Hydraulic Fracturing and its Impact on Environment and Human Life

Abhishek Anand
Department of Petroleum Engineering,
Aditya Engineering College, Andhra Pradesh, India.

Mohammed Yasser Arafath Khan
Department of Petroleum Engineering,
Aditya Engineering College, Andhra Pradesh, India.

Abstract- Hydraulic fracturing is a controversial oil and gas extraction technique developed in the late 1940s to gain access to fossil energy deposits previously inaccessible to drilling operations. Hydraulic fracturing also known as fracking has played an important role in America's oil and natural gas production for the past 60 years. Roughly 35,000 wells are estimated to be processed with the hydraulic fracturing method. Natural gas consists of mainly methane and ethane, while butane and propane make up the remaining elements. The process," hydraulic fracturing" literally involves the smashing of rock with millions of gallons of water–along with sand and a undisclosed assortment of chemicals in order to bring gas to the surface. The exploration and exploitation of unconventional gas deposits especially as it involves hydraulic fracturing has been generating intensive public discussion. Such discussion has focused especially on the potential impacts on the environment which includes land use, noise pollution, air emissions, water consumption, water contamination, risk of secondary accidents, and health effects. Governments are attempting to forge policies to manage risk, working under pressure from industry on the one hand, and from anti-fracking groups on the other. Advances in technology have enabled companies to pursue hydraulic fracturing on a commercial level.

Keywords: Hydraulic Fracturing, Anti-fracking,

I. INTRODUCTION

In 1947 hydraulic fracturing was used for the first time to extract natural gas. Two years later the Halliburton Oil Well Cementing Company performed the first two commercial hydraulic fracturing treatments. As the fracturing process evolved opinions have varied on whether the benefits outweigh the negative consequences. The technique of hydraulic fracturing was initially conceived to restore and increase the rate at which water, natural gas, and petroleum is recovered from natural reservoirs. For many years the United States has been highly dependent upon foreign countries to meet its energy needs. Americans spend approximately $632 billion a year on oil alone requiring the United States to import 10.6 million barrels of petroleum products per day. This dependence on other countries to meet their energy needs has caused concern among U.S. stakeholders. However, large discoveries of shale gas reserves in the United States have begun to change the country's energy outlook. Natural gas consists of mainly methane and ethane, while butane and propane make up the remaining elements. Advances in technology have enabled companies to pursue hydraulic fracturing on a commercial level. With the advent of hydraulic fracturing, two polarizing sides have formed. One side argues for the positive economic benefits that hydraulic fracturing can produce. The other side claims that the negative environmental impact of hydraulic fracturing is unacceptable. There is worldwide concern over the possible adverse implications of hydraulic fracturing activity.

In June 2004 the EPA reported that fracking fluids are toxic and traces of toxicity remain in the ground after hydraulic fracking is completed. This finding supports proponents' arguments that properly controlled fracking activities can limit environmental impact.

In January 2012, President Barack Obama voiced his support for natural gas extraction.
Both sides of the argument continue with proponents arguing for the positive attributes of fracking and critics claiming that the dangers of fracking outweigh the benefits.

Although as of 2013 there is little evidence from which to draw a conclusion intensive
research is underway to ascertain whether there are impacts on a number of health conditions.

II. PROCESS OF HYDRAULIC FRACTURING

Through the development of innovative techniques drilling companies have developed new technologies to access trapped oil and gas located within the earth's core. Newer techniques are attempting to reduce surface footprints when drilling. Based on geologist research a site with abundant shale formations far underground is chosen. Drillers then drill a well bore using a drill pipe and bit. Drilling mud is pumped down into the pipe to lubricate and cool down the drill bit. In addition the mud aides in the stabilization of the pipe preventing it from collapsing. After the appropriate distance has been chosen (approximately 5,000 feet) the drill pipe and bit are removed and a steel tube known as a "surface casing" is placed inside the well. This tube helps stabilize the well sides and reinforces the barrier between liquids outside the well such as drinking water and the fracking fluids inside the well. This barrier is reinforced with cement sealing off the well. After the cement sealing is complete the pipe is pressure tested to ensure that no outside materials enter the pipe and no fracking fluid leaves the pipe. The drill pipe and bit are again lowered down. A special drill piece is added enabling the drill to continue its path horizontally.
Once the desired horizontal distance has been reached the drill pipe and drill bit are removed from the well.
A perforating tool is inserted down the well to create holes within the shale layer for hydro-carbons to enter the well stream. After the perforating tool has been removed fracking

