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The health impact of fracking: occupational risks

Abstract

This is an in-depth investigation into the environmental, social and occupational health impacts of the fracking industry. Hydraulic fracturing, or fracking, is the process of injecting mass quantities of pressurized liquid into an underground well to recover natural gas. Although this form of natural resource extraction originated in the late 19th century, hydraulic fracturing has greatly expanded since the dawn of the 2000s.[1] Included is a summary of the legal and economic background behind natural gas extraction, an analysis of the chemicals used in the injection process and a review of current control measures, occupational risks and regulations.

Keywords: permian;, fracking, polyacrylamide, geophysical research, cincinnati arch, pipelines, hydrocarbons, organisms, creatures, combusted, Pennsylvania, health impact

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Industry & manufacturing process of fracking

Millions of years ago, plants and organisms living in sea basins absorbed solar energy and stored it within their bodies as carbon. As time progressed, these creatures would expire and become buried deeper and deeper into the ocean floor. With the increase in depth and decomposition came an increase in intense heat and pressure which converted the stored carbon into oil and natural gas. A portion of these fossil fuels traveled to the earth's surface while the rest remained trapped in the subterranean layers of shale and stone. If released, the energy from the natural gas can be combusted to produce electricity.[1,2]

Natural gas shale basins are found all across the globe. While the United States contains a significant portions of this fossil fuel; China, Argentina, Mexico, Canada, South Africa and Australia hold noteworthy amounts. However, North America is leading the world in the extraction of shale gas. The seven major shale plays in the United States are the Bakken, Eagle Ford, Permian, Marcellus, Anadarko-Woodford, Granite Wash and Niobrara. Heavily fracked states include: New York, Texas, Pennsylvania, West Virginia, Ohio, Colorado, Wyoming and North Dakota among others.[2]

Hydraulic fracturing, or fracking, is the process of injecting mass quantities of pressurized liquid into an underground well to recover natural gas. This liquid, which is composed of water, sand and additional chemicals, travels deep into the earth through vertical and horizontal pipes until it reaches the targeted shale formation containing the fuel. Horizontal pipes were first used in the 1990s to increase the natural gas flow. The pipes, which travel thousands of feet into the earth, are constructed with concrete to prevent fluid leakage. This chemical mixture creates and enlarges fractures within the rock, unlocking the trapped natural gas. After the fuel is extracted from the ground it is shipped to a gas plant where it is then purified to remove any moisture, sulfides, hydrocarbons and other contaminants. Pipelines transport the cleaned natural gas to power plants for use and the generation of electricity[3] (Figure 1).

The idea of using liquid to stimulate relatively shallow rock layers began in the 1860s. Acid was first injected into wells in the 1930s. It was successful in increasing the natural gas flow. The first company to begin hydraulic fracking in commercial industry was Halliburton in 1949. Technology was much different than it is today and thus, the shale formations used were already loose. In the 1970s the Department of Energy conducted a thorough research study to explore unconventional natural gas resources. Vertical wells were primarily used up until the 1990s when companies began drilling horizontal wells in order to maximize natural gas flow. In 2004 the United States Environmental Protection Agency declared that a portion of the toxic fracking fluid remains in the ground after the completion of a job, do not pose a threat to the drinking water (EPA)[4] (Figure 2).

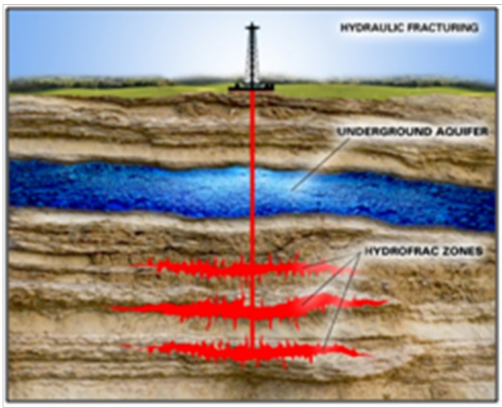

Figure 1 Initiative 2013: The effects of hydraulic fracturing on communities. n.d.

Figure 2 The history of fracking (a timeline). n.d. photograph. n.p.

