niobrara*
Bakken ***
Cody
Heath**
Gammon
Mowry
Hilliard- Baxter-Mancos-Niobrara
Niobrara*
Mancos
Hermosa
Monterey-Temblor
Monterey
Lewis
Pierre-Niobrara
Excello-Mulky
Woodford
Fayetteville
Bend
Avalon
Barnett
Barnett-Woodford
Eagle Ford
Eagle Ford, La Casita
Eagle Ford, Tithonian
Pimienta
Pimienta, Tamaulipas
Haynesville-Bossier
Tuscaloosa
Floyd-Neal
Chattanooga
Conasauga
New Albany
Antrim
Utica
Frederick Brook
Horton Bluff
Devonian (Ohio)
Marcellus
Utica
Current shale plays
Stacked plays
Shallowest / youngest
Intermediate depth / age
Deepest / oldest
* Mixed shale & chalk play
** Mixed shale & limestone play
*** Mixed shale & tight dolostone siltstone-sandstone play
Prospective shale plays
Basins
N

What is Fracking?

- Fracking is only one step in shale gas production. It involves fracturing shale formations, either by means of hydraulic fracturing or supercritical CO2.
- The fracking debate is not really about fracking itself, but about the safety and environmental risk of each step of the shale gas production system.

What Is Fracking?

- The specific answer. What is hydraulic fracturing, often called fracking, fracing or hydrofracking? It is the process of initiating and subsequently propagating a fracture in a rock layer, by means of a pressurized fluid, in order to release petroleum, natural gas, coal seam gas, or other substances for extraction. The fracturing is done from a well bore drilled into reservoir rock formations. The energy from the injection of a highly pressurized fluid, such as water, creates new channels in the rock which can increase the extraction rates and ultimate recovery of fossil fuels.

What Is Fracking?

- Hydraulic fractures, created by human activity, are extended by internal fluid pressure which opens the fracture and causes it to extend through the rock. Man-made fluid-driven fractures are formed at depth in a borehole and extend into targeted formations. The fracture width is typically maintained after the injection by introducing a proppant into the injected fluid. Proppant is a material, such as grains of sand, ceramic, or other particulates and chemicals, that prevent the fractures from closing when the injection is stopped

What are the steps of shale gas production?

- Objections to fracking is really aimed against shale gas production in general:
  - –The initial stages of shale gas production do not differ in any way from a conventional gas well, until the kick-off point
  - –The kick-off point is well below any groundwater formation. The well is already sealed off from the ground water via steel and concrete casing.
  - –The kick-off point is about 500 feet above the target formation
  - –The well is angled until it is horizontal
  - –Using plugs, the well is perforated and fractured in stages
  - –Production goes to gathering wells that take gas to the pipeline network
  - –Multiple horizontal wells on a single platform are possible.
  - –Backflowing fracking fluid goes into on-site containment ponds, before it is recycled or is subject to disposal (UIC Class II -- nonhazardous injection wells)

How is current shale gas production different?

- Vertical hydraulic fracking of shale and other gas formations has gone on for over six decades.
- What is different is a technological breakthrough in 2002,the coupling of two separate pre-existing technologies: hydraulic fracturing and horizontal drilling.

The #1 Concern: Surface and/or Groundwater Contamination

- The leading concern about shale gas production involving horizontal drilling and fracturing in the possibility of surface or groundwater contamination

Would This Concern Be Different From Vertical Fracking?

- Rationally, the concern would not be different in kind.
- However, the concern would be different in degree because of the greater potential risk that horizontal fracking represents
- Risk = Probability * Impact
- The risk can be approximately forty times greater per well assuming the probability of error stays the same.

How Does the Risk Differ?

- The Probability of Mishap Is the Same as That of Vertically Fractured Wells
- Indeed, API is collecting and publishing general best practices so that the probability of mishap is minimized
- Specific best practices would be specific to the formation/reservoir and should probably be done at a state or regional basis

Does the Risk Differ Per Well?

- Yes, because the length of the fracked area is increased, the potential impact of a mishap because of backflow of fracking fluid also increases proportionately, depending on the relationship of the depth of the formation to the length of the horizontal lateral(s).

Has There Been Evidence of Groundwater or Surface Water Contamination?

- Until recently, an industry talking point that has been and is still being repeated is that there has been no EPA or BLM studies verifying groundwater contamination from a gas well involving fracking.
- The NY Times uncovered one such study.
- Also, 47 incidents of groundwater or surface water contamination (whether due to surface spills or off-site disposal issues), air quality, or blow outs are noted in Appendix 2E of the 2011 MIT Study on the Future of Natural Gas.

Did the Fracking Itself Cause the Groundwater Contamination?

- The chances of that are remote. That is out of 36,000 wells.
- Groundwater Contamination, in the rare instances when it has occurred, is most likely caused by poor cementing jobs in the well bore or operational errors.
- Our concern, however, is whether the fracking fluid, if it does have contact with the groundwater, would result in contamination, and, if so, how to minimize that risk.