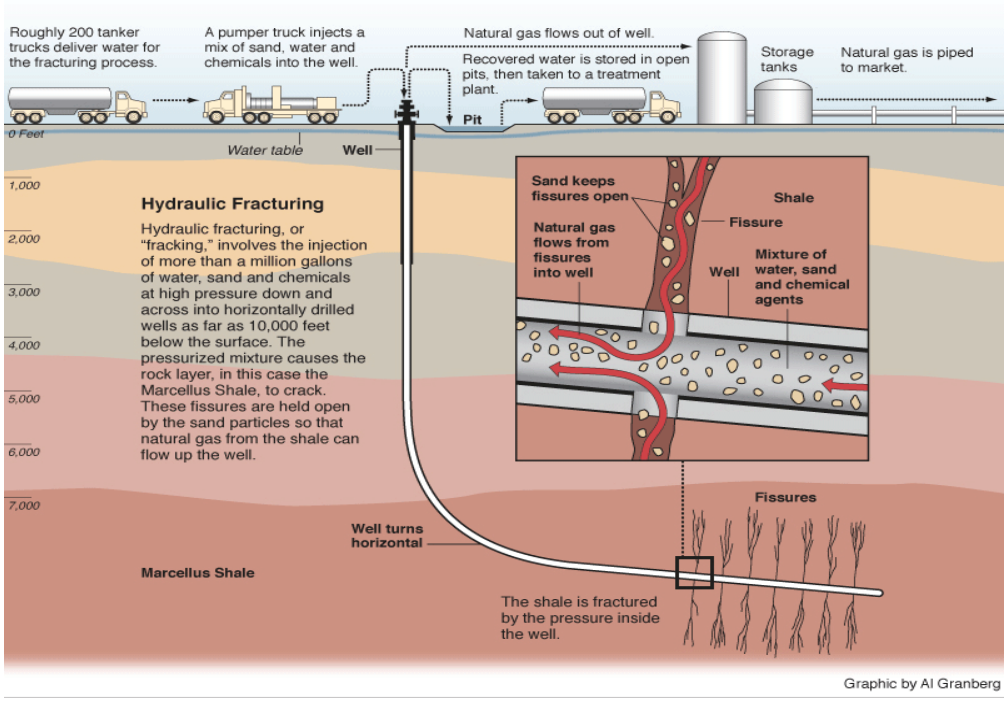

Fig. 1: Process of Hydraulic fracturing

Fluid is pumped into the well. This fracking fluid is made up of water, sand, and other chemical ingredients which create tiny fractures within the shale allowing gas to escape through the well. Afterward the plugs are removed and the gas can flow from the depths of the well to the top where it is gathered, stored, and made ready for transport.

III. THE CONTROVERSY OF HYDRAULIC FRACTURING

Fracking has recently come under heavy scrutiny largely from environmental groups and politicians. On the other hand many communities welcome fracking sites to their communities because of the benefits associated with them. Fracking produces natural gas, creates jobs, generates revenue, lowers energy costs, and creates overall economic growth. The following section will discuss some of the major benefits and potential disadvantages of hydraulic fracturing.