The fracking liquid is a combination of water, sand and chemical additives. Typically, the water base comprises 90-95 percent of the fluid. A single well requires between 1 and 8million gallons of water per fracking job. All of the hydraulic fracturing in the United States collectively requires over 40billion gallons of water. Water cannot be used alone in fracking because it would remain in the rock layer without cracking the shale. The sand, which accounts for 4- 9 percent of the mixture, is used as a proppant, keeping the fissures open so that the gas has porous space to flow out of the rock and into the well. Silica sand is used quite often however; other sands and ceramics are also used such as fused bauxite beads which are very crush resistant. Without an adequate amount of sand, the fractures would close up as soon as the pressured injection process concluded and the gas would remain trapped below the earth's surface. Single wells can require several thousand tons of sand (between 75,000 and 320,000 pounds) to successfully operate. Frac sand is unique in that it is large in size and has durable rounded edges. The intense demand for frac sand has created another environmental concern and negative side effect of fracking, sand mining[5] (Figure 3).

Figure 3 Fracking fluids. n.d. photograph. energy from shale.

Currently, companies are not legally mandated to release the recipe of their fracking recipe, creating quite a challenge when assessing the risks associated with the concoction. The chemical components vary depending on if the fluid needs to be gel-like, foam-like or slick. Although, the chemical portion of the mixture accounts for the least volume, approximately 0.5-1 percent, around 40,000 gallons are needed per fracking job. Each company has a unique combination of 5 to 10 ingredients that can be protected under the federal trade secret exemption. However, several studies have been conducted to analyze the fluid and identify 600 potential chemicals. The list includes formaldehyde, acids, benzene, ethyl benzene, toluene, polyacrylamide, sodium chloride, guar gum, glutaraldehyde and Polyacrylamide. Acids are present in order to commence the fissure process and to dissolve carbonate minerals and debris such as cement. Polyacrylamide reduces the abrasions between the liquid and pipe. Guar Gum is needed to thicken the water and enable the suspension of the frac sand. Sodium chloride helps break down the gel polymers. Glutaraldehyde is needed to kill corrosive bacteria in the liquid. The hydrocarbons, ethyl benzene, toluene, benzene (a known human carcinogen) and xylene are very hazardous chemicals to work with due to their potential for water contamination and adverse health effects.[5]

Why are there not harsh regulations for fracking operations? Contained within the Energy Policy Act of 2005 there is a loophole known as the "Halliburton Loophole". This allows hydraulic fracking companies exemption through the Underground Injection Control program. The only fracking fluid that is currently regulated by the EPA is the fluid that contains diesel fuel. According to the Congressional Committee on Energy and Commerce's Report, from 2005-2009 32million gallons of diesel fuel have been used as fracking fluid. The Safe Drinking Water Act designates regulatory power for fracking operations to the states unless diesel fuel is involved. Although this fuel is very unsafe for the environment, it is not currently banned. Underground Injection Control Class II EPA permits are required to allow the use of diesel in the fracking industry.

The Safe Drinking Water Act was passed in 1974 by Congress in an attempt to keep hazardous materials out of underground water sources. However, the EPA deemed hydraulic fracking exempt from the Act since their primary intent is to extract natural gas, not inject the toxic fluid into the ground. In 2005 the Energy Policy Act exempted the fracking industry from not only the Safe Drinking Water Act but also the Clean Water, Clean Air Act and Comprehensive Environmental Response Compensation and Liability Act or the Superfund Act. The EPA began a study in 2011 to assess the "Potential Impacts of Hydraulic Fracturing on Drinking Water Resources". The study is expected to be completed by 2014 (USEPA) (Figure 4).

Figure 4 Energy policy act of 2005. n.d photograph. n.p.

