An Overview of Hydraulic Fracturing

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ABSTRACT

This report outlines an overview of the hydraulic fracturing process, and its boom in production of natural gas in the United States. Hydraulic fracturing, or fracking, is a method used in mining for the production of natural gas and crude oil. These are two, valuable non-renewable, resources that the United States relies heavily on for producing power and electricity to the nations inhabitants. While regulations aim at protecting against release of wastewater into surface water sources, much more research is necessary to identify potential negative environmental impacts the process generates. This article provides an overview of the fracking process, hazards associated, regulatory requirements, and measures necessary for further action.

INTRODUCTION

Hydraulic fracturing, or fracking, is a method used in mining for the production of natural gas and crude oil. These are two, valuable non-renewable, resources that the United States relies heavily on for producing power and electricity to the nations inhabitants. Fracking is the process of drilling down into the earth to reach shale deposit formations, which contain hydrocarbons, and use water mixed with sand and chemicals at high pressure, to cause fissures in the shale, which releases these hydrocarbons, and can then be extracted for future use. Once a mine has been depleted of the product, the waste water used during the process is either injected back down the well and capped shut, or can be disposed of at private hazardous waste sites which can remove most of the waste, and return the water to a natural body. However, the injection method is the preferred method, which leaves millions of gallons of waste in the soil, where it has the potential to pollute waterways over time. While many people have differing opinions on the practice,

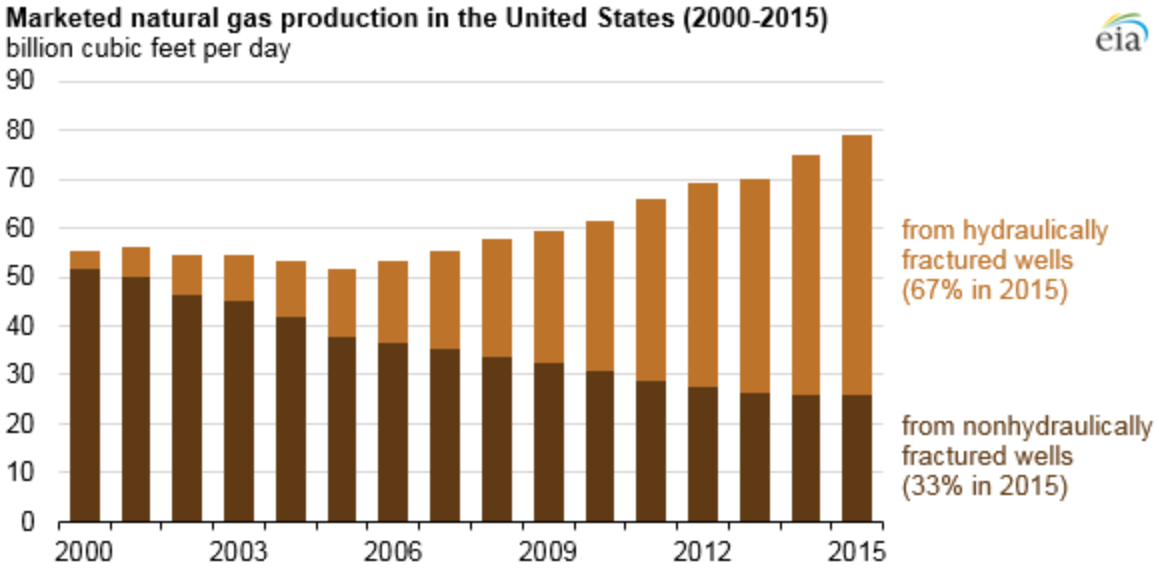
the recent boom in hydraulic fracturing operations raises concerns about the potential negative health effects from fracking, and the minimal regulatory guidance for the practice. In this report, hydraulic fracturing will be overviewed in detail, to provide information on current studies into fracking, potential health threats, and recommendations for minimizing the hazards associated with this process in the future of energy production.

