NATURAL GAS EXTRACTION

KEY ENVIRONMENTAL ISSUES IN US EPA REGION 2
MAY 29, 2014
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Advances in hydraulic fracturing and horizontal drilling have opened new areas for oil and gas development.
According to 2009 US Dept of Energy data:

- US natural gas **proved** reserves: 8.045 Tm$^3$
- US “**technically recoverable**” shale gas: 23.43 Tm$^3$
Natural gas and the Environment

- Natural gas is **cleaner burning**
  - About 53 kg of CO₂ for every million Btu equivalent of natural gas
  - **versus**
  - About 97 kg of CO₂ for every million Btu of coal, and 59 kg of CO₂ for every million Btu of fuel oil

- Methane is a **potent greenhouse gas**
  - CH₄ is the primary constituent of natural gas and may be released directly to the atmosphere in the drilling process
  - About 25 times more potent than CO₂
DRILLING RIG IN TROY, PA
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.
SAMPLE FLUID COMPOSITION

- Water, 90.60%
- Proppant, 8.96%
- Other, 0.44%
- Acid, 0.11%
- Breaker, 0.01%
- Bactericide/Biocide, 0.001%
- Clay Stabilizer/Controller, 0.05%
- Corrosion Inhibitor, 0.001%
- Crosslinker, 0.01%
- Friction Reducer, 0.08%
- Gelling Agent, 0.05%
- Iron Control, 0.004%
- Scale Inhibitor, 0.04%
- Surfactant, 0.08%
- pH Adjusting Agent, 0.01%
Hydraulic Fracturing

- Hydrofracturing injects fluid into wells at high pressure, creating fractures within the target zone (usually shale formations). The fractures provide channels for gas to flow to the well bore.
- In addition to sand and water, chemicals are used in the fracking fluid which could include: diesel, gels, foams, nitrogen, carbon dioxide, benzene, arsenic, etc.
- The number of gas wells using hydrofracturing is expected to rapidly increase.
  - Gas from shale formations is projected to make up an increasing share of total domestic gas production in the next ten years.
  - Hydrofracturing is a key technology allowing for the economic recovery of gas from shale formations.
NETWORK OF DRILL PADS, ACCESS ROADS, COMPRESSOR STATIONS AND PIPELINES IN ALLEGHENY, PA
Natural gas exploration, drilling and production may have many environmental impacts

- CWA – discharges of pollutants from a point source to waters of the US
- SDWA – public water system contamination and contamination of underground sources of drinking water
- CAA – air emissions
- TSCA – information regarding chemicals used that should be reported
- RCRA – non-exploration and production wastes
- CERCLA – 104 response authority
Natural gas drilling can result in discharges to surface waters. The discharge of this water is subject to requirements under the CWA.

**Direct Discharges:**
- The CWA prohibits the discharge of pollutants by point sources into waters of the United States, except in compliance with certain provisions of the CWA, including § 402. 33 U.S.C. 1311(a).
- The technology-based requirements for direct discharges from oil and gas extraction facilities into surface waters are found in 40 CFR Part 435.
- Zero discharge requirement – no direct discharge of process wastewater from onshore natural gas extraction facilities into surface waters.

**Indirect Discharges:**
- Sewer systems connected to POTWs and discharging to waters of the U.S.
- Discharge regulations for indirect dischargers are called pretreatment standards.
- No user of POTW can introduce a pollutant into the POTW that will “pass through” or cause interference with the POTW.

**Statutory exemption for stormwater runoff** for most oil and gas field activities (CWA § 402(l)(2))(Energy Policy Act of 2005)

**UIC permit required** for flowback and produced water injected underground for disposal.
Hydraulic fracturing often involves the injection of more than a million gallons of water, chemicals, and sand at high pressure down the well. The depth and length of the well varies depending on the characteristics of the hydrocarbon-bearing formation. The pressurized fluid mixture causes the formation to crack, allowing natural gas or oil to flow up the well.