After the pressurized injection step is completed, the resulting fluid mixture is called produced water, or flow back, which resurfaces through the well. The flow back, which can be potentially devastating to the environment, contains the chemicals that were initially present in the fracking concoction as well as naturally occurring brines, toxic metals, hydrocarbons and radio elements. The fluid can be recycled for future fracking projects, treated and discharged to surface water, or disposed. In Pennsylvania, 70 percent of the fluid used to fracture the Marcellus Shale is being recycled for multiple uses. Disposal is a common option where the wastewater is buried deep into the earth's surface. When "cleaning" the fluid for release back into the environment, typical municipal waste treatment plants are not adequate for the job. Due to the chemicals found in flow back, brine treatment plants must be used to treat the water.[6]

The upside to fracking

According to the US Energy Information Agency, there is over 750 trillion cubic feet of natural gas that is trapped in the shale beneath the earth. The majority of this gas can be accessed through hydraulic fracturing and if recovered it could provide the US with energy for the next 100years. With fracking, the US will be able to domestically produce natural gas providing stability and more affordable energy prices. As of 2010, approximately 435,000 people in the US were employed in the gas and oil extraction industry. It is estimated that within the next 12years, fracking will contribute 132billion dollars to the United States economy and create 1million new jobs.[7]

Up until the mid 1980s the US production and consumption of natural gas was balanced. Throughout the next couple of decades we relied heavily on foreign imports of natural gas, especially from Canada. Five years into the 21st century the United States began extensive fracking production, providing more independence from foreign commerce. As a result, US natural gas prices have recently hit all time lows. Natural gas usage is increasing as the price is decreasing. In 2011, natural gas was the source of 25 percent of the energy in the United States. As more and more electric customers are switching to natural gas their bills are subsequently decreasing. Natural gas is not only critical for the generation of electricity but it is also used as raw material in the production of things such as medicines, explosives, fertilizers, plastics and paints. As of September 2012, approximately 35 percent of the natural gas in the US was produced by hydraulic fracturing[7] (Figure 5).

Figure 5 A few days of fracking, decades of oil and gas production. n.d. photograph n.p

The movement towards natural gas has a positive effect on the environment and climate change, the reduction in carbon dioxide emissions. On average, coal emits two times the amount of carbon as natural gas does per unit electricity generated. In addition, the emissions of other greenhouse gases such as sulfur dioxide have lowered due to the reduction of productivity from coal fired power plants. The benefits of fracking are realized for decades after the initial site construction. The timeframe of initial construction lasts between 50 and 100days while the actual fracking procedure lasts only 2 to 5days. Several months of work equate to 20 to 40years of natural gas production from each well.[7]

Risks associated with fracking

Although hydraulic fracking can potentially provide economic growth, job creation and clean energy, there is another side to the fracking industry. When extracting natural gas, methane and carbon dioxide are released into the environment. Both are greenhouse gases that contribute to global climate change. Releasing methane also creates the potential for explosions.[6] Running a hydraulic fracking procedure requires an extensive portion of water. Each well needs millions of gallons of water to operate (between 2 and 5million). This can create stress on community fresh water sources. The chemicals in the fracking fluid can contaminate drinking water. The pipes that travel deep into the earth pass the ground water table, if leakage occurs the fresh water source is in danger. One study reported that in wells near a fracking site the drink water contained 17 times more methane than in average wells .[6]

Disposal of the fracking fluid creates many concerns for the environment. At first, the idea of injecting the brine water back into deep wells may seem like a harmless idea. However, in several instances this treatment has resulted in small earthquakes. One example of this phenomenon is in Youngstown, Ohio, a town located above the Marcellus Shale. Research on the town's geology goes back as far as 1776. From 1776 until 2011 there has never been a recorded earthquake in Youngstown. In late 2010, an injection well called the North star 1 was constructed in Youngstown to pump flow back water into the earth from fracking in Pennsylvania. In the year that followed there were 109 detected earthquakes. The well was shut down after a 3.9 magnitude quake on December 31, 2011, a year after the opening of North star 1. The journal Geophysical Research Letters, confirmed that the geological activity in this Ohio town was in fact due to the injection well. This is not an isolated incident; earthquakes in Texas and Oklahoma have also been linked to injection wells. However, all injection wells have not been known to stimulate earthquakes. It has been stated that these quakes resulted from the placement of the injection well close to a fault line[8] (Figure 6).