OVERVIEW OF HYDRAULIC FRACTURING

The process of hydraulic fracturing originated in 1949, as a method for extracting natural gas and crude oil from shale deposits in the soil. This process involves using water with chemicals and solid particles added, to fissure shale rock formations underground under high pressure, to obtain these non-renewable resources. Though this process has been around for a long time, it has recently has seen a boom in production, which has led to more attention from various environmental groups. "Fracking is not a new process. It was initially developed in the 1940s to increase the production of oil reserves. The rate of fracking operations expanded significantly in the 1980s and through the 1990s to reach coalbed methane (CBM) deposits. The demand for natural gas, advancing fracturing technologies and federal tax credits for nonconventional energy production in the 1980s led to prominent growth in CBM, from fewer than 100 coalbed wells in 1984 to nearly 8,000 coalbed wells in 1990. The boom in CBM led to the use of hydraulic fracturing on other sources of fuel, such as shale gas. The Energy Information Administration (EIA), part of the U.S. Department of Energy (DOE), reports that production from shale formations is the fastest growing source of natural gas" (Callies, 2015).

Even with the increases through the 1980's and 1990's, the EIA reports that only 7% of all natural gas produced in the country was mined through hydraulic fracturing. "In 2000, approximately 26,000 hydraulically fractured wells produced 3.6 billion cubic per day (Bcf/d) of marketed gas in the United States, making up less than 7% of the national total. By 2015, the number of hydraulically fractured wells had grown to an estimated 300,000, and production from those wells had grown to more than 53 Bcf/d, making up about 67% of the total natural gas output of the United States" (EIA, 2016). This can be seen visually in figure 1.

(Figure 1)



Source: U.S. Energy Information Administration, based on IHS Global Insight and DrillingInfo Inc.

As the graph shows, in 15 years, hydraulic fractured wells went from 7% of the total production of natural gas, to 67%, which has also led to an increase in the total production of natural gas.

The problem with hydraulic fracturing is that it generates waste, a lot of waste. Conventional mining methods don't require water, but hydraulic fracturing does, and it requires substantial amounts of the resource. "In addition, from 2000 to 2014, median annual water volume estimates for hydraulic fracturing in horizontal wells had increased from about 177,000 gallons per oil and gas well to more than 4 million gallons per oil well and 5.1 million gallons per gas well" (USGS, 2015). Oftentimes, this waste water is reused, and then injected back into the site when mining is done in that location, leaving millions of gallons of contaminated water in the soil. But why is this method being used, when conventional methods worked for so long? As conventional methods of mining exhausted larger resource deposits, going into the 2000's, natural gas prices started to rise. In 2000, natural gas prices were at 2.50 USD/MMBtu, and peaked in 2006 at about 14 USD/MMBtu. This increase in price made hydraulic fracturing more economical to producers, as the fracking process costs more than conventional mining methods.

The waste generated from the water contaminated with chemicals added during the fracking process is the main concern with this industry. Common practice for the wastewater is to inject it back into the well, and seal it off, leaving millions of gallons of gas in the soil to permeate, and the subsequent toll of water consumption on local water tables. While regulations governing this waste water exists, there is little science, nor enough information on the additives, to assess potential environmental impacts of this process. However, regulations governing some fracking locations require submittal of chemicals that the site is adding to the water, and this listing contributes to a totaled listing for the industry, and is even ranked by most common chemicals used throughout the industry. While companies are not required to disclose the concentration of the

chemical they are using as it can be classified as a trade secret, they do identify the chemical, and the list is very large throughout the industry. Chemicals such as ethylene glycol, hydrochloric acid, glutaraldehyde, and methonal are just 4 of the many chemicals commonly used (Fracfocus.org). These chemicals can be very hazardous to health in varied quantities over varied amounts of time, and they are present in many of the injection sites at these wells, when the wastewater is sent back underground before sealing a location off.

Regulations governing this process have begun to surface more at state levels, than federal levels, and most focus on the storage of the wastewater generated during the fracking process.