Can Fracking Fluid Contaminate Surface or Groundwater?

- EPA: “Contaminants of concern to drinking water include fracturing-fluid chemicals and degradation products and naturally occurring materials in the geologic formation (e.g., metals, radionuclides) that are mobilized and brought to the surface during the hydraulic fracturing process.”
- The Technology Enhanced Naturally Occurring Radioactive Materials (TE-NORM) issue.

Chemical Additives?

- •US Geological Survey: “Whereas the percentage of additives in a typical hydrofrac fluid is commonly less than 0.5% by volume, the quantity used in these hydrofracs is so large that a three million gallon hydrofrac job, for example, would result in about 15,000 gallons of chemicals in the waste.”
- •Some fracking fluids are “green” meaning they contain water and proppants without additional chemicals.

What Chemicals?

- For the 0.5%, the composition of chemicals varies company-by-company, formation-by-formation, sometimes well-by-well.
- Can include sodium and potassium chloride , citrus acid, guar gum -- all consumable food additives
- Can also include petroleum distillates, ethylene glycol, and other chemicals, some of which are suspected or known carcinogens.
- A mixed bag. We need CAS registration numbers for fracking fluids available on site.

Surface Water Contamination

- Backflow fracking fluid and produced formation water is stored until disposal or reuse.
- Stored in a dike or pit, steel tank, or earthen impoundment for spill prevention until disposal or reuse. Sometimes long-term.
- Disposal in UIC Class II Non-hazardous waste injection wells
- Reuse: recycling
- Brine or trace chemicals often prevent sending the water through waste water treatment. Problems in PA.

Overall Industry Record

- The Overall Industry Record Has Been Very Good, If Not Excellent. However, it is not flawless.
- After hundreds of thousands of fracked gas wells, there have been a few incidents; all of the incidents were preventable.

A Red Herring Issue? Earthquakes

- Fracking is a man-made micro-seismic event.
- By definition, fracking causes a micro-earthquake that is too small to feel on the surface
- Less than 1 on the logarithmic Richter scale. Earthquakes that can be felt begin about 3. Damage begins around 4.
- Injection wells for disposal of waste water can be and have been a persistent problem.
- One Ohio horizontally fractured well is suspected of inducing an earthquake
- A persistent problem of avoiding faults, knowing the formation, making certain that injection pressures are not too great.

Air Pollution

- Methane leakage at the production site would not be a problem unique to fracking.
- Vapors from petroleum distillates are potentially problematic.
- 1.5% average methane loss from production to end use, compared to 3.2% for a breakeven with a coal power plant's CO2e emissions.
- EPA has issued regulations that are effective 2015 to tighten standards on volatile organic compounds, methane, and other gases

Gas Migration into Groundwater

- Not From the Fracking Process Itself.
- It could only occur if there is poor cementing in the well bore.
- Many formations are under shallow gas formations that were previously drilled.

Water

- While fracking utilizes a large amount of fresh water, the water consumption is small compared to producing other sources of energy.
- Consider avoiding or scaling back production in drought-stricken/prone areas
- Many states have issues of riparian use
- Watershed restrictions
- Water consumption restrictions

Socio-economic

- Consider how to deal with environmentally sensitive areas, particularly because of the roads and traffic needed to go to wells and gathering lines that must be built .
- Boom and bust.
- Be prepared for fall-off in production levels after the initial peak production period

Infrastructure

- Expect gathering lines
- Expect a further build out of the natural gas pipeline system
- Legitimate siting concerns on gathering lines and pipelines, include: wetlands, endangered species, water crossings and impacts, sediments, historical preservation, preservation of natural areas, parks, and preserves

Infrastructure

- Roads – primary and secondary for transportation of drilling rig, fracking fluid, and all components
- Well roads
- The need to make certain that erosion along roads do not lead sedimentation of nearby streams, erosion.

Federal versus State

- State agencies that are members of the Interstate Oil and Gas Commission Compact regulate UIC Class III wells, involved in fracking.
- Provide input from STRONGER (the State Review of Oil and Natural Gas Environmental Regulation) NGO and the Ground Water Protection Council (made up of State EPAs).
- FracFocus.
- Best case practices are necessarily formation-by-formation, which is state or regional

Two Excellent Sources

- The SEAB (Secretary of Energy Advisory Board) Shale Gas Production Subcommittee Ninety-Day Report -- August 11, 2011
- Ken Costello, “Hydraulic Fracturing: Placing What We Know Today in Perspective,” The National Regulatory Research Institute, October 2011.

Gas Versus/Complements Renewables?

- Electric Generation is the largest, growing use of gas.
- Problem: The long-run price of natural gas is volatile, short-term and long-term.
- The price is likely to rise over time.
- Renewables are cleaner from a GHG perspective
- Renewable energy can act as a price hedge against gas price volatility
- Natural gas generation (and dispatchable demand response) is needed for rapid ramping for voltage support and stability to back up intermittent renewable power sources, such as wind power and solar power generation.