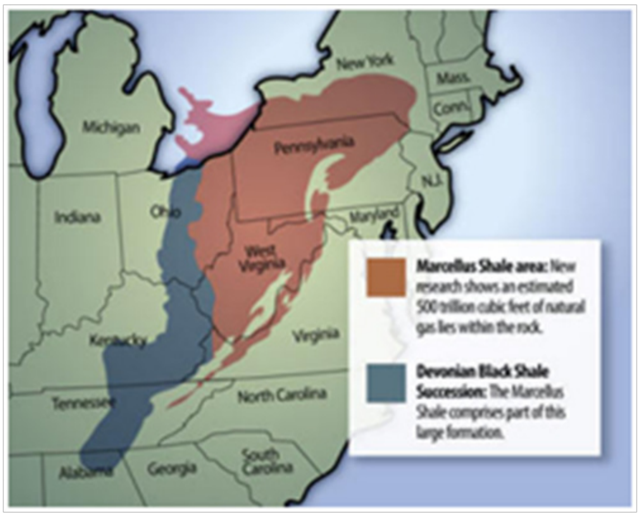

Figure 6 The marcellus shale – America's next super giant. n.d. photograph. catskill mountain keeper.

Recent controversy exists in Cincinnati over the disposal of fracking fluid. There is a proposal to begin transporting flow back from wells in Pennsylvania down the Ohio River via barges in order to find dumping sites. This is a very worrisome idea due to the potential for contamination of the waterway which provides drinking water to millions of people. Another proposed idea is to inject the wastewater into the places like the Cincinnati Arch. The sandstone is southwest Ohio is optimal for disposal because of its proximity to the earth's surface.[9]

The chemicals used in the fracking fluid can be lethal to the human, plant and animal populations. Not only are they released to the environment through polluted water but by air pollution as well. Estimates claim that over 25 percent of the chemicals present in fracking have been linked to cancer and birth defects. As mentioned above, benzene, a known human carcinogen, is commonly found in the fracking industry. In 2011, the Institute of Medicine released a

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report that publicly linked benzene to breast cancer. Approximately 1/3 of the chemicals used in fracking fluids are classified as endocrine disruptors. These compounds cause birth, developmental and reproductive effects.[5] According to the US EPA, toluene, specifically, can cause spontaneous abortions in pregnant women who are exposed. A study was conducted in Texas in 2008 and focused on the health status of the six counties where the most hydraulic fracking occurred. The average breast cancer rate among the counties was 60.7 per 100,000 people in 2008 while only 58.7 per 100,000 in 2005. Every other county in Texas had decreasing cancer rates while the rates near fracking wells increased.[10]

Naturally occurring hazardous metals and radioactive materials deep within the earth are present in the flow back fluid. Drilling sludge frequently contains thorium and uranium derived from the within the earth. A survey by the New York's Department of Environmental Conservation examined 13 flow back samples and concluded that the water was contaminated with radium-226. Some sources had radium levels 267times higher than deemed safe for discharge and 3,000times greater than the drinkable level. Radium 226 has a half like of 1600years and while 80 percent is rapidly excreted from the human body, the remainder stores mainly in bones. High exposures to radium 226 have been linked with lymphoma, bone cancer, leukemia, cataracts and anemia. Unfortunately, treatment plants, even brine treatments plants, are not equipped to handle this extent of contamination. There have been multiple instances of these plants producing water that fails to meet the Clean Water Act.[6]

Worker population

Due to the nature of the transient work in the fracking industry, the workforce is primarily composed of young males. The sudden flood of workers into a town creates a challenge for housing. Many men live in temporary housing units referred to as "man camps" due to the scarcity of other housing options or astronomical rent prices. Decently compensated workers, free time and lack of ownership of the community lead to elevated crime rates, vehicular accidents and sexual transmitted infections. This phenomenon, historically referred to as the Boomtown Health Effect, is not a new concept. As a result of the fracking industry boom in North Dakota, the state has one of the greatest single men to women ratios in the United States. Women in fracking towns, both workers and residents, are extremely vulnerable to a host of social dangers stemming from this disparity. An influx of young men, many of whom are away from their families, has lead to heightened crime rates. Many of these crimes involve sexual assaults, domestic violence, drug abuse and rape. In the town of Dickinson, North Dakota, a fracking boomtown, there has been a 300 percent increase in sexual assault and crimes within the past year.[11]

