Fracking in Kentucky

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Kentucky Geological Survey

Water Wednesday, U. Ky. Ag & Natural Resources
Lexington, Kentucky, 17-Feb-2016
Well Construction & Operation

- Pad construction
- Rig move
- Drilling
  - Casing & cement
  - Logging
- Rig release
- Completion
  - Perforating
  - Stimulation (fracking)
- Production
- Plugging & abandonment
- Reclamation

Public discussion

Industry discussion
Drilling (not Fracking)
A reservoir is an underground accumulation of fluid.

Marbles (sediment)

Porosity – space to hold fluid

Permeability – “Connectedness”

Seal – (Jar & gasket) forms a trap
Range of Permeabilities

After SPE 152596, fracfocus.org
What is Fracking?

- Inject high-pressure fluids underground
- Induce new fractures
- Connect to existing natural fractures
- Create
  - A larger stimulated reservoir volume
  - Permeable pathways for oil and gas to flow into the well bore
Why Frac?

- **Energy**
- **Reduce CO₂ emissions**
U.S. Primary Energy Production

Quadrillion BTU


Coal  Gas  Oil  NGL  Nuclear  Renewable

>40% increase
U.S. Crude Oil Imports

Percent of Total Consumption

0% 25% 50% 75%


www.eia.gov/dnav/pet/pet_sum_snd_d_nus_mbbl_a_cur.htm
U.S. Greenhouse Gas Emissions

8% decrease in emissions since 2006

www3.epa.gov/climatechange/science/indicators/ghg/us-ghg-emissions.html
U.S. Greenhouse Gas Emissions

35% increase in gas production since 2005

www3.epa.gov/climatechange/science/indicators/ghg/us-ghg-emissions.html
www.eia.gov/dnav/ng/hist/n9070us2a.htm
Horizontal wells minimize surface impact of drilling.

Many surface locations

32 wells on 20 acre spacing

Many underground laterals

1 well on 640 acre spacing
Issues: EEC Listening Sessions

1. Water Contamination (707)
2. Earthquakes (126)
Hydraulic Fracture Chemistry

- Water – 95% to 99%
- Sand – 1% to 2%
- Chemicals – 2% or less (median 0.43%)
  - Friction reducers (polyacrylamide)
  - Biocides (glutaraldehyde, quaternary ammonium chloride)
  - Surfactant (lauryl sulfate, ethanol)
  - Thickeners (guar gum)
  - Acids (HCl)
  - Corrosion inhibitor (ethylene glycol, isopropanol)

Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources

U.S. EPA Review Draft

- 5-year study
- 998 pages

www.epa.gov/hfstudy
Fracture Stimulation Water Cycle

- Withdrawal
- Mixing of water, chemicals, proppant
- Injection of fracturing fluids
- Management of flowback and produced water
- Reuse, treatment and discharge, or disposal of wastewater
EPA Identified Potential Pathways

• Water withdrawal (supply)
• Spills
  – Hydraulic fracturing fluids
  – Produced water
• Fracturing directly into USDW
• Below ground migration of fluids and gas
• Inadequate treatment and discharge of wastewater
EPA Finding

• “We did not find evidence that these mechanisms have led to widespread, systemic impacts on drinking water resources in the United States.” ...

• “[W]e found specific instances where one or more mechanisms led to impacts on drinking water resources, including contamination of drinking water wells. The number of identified cases, however, was small compared to the number of hydraulically fractured wells.”
A well is constructed using nested pipe, “casing”, that is cemented into place.

Relative widths exaggerated

Typical Well Construction (not to scale)

Cement
Cement
Cement
Cement

Production tubing

1,000s of ft.

Reservoir
Spill Prevention Control and Counter Measures (SPCC)

www.epa.gov/osweroe1/content/spcc/index.htm
Baseline Groundwater Monitoring in the Berea SS

- **Characterize**
  - Major producing aquifers
  - Groundwater uses

- **Obtain**
  - Baseline groundwater chemistry data
  - Long-term data from select wells
  - Dissolved methane
  - Carbon isotopes
  - Major ions and cations
Project Status

- Visited Ag. Ext. agents
  - All counties except Martin
- Contact
  - Bart Davidson
  - bdavidson@uky.edu
Earthquakes

No!

Loma Prieta Earthquake, San Francisco Mission District, 1989 (photo by USGS)
Maybe
Differences

Fracking

Producing well

Higher pressure

Low permeability

Seal

Permeable

Continuous injection

Disposal

Lower pressure

Low permeability
Factors Needed for Felt Earthquake

• Fault large enough to produce a felt event
• Stress in rocks large enough to produce earthquakes
• Presence of fluid path between injection point and fault
• Fluid pressure changes large enough to induce an earthquake

Adapted from:
Rubinstein & Mahani, 2015, Seismic Research Letters, v. 86, n. 4
IOGCC/GWPC, 2015, Potential Injection-Induced Seismicity Associated with Oil & Gas Development
NSF, 2013, Induced Seismicity Potential in Energy Technologies
What the Science Says

“The process of hydraulic fracturing a well as presently implemented for shale gas recovery does not pose a high risk for inducing felt seismic events.”