REGULATORY REQUIREMENTS

Since the boom of hydraulic fracturing in the United States, efforts have begun to further study the possible negative environmental effects associated. A report by the EPA, Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report), potential hazards from the fracking process are identified:

 “Water withdrawals for hydraulic fracturing in times or areas of low water availability, particularly in areas with limited or declining groundwater resources;

 Spills during the handling of hydraulic fracturing fluids and chemicals or produced water that result in large volumes or high concentrations of chemicals reaching groundwater resources;

 Injection of hydraulic fracturing fluids into wells with inadequate mechanical integrity, allowing gases or liquids to move to groundwater resources;

 Injection of hydraulic fracturing fluids directly into groundwater resources;

 Discharge of inadequately treated hydraulic fracturing wastewater to surface water; and

 Disposal or storage of hydraulic fracturing wastewater in unlined pits resulting in contamination of groundwater resources" (EPA, 2016).

This helps environmental groups narrow their focus of research, to further research in those particular areas. Due to the Clean Water Act, this waste cannot be dumped into surface water sources. "The Safe Drinking Water Act's (SDWA) Underground Injection Control (UIC) program sets requirements for proper well siting, construction, and operation to minimize risks to underground sources of drinking water. The Energy Policy Act of 2005 excluded hydraulic fracturing, except when diesel fuels are used, for oil, gas or geothermal production from regulation under the UIC program" (EPA, 2016). The Resource Conservation and Recovery Act has regulations for hazardous waste, but waste from fracking is exempt, and instead classified an non-hazardous waste. While there is some regulation against this waste, most of the regulatory power is reserved for each state to develop. In the state of Michigan, specific measures regulating the storage of wastewater from fracking while it is being reused in the process under Part 615, Supervisor of Wells, of the Natural Resources and Environmental Protection Act, Public Act 451 of 1994. "Some specific protective measures in Michigan's rules include:

- Confirmation that there will not be an adverse resource impact to the local hydrology due to a large volume water withdrawal associated with HVHF; Michigan rules require additional monitoring and further approval through Michigan's Water Withdrawal Assessment Tool (WWAT).

- Requiring that operators conduct sampling of area water wells to establish baseline water quality and provide additional assurance that water quality is not impacted from development activities
- Requiring operators to disclose the chemical additives through the nationwide FracFocus Chemical Disclosure Registry and conduct baseline sampling of nearby water wells.
- Requiring that all flow back and produced fluids to be properly contained. In Michigan, this means steel tanks with secondary containment. Open pits storage of these fluids is prohibited. These fluids are ultimately disposed in deep injection wells that are permitted specifically for that purpose and are protective of fresh water resources" (Michigan DEQ, 2015)

These regulations mainly aim toward preventing exposure to surface water, and not on the actual prevention of potential pollution in the future. But to obtain regulatory requirements against the wastewater in this process, more research over the longitudinal effects of fracking are needed.

CONCLUSION

Hydraulic fracturing has come into the spotlight within the past 10 years, as concerns grow over the significant rise of the process. While voter opinion largely effects legislation toward regulation, public opinion is largely divided. In the report, "Fracking" controversy and communication: Using national survey data to understand public perceptions of hydraulic fracturing, by Hilary Boudet, the author examines public perception of the topic. "Similar to findings on other emerging technologies, our results suggest limited familiarity with the process and its potential impacts and considerable

uncertainty about whether to support it. Multiple regression analysis (r^2=.49) finds that women, those holding egalitarian worldviews, those who read newspapers more than once a week, those more familiar with hydraulic fracturing, and those who associate the process with environmental impacts are more likely to oppose fracking. In contrast, people more likely to support fracking tend to be older, hold a bachelor's degree or higher, politically conservative, watch TV news more than once a week, and associate the process with positive economic or energy supply outcomes" (Boudet, 2014). Awareness and understanding of the issue are great factors in creating an educated opinion about the hydraulic fracturing process. Research identifying the negative effects and their impact are necessary to create enough social impact to create legislation toward further regulatory requirements. While continued research could lead to better understanding of these hazards associated with fracking, much broader ambitions could lead to a reduction in the need for hydraulic fracturing. Moving energy production to more green and sustainable methods such as, wind, and solar energy production, would require a reduced dependence on non-renewable energy sources, requiring less production of these resources, leading to fewer fracking sites.

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