Food and Water Watch, an environmental group, conducted a study called, "Social Costs of Fracking: A Pennsylvania Case Study" from 2005 to 2010. The study evaluated the cases of gonorrhea and Chlamydia in counties with high levels of fracking in comparison to nonfracking counties. The data collected demonstrated that in the heavily fracked counties the STI rate increased 8 percent each year, while in the nonfracking counties the rate only increased by 3.8 percent annually. No direct cause and effect relationship could be drawn from the study however, a correlation was clearly apparent. The issue is so immense that the US Department of Justice has begun investigations.[11]

Occupational exposures

Many of the jobs in the fracking industry are contracted out such as the drillers and crane operators. Frac opertator positions include jobs such as working in the chemical and blender units, sand truck operators and frac pump personnel. Other jobs involved in a fracking operation include, mechanics, health, safety and environmental coordinators, welders and supervisors. Depending on the specific company, the requirements for these jobs can include a GED, 0-5years of experience and a commercial driving license.[12] Entry-level fracking workers can start out earning 80,000 dollars per year or more (Engery from Shale). These jobs are physically demanding, requiring the employees to work long hours in outdoor conditions. Employees are exposed to extreme heat and cold situations. During the warmer months they are encouraged to wear light clothing, take sufficient time to rest and drink plenty of fluids. When the temperature is colder, employees need to be wary of frostbite and hypothermia by wearing protective clothing and remaining warm (Figure 7).

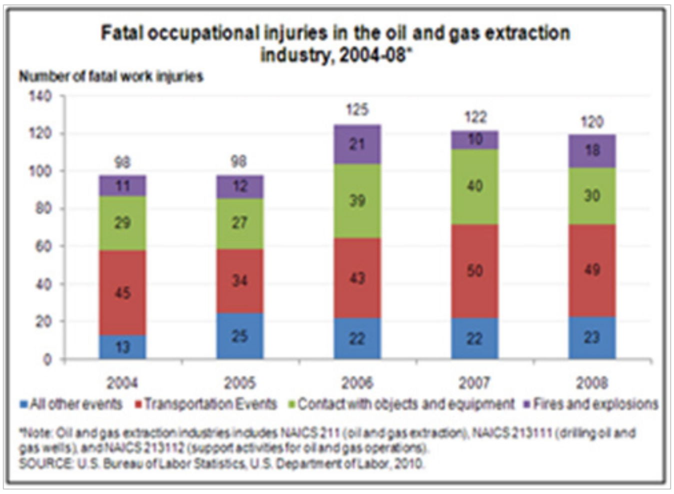

Figure 7 Oil and Gas Industry Fatal and Nonfatal Occupational Injuries. N.d. Photograph. Bureau of Labor and Statistics.

Working in the natural gas extraction business carries heavy physical risks. Workers are in danger of falling, injuring their heads and getting hurt by machinery. According to the Bureau of Labor and Statistics, the oil and gas industry has a fatality rate of 27.5 per 100,000 workers. This rate is 7 times the US average occupational fatality rate. The most common causes of injury in this industry come from transportation incidents, contact with object and equipment and fires and explosions. The median for days away from work is 30 while the average US rate is 7. This is attributed to the nature of the injuries experienced in the fracking industry. Many injuries involve fractures where significant time is needed for healing.[13]

As mentioned in the Environmental Risk Section of the paper, chemicals not only pose a risk to the general public, but also to the workers through absorption and inhalation. Many of the VOCs and particulates can contaminate the air, jeopardizing the respiratory safety of the workers. Radiation is also a potential occupational exposure due to the radioactive materials within the earth. Since hydraulic fracking is a fairly new commercial industry there hasn't been significant research regarding the occupational health risks. However, we can identify several. Noise from heavy equipment poses

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a potential hazard to the worker. Noise induced hearing loss may be a future reality for many of these young men in the fracking industry. Unfortunately, there is no published data regarding the levels of noise exposure experienced in the fracking industry. There are several engineering solutions that can lessen this impact on the employees' ears. One option is to utilize noise absorbing materials. An alternative is to implement a "buy quiet" program. This program entails buying the lowest noise emitting equipment such as drills and other heavy machinery.