BENEFITS OF HYDRAULIC FRACTURING

Fracking is contributing significantly to natural gas production, increasing it to its highest point since 1993. In 2011 production exceeded 8.5 million cubic feet of natural gas. This production is only increasing and has helped contribute to lower energy prices. The additional natural gas has directly contributed to record low natural gas prices by increasing supply. It has also allowed the United States to continue toward a path of energy self-sufficiency and economic growth. Since the aggressive expansion of fracking the United States is now the world's second leading producer of natural gas, behind Russia. Fracking has contributed to thousands of jobs, and since 2003, 80,000 new jobs have been created. This represents a 67 percent increase in the oil and gas industry. Beneficiaries of fracking include states such as Pennsylvania and North Dakota in fact North Dakota now enjoys the lowest unemployment rate in the United States at 3.3 percent. Greater jobs lead to higher disposable incomes and benefits in other areas of the economy. For example, North Dakota luxury car dealers have experienced record sales in the past couple of years. Fracking has also been responsible for billions of dollars in new revenue generation, including tax revenue. As mentioned earlier, this additional revenue has helped local, state, and federal government revenue generation.

Fracking has contributed to multiple indirect economic and environmental benefits as well. Since the increase in natural gas production, coal energy has begun to decline. This decline in coal burning leads to a decline in carbon dioxide (CO2) emissions as well. Natural gas is estimated to produce approximately half of the CO2 of coal. Natural gas is also cleaner than coal because it releases less sulfur dioxide, nitrogen oxide, and mercury emissions. Although fracking uses chemicals, these chemicals constitute about 0.5 percent of the drilling fluid.

Many energy companies claim that they try to ensure environmental safety at all of their fracking sites. They exert precautions and are sometimes able to recycle the contaminated water used for the fracking process. Additionally the chemicals for fracking are used to minimize the fractures in the underground well sites and seal off the natural gas from clean water sites.

NEGATIVE ATTRIBUTES OF HYDRAULIC FRACTURING

The environmental impact of hydraulic fracturing includes land use, noise pollution, air emissions, water consumption, water contamination, induced seismicity or micro earthquakes risk of secondary accidents and health effects. Governments are attempting to forge policies to manage risk, working under pressure from industry on the one hand, and from anti fracking groups on the other.

a) Noise pollution- Each well pad (in average 10 wells per pad) needs during preparatory and hydraulic fracturing process about 800 to 2,500 days of noisy activity, which affect both residents and local wildlife. In addition, noise is created by transport related to the hydraulic fracturing activities.

b) Air emission- The main hydraulic-fracturing-related air emissions are methane emissions from the wells during fracturing and emissions like diesel fumes and other hazardous pollutants, ozone precursors or odours from hydraulic fracturing equipment, such as compressors, pumps, and valves. Whether natural gas produced by hydraulic fracturing causes higher well-to-burner emissions than gas produced from conventional wells is a matter of contention.

c) Water consumption-Hydraulic fracturing uses between 1.2 and 3.5 million US gallons (4,500 and 13,200 m3) of water per well with large projects using up to 5 million US gallons (19,000 m3). Additional water is used when wells are refractured. An average well requires 3 to 8 million US gallons (11,000 to 30,000 m3) of water over its lifetime. According to the Oxford Institute for Energy Studies greater volumes of fracturing fluids are required in Europe, where the shale depths average 1.5 times greater than in the U.S. Concern has been raised over the increasing quantities of water for hydraulic fracturing. Use of water for hydraulic fracturing can divert water from stream flow, water supplies for municipalities and industries such as power generation as well as recreation and aquatic life. It converts water into wastewater taking this water out of the water cycle and the possibility of further use, except in hydraulic fracturing itself after recycling. The Environmental Protection Agency (EPA) and United States Geological Survey (USGS) have recently confirmed what residents of Pavillion, Wyoming had been claiming that hydrofracking had contaminated their groundwater.

d) Surface spills- Surface spills related to the hydraulic fracturing occur mainly because of equipment failure or engineering misjudgments. Volatile chemicals held in waste water evaporation ponds can to evaporate into the atmosphere, or overflow. The runoff can also end up in groundwater systems. Groundwater may become contaminated by trucks carrying hydraulic fracturing chemicals and wastewater if they are involved in accidents on the way to hydraulic fracturing sites or disposal destinations.