Water Use in Hydraulic Fracturing Operations
- **Water Acquisition** - Large volumes of water are transported for the fracturing process.
- **Chemical Mixing** - Equipment mixes water, chemicals, and sand at the well site.
- **Well Injection** - The hydraulic fracturing fluid is pumped into the well at high injection rates.
- **Flowback and Produced Water** - Recovered water (called flowback and produced water) is stored on-site in open pits or storage tanks.
- **Wastewater Treatment and Waste Disposal** - The wastewater is then transported for treatment and/or disposal.
CWA - OIL STORAGE

• Development and implementation of an oil spill prevention, control, and countermeasure plan (SPCC) if
  – An oil spill at the facility could discharge into or upon navigable water of the U.S. or adjoining shorelines; and
  – The facility has an aggregate above ground storage capacity of oil greater than 1,320 gallons (only counting containers 55 gallons or greater); or
  – The facility has a completely buried (underground) oil storage capacity greater than 42,000 gallons excluding underground storage tanks fully regulated under RCRA

http://www.epa.gov/osweroe1/content/spcc/

• For the prevention, preparation for, and response to oil discharges to waters of the US or adjoining shorelines.
SAFE DRINKING WATER ACT (SDWA)

Underground Injection Control Program

– The UIC Program protects underground sources of drinking water (USDWs) by setting requirements for injection wells that prevent endangerment to USDWs.

– Background:
  • Prior to 1997, EPA considered hydraulic fracturing to be a well stimulation technique associated with production and therefore not subject to the UIC program.
  • In 1997, the 11th Circuit held that hydraulic fracturing operations are subject to the SDWA. Legal Environmental Assistance Foundation, Inc. (LEAF) v. EPA, 118 F.3d 1467.
  • Subsequently, in 2001, the 11th Circuit held that wells used for the injection of hydraulic fracturing fluids fit within the definition of Class II wells under the UIC Program. Legal Environmental Assistance Foundation, Inc. v. EPA, 276 F.3d 1253.

– 2005 Energy Policy Act revised the SDWA definition of “underground injection” to exclude “the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities.” (Italics Added)
EPA INJECTION WELL CLASSIFICATION

- **Class 1**: Wells used to inject hazardous, industrial, municipal or radioactive waste beneath the lowermost USDW.

- **Class 2**: Wells which inject fluids:
  - brought to the surface in connection with natural gas storage or oil or natural gas production, aka disposal wells;
  - for enhanced recovery of oil or natural gas;
  - for storage of hydrocarbons which are liquid at standard temperature and pressure.
  - “Other” wells: wells used to inject brine into liquefied petroleum gas storage caverns.

- **Class 3**: Wells which inject for extraction of minerals.

- **Class 4**: Wells used for injection of hazardous or radioactive waste into or above a USDW (banned except if used for remediation.)

- **Class 5**: Wells not fitting in Classes 1-4 or 6. Typically shallow wells such as drywells and septic systems, receiving anything from industrial waste to storm water.

- **Class 6**: Carbon sequestration injection wells.
<table>
<thead>
<tr>
<th>Well Class</th>
<th>Function</th>
<th>Inventory*</th>
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</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Non-Hazardous and Hazardous industrial and municipal wastes</td>
<td>650</td>
</tr>
<tr>
<td>Class II</td>
<td>Fluids related to oil and gas production</td>
<td>151,000</td>
</tr>
<tr>
<td>Class III</td>
<td>Solution mining (e.g. salt, uranium)</td>
<td>21,000</td>
</tr>
<tr>
<td>Class IV</td>
<td>Shallow hazardous waste – only used for remediation activities</td>
<td>24 sites</td>
</tr>
<tr>
<td>Class V</td>
<td>Injection wells not included in Class I, II, III, IV, or VI</td>
<td>400,000 – 650,000 (Estimate – precise inventory is unknown)</td>
</tr>
<tr>
<td>Class VI</td>
<td>Geologic sequestration of carbon dioxide</td>
<td>6-10 commercial wells expected to come online by 2016</td>
</tr>
</tbody>
</table>
EPA UIC regulations designed to minimize risk of contamination of USDWs from the subsurface injection of fluids.

Class 2 UIC permit required for the underground disposal of wastewater from hydraulic fracturing activities (injection of flowback and/or produced water) irrespective of whether diesel was used in the operation.

EPA also has emergency authority under SDWA 1431 to take action where contaminants in the drinking water supply present an “imminent and substantial endangerment” to the health of persons.
Gas extraction and production have resulted in:

- Adverse human health effects resulting from elevated levels of air pollutants such as VOCs (e.g., benzene) and particulates, and
- Significant increases in ozone levels, in both attainment and non-attainment areas.