Temperature provides another possible risk. Workers such as the drillers, those who work the pump and those who work with the blender hopper are outside during their shifts. Cold temperatures can potentially lead to hypothermia, frost bite, snow blindness, carbon monoxide poisoning and dehydration. The heat creates serious health effects as well. Adverse effects can range from heat rash or prickly heat, syncope, cramps, exhaustion, stroke and potentially death. All new employees and employees who have been absent for a notable length of time, need to be acclimated to the heat before working full shifts. Employees should be evaluated before working in a heat stress environment to ensure they are physically fit to do so. Work/rest regimens need to be scheduled and followed to avoid breaking the ACGIH limit. Reducing worker activity levels would decrease the metabolic rate of the workers. Rearranging shifts to earlier or later times in the day would reduce the risk of working during the hottest part of the day. Hydration is critical in a heat stress environment. All employees should be encouraged to drink water. Educating employees on the importance of hydration will aid with compliance. Outdoor environments increase the risk of skin cancer in fracking workers. Employees should wear clothing that provides adequate protection for the sun as well as sunscreen.

Respiratory diseases

Workers on the hydraulic fracturing industry are at a very increased risk for respiratory diseases. Particulate matter, volatile organic compounds and silica all contribute to the air pollution. Breathing these exposures can lead to the development of asthma, respiratory infections and COPD. However, acute exposures can manifest themselves in headaches, dizziness, nosebleeds, memory issues, fatigue, visual complications, ear, nose and throat irritation, personality changes and irritability. Risk factors for acute exposure are age, cardio vascular disease and physical fitness. Exposure to silica dust is a hazardous reality for those in the fracking industry. Crystalline silica, a typical component of "frac sand", is included in the fracking fluid in order to open the fractures allowing the natural gas to flow out of the shale. Silica comprises roughly 99 percent of the frac sand. In preparation for fracking, the silica sand is transferred to the site via trucks and transfer belts. This process creates large amounts of respirable silica dusts, exposing the workers to higher levels than deemed safe. Respirable silica particles have diameters less than 10 micrometers allowing them to penetrate the gas exchange portion of the lung.[14]

In July of 2012, the US Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) issued a hazard alert on the fracking industry regarding occupational silica dust exposure. NIOSH conducted a study regarding the exposure called, "Occupational Exposures to Respirable Crystalline Silica during Hydraulic Fracturing," and released the following statement: "NIOSH worked in cooperation with oil and gas industry partners to sample the air at eleven sites in five states where hydraulic fracturing operations were taking place. NIOSH identified seven primary sources of silica dust exposure during fracturing operations and found that workers downwind of sand mover and blender operations, especially during hot loading, had the highest silica exposures."

The samples gathered by NIOSH were from the personal breathing space of workers during a full time shift. According to the data collected, 47 percent of the air samples contained higher silica concentrations than the OSHA Permissible Exposure Limit of approximately 0.1milligrams per cubic meter. 79 percent of the samples had higher silica concentrations than the NIOSH Recommended Exposure Limit of 0.05milligrams per cubic meter and the ACGIH TLV. Not only were the limits exceeded in many cases, but 31 percent of the cases surpassed the REL by ten times. Unfortunately, with levels of silica this high, respirators will not be effective to reduce the exposure to a safe level. No requirements were made mandatory through the hazard alert however, NIOSH made several recommendations to company representatives including, personal protective equipment, engineering controls, changes in workplace practices and employee training regimen.[15]

Silica inhalation can lead to several critical diseases. The most notorious silica related illness is silicosis, an incurable, potentially disabling and fatal restrictive lung disease. When the silica particles are inhaled into the lungs an inflammatory reaction is triggered. Repetitive inflammation results in the scarring of the lung which in turn reduces the capability to take in oxygen. Silicosis can present itself in the body in 3 forms: chronic, accelerated and acute. Chronic silicosis is the most common form, typically resulting from 10-20years of repeated exposure to low concentrations of crystalline silica dust. Accelerated silicosis is very similar to the chronic disease except that it progresses more rapidly, generally 5-10years following repeated high exposure to silica dust. Acute silicosis, the most critical form, is unique in that it can present itself after only several months or years of high level exposure. The symptoms can manifest through shortness of breath, coughing, chest pain, weakness and respiratory failure. Risk factors for silicosis are cigarette smoking and job activity. Those who work with sand movers, sand transfer belts, blender hoppers and those who work near the fracking traffic inhale higher levels of silica and are at a greater risk of developing silicosis. If a person does in face suffer from silicosis they are at an increased risk of developing other respiratory infections such as tuberculosis.