Fig.2: Air Emission

Fig.3: Soil and Oil Spill Contamination

According to journalists at Pro Publica, oil companies reported over 1,000 oil spills in North Dakota 2011, with many more going unreported, state officials admit. An ExxonMobil pipeline rupture spilled 42,000 gallons of oil into the Yellowstone River, near Billings, MT. In the aftermath of the spill ExxonMobil has disclosed that the pipeline has been transporting tar sands oil from Alberta, Canada, which is a low grade, more toxic and corrosive type of oil. Regulators had not been informed that the pipeline was carrying tar sands oil and the disclosure was a result of the spill. Tar sands oil was not in the pipeline at the time of the spill though regulators are investigating whether or not it played a role in causing the pipeline to corrode.

e) Injected fluid- Hydraulic fracturing fluids include proppants, radionuclide tracers, and other chemicals, many of which are toxic. Hydraulic fracturing fluids may cause contamination both as it is injected under high pressure into the ground and as it returns to the surface. To mitigate the effect of hydraulic fracturing on groundwater, the well and ideally the formation itself should remain hydraulically isolated from other geological formations, especially freshwater aquifers.

f) Land uses- Significant amount of land is used during hydraulic fracturing. About 3.6 hectares (8.9 acres) is needed per each drill pad for surface installations. During re-fracturing additional land is used. In total about 1.4% of land above gas reservoir is needed for its full extraction. This is a potential risk in high-density areas. It may not be possible to fully restore the surface area after completion of works.

g) Seismology- Hydraulic fracturing causes induced seismicity called micro-seismic events or micro-earthquakes. These micro-seismic events are often used to map the horizontal and vertical extent of the fracturing. The magnitude of these events is usually too small to be detected at the surface, although the biggest micro-earthquakes may have the magnitude of about -1.5 (Mw). However, as of late 2012, there have been three instances of hydraulic fracturing, through induced seismicity, triggering quakes large enough to be felt by people: one each in the United States, Canada, and England.

h) Health risk- There is worldwide concern over the possible adverse public health implications of hydraulic fracturing activity. Although in 2013 there is little evidence from which to draw a conclusion intensive research is underway to ascertain whether there are impacts on a number of health conditions.

In June 2014 Public Health England published a review of the potential public health impacts of exposures to chemical and radioactive pollutants as a result of shale gas extraction in the UK based on the examination of

literature and data from countries where hydraulic fracturing already occurs. Most evidence suggests that contamination of groundwater, if it occurs is most likely to be caused by leakage through the vertical borehole. Contamination of groundwater from the underground hydraulic fracturing process itself (the fracturing of the shale) is unlikely.

A 2013 review found that hydraulic fracturing technologies are not free from risk of contaminating groundwater and described the controversy over whether the methane that has been detected in private groundwater wells near hydraulic fracturing sites has been caused by drilling or by natural processes. Due to the multitude of potential health and environmental impacts of hydro-fracking source contamination can be complicated. The well location where drilling takes place is only one piece of the frack puzzle. Since each well can require up to 8 million gallons of water, and up to 40,000 gallons of chemicals, a well site may need up to 2000 tanker truck trips per frack. A well can be fracked up to 20 times.

A 2011 article in the journal, Human and Ecological Risk Assessment, examined the potential health impacts of oil and gas drilling in relation to the chemicals used during drilling, fracking, processing, and delivery of natural gas. The paper compiled a list of 632 chemicals (an incomplete list due to trade secrecy exemptions) identified from drilling operations throughout the U.S. Their research found that 75% of the chemicals could affect the skin, eyes and other sensory organs, and the respiratory and gastrointestinal systems. Approximately 40–50% could affect the brain/nervous system, immune and cardiovascular systems, and the kidneys 37% could affect the endocrine system and 25% could cause cancer and mutations.