Some of the emissions are from “leaks” in equipment. The VOC leaks are often invisible to the naked eye. Some emissions = lost product.
A fleet of trucks used to transport water and supplies to a hydrofracking site
CLEAN AIR ACT (CAA)

Standards to reduce harmful air pollution associated with oil and natural gas production and processing equipment

• EPA has a variety of regulations that set air emissions standards that apply to certain oil and gas production and processing

• New Source Performance Standards (NSPS) pursuant to CAA Section 111
  • Operational standards for well completions of hydraulically fractured natural gas wells
  • Designed to reduce volatile organic compound (VOC) emissions from gas wells, also reduce associated methane and hazardous air pollutant (HAP) emissions

• National Emission Standards for Hazardous Air Pollutants (NESHAP) issued pursuant to CAA Section 112
• New Source Review (NSR) permitting

• Requirements vary depending on whether drilling area is attainment or non-attainment for a given pollutant: attainment – must comply with Prevention of Significant Deterioration (PSD) program (CAA Sec. 165 et seq; 40 CFR Part 52.21; non-attainment – must comply with the nonattainment NSR (NANSR) program (CAA Sec. 171 et seq, 40 CFR Part 51.165).

• Major stationary source that constructs or undertakes major modification must obtain a permit for any pollutant which it emits in significant amounts (new construction) or for which the project results in a significant increase and a significant net increase (modifications)(CAA Sec. 165(a) and 40 CFR Part 52.21 (PSD); CAA Sec. 173 and 40 CFR Part 51.165 (NANSR)).

• Smaller sources and smaller changes may also be subject to minor source permitting requirements.
• General Duty Clause
  – CAA Sec. 112(r)(1) imposes a general duty on the facility to minimize and prevent an “accidental release”
  – Sec. 112(r)(2) defines “accidental release” as “an unanticipated emission of a regulated substance or other extremely hazardous substances into the ambient air from a stationary source

• Risk Management Program (RMP)
  – if HF facility stores more than a threshold quantity of a listed toxic or flammable substance, may be required to implement a chemical accident prevention program and submit a risk management plan (RMP) to EPA (CAA Sec. 112(r)(7)(B)
HAZARDOUS AND SOLID WASTES - RCRA

• Certain wastes generated uniquely in unconventional oil and gas drilling and production operations, such as drilling fluids, produced water and other wastes from exploration, development or production of natural gas, are exempt from management as hazardous waste (40 CFR Sec. 261.4(b)(5). Exempt waste may be regulated if mixed with non-exempt waste.

• § 7003 of the Resource Conservation and Recovery Act (RCRA) gives EPA the authority to address solid waste handling that may present an imminent and substantial endangerment to public health or the environment.
• Currently no regulations or proposed regulations specifically regulating unconventional oil and gas drilling under TSCA.

• On March 11, 2014, EPA released an Advance Notice of Proposed Rule Making (ANPRM) regarding chemicals and mixtures used in hydraulic fracturing. Begins a public process to seek input on information that should be reported and the mechanism for obtaining the information.

• TSCA Section 5 applies to all new chemicals, and requires manufacturers to notify EPA at least 90 days before beginning to manufacture or import a new chemical substance (15 USC Sec. 2604; 40 CFR Part 720).

• Significant new use rules can be issued for chemical substances already in commerce; require notice to EPA before engaging in new use (15 USC Sec. 2604; 40 CFR Part 721).
Generally, EPA can require persons to conduct or pay for response to releases of hazardous substances (CERCLA Sec. 106 and 107); hazardous substances excludes petroleum and petroleum products not specifically listed and natural gas (CERCLA Sec. 101(14); 40 CFR Part 302.4.)
Final Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources – Office of Research and Development (ORD)

- Congressionally directed study
- Focused only on hydraulic fracturing water life cycle

Purpose:
- To assess whether hydraulic fracturing can impact drinking water resources.
- To identify driving factors that affect the severity and frequency of any impacts.

- Analyzing existing data – two information requests
- Use of retrospective and prospective case studies
- Evaluate potential scenarios for water impacts

Results
- Final draft report for peer review and comment in 2014
Headlines from the *New York Times*:

- Experts Eye Oil and Gas Industry as Quakes Shake Oklahoma – Wastewater Disposal May Be Causing Rise in Temblors (12/13/13)
- California Plans Tighter Control of Fracking, but Not Enough for Some (12/14/13)
- Concern Over Safety Grows As More Oil Rides the Rails (1/3/14)
- Opposition Grows as Albany Port Becomes a Hub for Oil Shipping (2/28/14)
- China Takes on Big Risks In Its Push for Shale Oil – Effort to Gain Energy Independence Raises Safety, Health, and Pollution issues (4/12/14)
- Scientists See Quake Risk Increasing in Oklahoma (5/7/14)
- US Issues Safety Alert for Oil Trains (5/8/14)
- California’s Thirst Shapes Debate Over Fracking – Municipalities Move Against the Process As Concerns Grow Over Drought (5/15/14)
- Bill would ban waste from fracking – Senate hopes to defeat Christie’s opposition (Bergen Record 5/13/14)