Exposure to crystalline silica, a known occupational lung carcinogen, can not only lead to the development of silicosis but other diseases as well. Chronic obstructive pulmonary disease, renal failure, lung cancer, tuberculosis and multiple autoimmune diseases can also result from silica exposure[14] (Figure 8).

Figure 8 N.d Photograph. Centers for Disease Control and Prevention Web. 7 Dec 2013.

Control measures

Currently OSHA's silica limit is set at 100 micrograms per cubic meter. However, this limit has been in place for the last 40years and is rather outdated. On August 23, 2013 OSHA issues a news release that stated its proposal to update the silica limit and reduce it to 50 micrograms per cubic meter. This change would save an estimated 700 lives per year. After the OSHA/NIOSH investigation of the silica concentrations found in the fracking industry, several recommendations were made:

1. Use a less hazardous non-silica propant (e.g., ceramic)
2. Use local exhaust ventilation for capture and collection.
3. Use passive enclosures at points of dust generation.
4. Minimize distances between the dragon tail and T-belts and blender hoppers.
5. Replace transfer belts with screw augers on sand movers.
6. Use amended water (e.g., containing chloride and magnesium salts) to reduce dust generation.
7. Mandate use of cam-lock caps for fill ports on sand movers.
8. Use administrative controls.
9. Provide worker training.
10. Monitor workers to determine their exposure to crystalline silica.
11. Use appropriate respiratory protection as an interim measure until engineering controls are implemented.

This hazard alert does not legally require any of the fracking companies to take action. Recommendations are intended to be informatory and provide a suggested blueprint for improvement (Figure 9). Substitution was the first recommendation by NIOSH because if it is enforced the other controls might not be necessary. Many of the companies already implement a rigid training program. Several companies claim to put new employees through a one month long training program. However, they do not specify the portion of that time dedicated to health and safety.[15]

Figure 9 N.d. Photograph. n.p.Web.

The employees who work directly with the chemicals are required to wear aprons, goggles, respirators, gloves and face shields. If the workers are found to be non compliant with the requirements, they are eligible for termination. The workers near the silica dust must also wear respirators even though the extremely high levels are not protected by them. Employees are encouraged to properly clean all of the equipment before leaving their shift to avoid contaminating their homes.[16]

In April of 2012, there was an explosion at High Roller Wells, a disposal well in South Texas. Three workers were injured in the fire. OSHA cited the company for 10 serious safety violations with $46,200 in proposed fines. The following are several of the safety violations:

1. Ensure workers fall protection while working on the tops of tanks;
2. Ensure that equipment and electrical wiring were rated for the environment in which they are being used
3. Precautions to prevent possible ignition sources (sparks or static electricity)
4. Determine what PPE is needed;
5. Ensure that there was an emergency action plan in place
6. Provide an eyewash station for employees working around acids.

Photo courtesy of Pearsall volunteer fire department

Josh Fox, the director of the Oscar nominated film, Gasland, has just released a short film on the topic of worker safety in the fracking industry.[17] The idea for the film was sparked by the death of a young fracking worker named CJ. He was killed while on the job in New York. CJ was against a trailer by a forklift. As a result, the company was fined only $4,900 by OSHA. Anti-fracking activists have created a law, S3466-2013, in an attempt to increase safety among the workers. Below are the goals of this law:

1. "Notify workers when they are being exposed to toxic chemicals in the workplace and limit that exposure,
2. Limit the number of consecutive hours that can be worked by both on-site workers and those involved in off-site transportation activities,
3. Provide proper training and safety equipment to workers,
4. Properly care for and treat workplace clothing that has been exposed to hazardous materials and
5. Provide clean and safe living conditions to workers who live on site."

The one consensus that can be drawn from a multitude of sources is that more research needs to be done on worker safety in the fracking industry. Without adequate data, improvements will not be made. If this industry continues to boom as expected, the number of humans at risk for occupational exposures will dramatically increase. Not only do we need more research but harsher penalties for non compliant companies. OSHA fines are nearly pocket change to these multi-billion dollar companies. The United States government needs to stand up for its citizens and ensure each and every job is a safe job.

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Conflict of interest

The author declares no conflict of interest.

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