• “Injection for disposal of wastewater ... into the subsurface does pose some risk.”
• “Reducing injection volumes, rates, and pressures has been successful in decreasing rates of felt seismicity.”
IOGCC and GWPC Report

- Understanding induced seismicity
- Assessing potentially injection-induced seismicity
- Risk management and mitigation strategies
- Focus
  - Hazards – what can go wrong
  - Risk – likelihood of consequences to people and property
  - State-level regulation

Potential Injection-Induced Seismicity Associated with Oil & Gas Development:
A Primer on Technical and Regulatory Considerations Informing Risk Management and Mitigation

East Kentucky Microseismic Monitoring Project

- Investigate
  - Background level of natural micro-earthquakes
  - Monitor low-level seismicity
  - Discrimination between natural and manmade events
Network Status

- 12 new stations
- Real time event detection and location

- ≈175 mine blasts/week
- Natural earthquakes
  - ≈15 global events/week
  - At least 6 micro-earthquakes not detected by other agencies
Burning Tap Water

Weld County, CO: Investigated and not due to fracking or shale gas drilling.

Parker Co, TX: Staged, not hooked to a water supply, leaking from shallow natural sources into water.
Salt, Burning, and Oil Springs

Does not include places like Big Bone Lick, Ky
Does indicate naturally “impaired” groundwater
What’s happening in Kentucky?

At least 100’ thick and 1,000’ deep
Fracked Wells in Kentucky

More than 11,000 since 1980
Typical Completions

- Lawrence & Greenup: 1,000 ft to 1,800 ft
- East Kentucky: 2,000 ft to 5,000 ft

Depth and thickness varies across Kentucky

- Coal
- Water
- Oil
- Gas
- Brine

Mixed shale
Gray shale
Black shale
Sandstone
Limestone
Dolomite
Water Use in Kentucky Fracks

- **Berea**: "Slickwater" (hydraulic) frac
- **Huron**: Nitrogen-foam frac
- **New Albany**: Hydraulic frac

Thousands of gallons or thousands of pounds

![Graph showing water use in Kentucky fracking.]
Nitrogen Frac, Eastern KY
Kentucky Natural Gas Production

2014: 256 Bcf

East Kentucky 99%

34 Kentucky counties
Devonian Berea Activity

Oil production (barrels)

- Greenup
- Lawrence
- Henderson
- Union

- 675,000 bbls

2000 2005 2010

Oil production (barrels x 100000)

Miles

Greenup     Lawrence
Henderson   Union
Division of Oil and Gas

The mission of the Division of Oil and Gas is to regulate the crude oil and natural gas industry in the Commonwealth; protect the correlative rights of mineral owners, fresh water zones and minable coal seams; and conserve and protect oil and gas reserves in Kentucky.

The Division of Oil and Gas maintains a well history database for each well containing data relative to the permit, operator, well location, pertinent dates and well completion. Currently, there are 136,286 wells stored online. This information is shared with the Kentucky Geological Survey (KGS) to assist in the compilation of oil and gas data.
Oil and Gas Regulatory Update

- Energy & Environment Cabinet Workgroup
  - Dept. of Natural Resources
    - Div. Oil & Gas
    - Div. Water
  - Economic Development
  - Department of Ag
- Kentucky Oil and Gas Regulatory Modernization Act
- Signed by Governor Beshear 19-Mar-2015
- Law 24 Jun-2015
KRS 353: Hydraulic Fracturing

- “High-volume” (HVHF) defined
  - >80,000 gallons for any stage
  - >320,000 gallons in aggregate for all stages
- Baseline water quality testing, post-frac monitoring
- Notification (surface owners within 1,000’)
- Disclosure at chemical registry, FracFocus.org
  - Trade secrets must be available to health professionals on request
- Site reclamation, BMP
FracFocus 3.0

It's almost here...

FracFocus is continuing to evolve and expand its performance and versatility by providing more than a dozen enhancements including:

- Expand the public's ability to search records
- Improve data accuracy
- Provide extraction of data in a “machine readable” format
- Update educational information on chemical use, oil & gas production and potential environmental impacts

These upgrades will be designed to dramatically enhance the site’s functionality for the public, state regulatory agencies and industry users.

Adding more participating companies and reported wells from across the country, FracFocus' continued success is the result of state and federal government agencies and the oil and natural gas industry to provide public transparency.

FIND OUT MORE

Looking for information about a well site near you?

Search for nearby well sites that have been hydraulically fractured to see what chemicals were used in the process.

TOTAL WELL SITES REGISTERED 109955

FAQs
Reclamation Plans

- Site description
- Steps to prevent erosion
- Revegetation plan

From example FORM ED-10
Scanned Documents are available for browsing, printing, or downloading.

Casing and cement

Completion and stimulation

Public records: www.uky.edu/kgs
Take Aways

- Fracking is a hazardous industrial activity
  - Risk of affecting people or property is small (not systematic or widespread)
  - Energy benefits are large

- Oil and gas development and fracking are regulated
  - Prudent and effective

- EPA (2015) ... “assessment advances the scientific basis for decisions by federal, state, tribal, and local officials, industry, and the public, on how best to protect drinking water resources now and in the future...
Thank you

- bnuttall@uky.edu
- (859) 323-0544
- www.uky.edu/KGS

Scan these tags with your smart phone.