Health impacts from fracking are only now being examined by health experts since such large-scale drilling is a recent phenomenon. Exposure to toxic chemicals even at low levels can cause tremendous harm to humans the endocrine system is sensitive to chemical exposures measuring in parts-per-billions, or less. Nevertheless many of the health risks from the toxins used during the fracking process do not express themselves immediately, and require studies looking into long-term health effects. Despite the complexities of the on-site mixtures of chemicals and their specific contributions to health and environmental problems involved in fracking conventional drilling practices are more old school and do have known health consequences. Researchers at the Colorado School of Public Health University of Colorado, analyzed existing research of exposure to conventional petroleum hydrocarbons in occupational settings, and residences near refineries, in conjunction with known pollutants associated with fracking (nonconventional), in order to assess health risks to those residents living near fracking operations. Their basic conclusions were: the closer you live to drilling operations the greater your health risk. Sounds obvious but if you were to sue an oil company for the suspected killing a loved one via cancer you would need a little more legal ammunition than "it just makes common sense" against an army of corporate lawyers.

Although the Centers for Disease Control and Prevention (CDC) has yet to investigate the potential impacts of fracking the director of CDC's National Center for Environmental Health and the agency for Toxic Substances and Disease Registry, Christopher J. Portier, PhD, has called for health studies to be published. A 2012 paper was published in the journal, Environmental Health Perspectives, examining the composition of state and federal advisory committees tasked to consider the potential environmental and health effects of fracking in the Marcellus shale region. The researchers found that there was not one health expert among the 52 people comprising the various state and federal commissions and boards even though public health was specified in the executive orders creating the committees.

IV. PREVENTION OR MITIGATION

While many state agencies function more as facilitators of fossil energy development than regulators, federal guardians of public health are also vulnerable to 'getting into bed' with big business, literally. One need only recall the former federal agency in charge of collecting oil and gas royalties on public lands the Minerals Management Service. Many people concerned by nonconventional oil and gas drilling would prefer the US adopt the so-called precautionary principle, which places the burden of proof on industries implementing new technologies and introducing new chemicals into our neighborhoods and environment. If your actions do not poison the water accelerate climate change cause cancer to those living near drilling and refineries. Current policy inverts such logic instead forcing the victim (or their surviving relatives) to get into a legal fight with some of the richest and most politically powerful companies.

At a minimum more stringent regulations should be passed at the national level including repeal of oil and gas exemptions from the Safe Drinking Water Act. Violators of clean water and air laws should be prohibited from obtaining federal and state land drilling leases. Flaring of natural gas should be more strictly regulated. If a carbon tax were to be passed energy companies would no longer get away with passing their so-called externalities (pollution) on to the community, tax payer or environment. Another approach would be the adoption of a legitimate national energy policy that is comprehensive in scope and science-based, as opposed to the current singular focus on short-term profits. Something more in line with what is occurring in Germany–where they have increased clean energy use from 6% in 2002, to 26% in 2012. A clean energy policy propelled by sophisticated technologies that require skilled workers could replace the third world fossil energy model en vogue these days. The spector of climate change makes the acclerated pursuit of carbon based fuel an irrational policy predicted to be far more expensive than the initial costs required to switch to clean energy technologies.

V. CONCLUSION

The controversy over fracking is not likely to be solved anytime soon. While proponents point out the economic benefits of hydraulic fracturing, opponents are quick to highlight the possible environmental dangers. Regulatory authorities have gotten involved as well. Some states and even countries have banned fracking because of the potential health and environmental dangers. The EPA is investigating the consequences of fracking and has set some regulations for fracking activities.

However, the newness of hydraulic fracturing means that there is not a clear consensus on its long-term impact. Although fracking has technically been used for 60 years, it is only recently that it has received much public attention. It is important for both businesses and regulatory authorities to monitor fracking activities continually to ensure that it is not creating significant health and environmental harm. Drilling companies can also take the lead in ensuring that best practices are implemented including investigating more eco friendly methods and supporting communities close to drilling sites. Companies that take a proactive stance in investigating, monitoring, and improving hydraulic fracturing can gain a good reputation and a competitive advantage, particularly in the face of proposed regulations impacting the industry.

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