

A Brief Review of Compressor Stations

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Compressor Stations and Pipelines

To transport natural gas across the country, the oil and gas industry relies on an extensive network of inter- and intrastate pipelines. A crucial component of this network is the compressor station. As gas is transported, it needs to remain under pressure (800-1500 psi) to ensure consistent movement against the friction and elevation changes it experiences through the pipeline. Compressor stations, located every 40-70 miles along the pipeline, are used to increase the gas pressure and to scrub the gas of any liquids or solids that may have accumulated through transport. These stations typically consist of 8-16 compressors of 1,000 horsepower or more running in parallel, operating continuously.ⁱ

Sources of Emissions

There are three types of compressor stations: reciprocal, centrifugal, and electric. Reciprocal and centrifugal stations are powered by unprocessed natural gas taken directly from the pipeline. Depending on the composition of the shale play from which the gas in the pipeline was extracted, this gas can be considered 'dry' or 'wet.' Wet gas, or gas that contains a higher composition of C₂₊ hydrocarbons such as ethane and butane, (commonly found in the Marcellus shale playⁱⁱ), often does not meet the necessary specifications for compressor engines, causing incomplete combustion of the natural gas and increased emissions of a number of chemicals, explained in detail below. Electric compressors are powered independently, so there are significantly fewer emissions associated with their operation.

Two other sources of pollutant emissions from compressor stations are from fugitive emissions (leaks) and blowdowns. A blowdown is a complete venting of the natural gas within a compressor or pipeline to the atmosphere, to reduce pressure and empty the system. These typically either occur during an emergency shutdown or during routine station maintenance. It is unknown exactly how often these events occur—a recent FERC risk assessment calculates exposures from a complete station blowdown happening once every 5 years,ⁱⁱⁱ though it has been noted that planned maintenance blowdowns typically occur 8 to 10 times a year.^{iv} Anecdotally, there are other reports of multiple blowdowns occurring per month.^v

A single compressor blowdown can release up to 15,000 cubic feet of methane to the atmosphere^{vi}, along with any other products in the pipeline. Anecdotally, there have been reports of respiratory conditions, headaches, and burning eyes associated with these events. Methods exist to reduce gas loss and human exposure during blowdowns, such as re-routing the gas to alternative pipelines or compressor station fuel

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tanks, or maintaining the gas at pressure within sections of the pipeline.^{vii} In addition to reduced human health impacts, there are also significant financial incentives to reducing the amount of natural gas released from the pipelines.

Health Impacts

The health impacts of residing near these compressor stations are far-ranging, from the chemical exposures to mental health impacts and greater community stress. The chemical emissions attributable to compressor stations are associated with the three forms of emissions mentioned above: leaks, blowdowns, and incomplete combustion. Leaks and blowdowns typically result in emissions of the pipeline contents, such as methane, heavier hydrocarbons, and any byproducts used to ‘sweeten’ (reduce hydrogen sulfide) or dry the gas, such as alkanolamines and ethylene glycols, while incomplete combustion is associated with increased emissions of nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM), and other volatile organic compounds (VOCs).^{viii}

NO_x, CO, and PM, all major components of smog, are known to cause significant health effects in exposed populations. These primarily increase respiratory symptoms and aggravate respiratory conditions such as asthma, especially in children, older adults, or individuals with heart or lung diseases. Recent measurements near the Minisink compressor station in Westtown, NY have demonstrated that families living within 1.5 km of a compressor station, many of whom reported repeated respiratory symptoms, were acutely exposed to elevated levels of PM_{2.5}.^{ix}

Along with the major operating emissions mentioned above, there have been a host of other chemicals found to be associated with the operation of these compressor stations that have potential to impact human health. Carcinogens such as benzene and formaldehyde have been found at levels exceeding federal risk levels over 2,500 ft from compressor stations,^x far greater than currently mandated residential setbacks (the largest of which is 750 ft). Other benzene-like chemicals known to impact the central nervous system such as ethylbenzene, toluene, and xylene have been identified as a fingerprint for compressor station emissions.^{xi} Beyond these, a wide range of chemicals have been found at different stations at varying levels across the country, which have been categorized elsewhere.^{xii} Further information concerning compressor station emissions and health impacts has been previously summarized.^{xiii}

Additionally, there have recently been reports about the increasing impact of shale gas development on mental health.^{xiv} This association continues when investigating the mental health impacts of the wider unconventional natural gas infrastructure—both mental and physical impairment has been found in greater proportions of populations that live in close proximity to compressor stations as compared to expected numbers in the U.S.^{xv}

Current and Future Regulations

Regulations for these stations are still in development. There is little being done to address the health concerns associated with compressor stations; much of the focus has been on greenhouse gases (GHGs). For example, while there are regulations on the amount of methane and NO_x that can be emitted from

these stations, the only health-oriented measures are mandated setbacks, which vary widely by town and state.

In August 2015, the Environmental Protection Agency released an update to their 2012 New Source Performance Standards, a set of measures to further reduce the amount of methane and VOCs released from compressor stations, primarily from improved engine operations and scavenging of leaks.^{xvi} Though these efforts are targeted to reduce GHG emissions, increasing maintenance on engines and proactively searching for and eliminating leaks will likely reduce exposures to health hazards as well. Notably, these proposed guidelines do not target equipment that routinely vents natural gas as its function, so blowdowns would not be impacted.

One potential regulatory method to reduce human exposures is to require electric engines at compressor stations, eliminating emissions from incomplete combustions. As well as the beneficial public health ramifications, this has also been shown to be economically beneficial for pipeline operators due to the reduction of gas used from the pipeline.^{xvii} Though some compressor stations are geographically isolated far from the electric grid, it is likely that any stations in an area populous enough to pose a public health risk would also have access to electricity.

Questions to be Answered

More information is continually emerging that demonstrates the impacts of unconventional natural gas development on human health, much of which has been categorized and summarized.^{xviii} Information on compressor stations has been scarce, but many of the same health impacts have been observed. Unfortunately, there is still a tremendous amount of information missing.

- *Daily Health Effects from Gas Quality*

It is difficult to determine potential health effects from exposure to compressor station emissions, since the actual contents of the pipeline vary from day to day. Some days the gas may be wet, others dry, which will ultimately change the symptoms of the exposed populations. Developing a monitoring and reporting program for the pipeline gas quality may provide a method for communities to know the potential health impacts they may face in a given day.

- *Acute Emissions and Associated Health Effects*

Much of the exposure research done to date has either measured the concentrations of compressor station emissions averaged over 12- or 24-hour periods, or calculated yearly total emissions, neither of which are particularly effective at linking immediate respiratory symptoms to acute exposures. Few have investigated these chemical emissions on a shorter time scale, though there are many anecdotal reports of acute symptoms associated with blowdowns, or with close residential proximity to compressor stations. Measuring emissions on a much shorter time scale, averaged over the minute or quarter-hour, would provide a more accurate measure of the acute exposures people are receiving, and may help link respiratory outcomes with measured exposures.

A recent study has used a community-based method to capture grab samples at times when they were experiencing negative health symptoms.¹⁰ This methodology can help elucidate the connections that exist between high exposures and immediate respiratory effects.

- *Long-term Health Effects*

Simultaneously, it is important to begin to observe long-term impacts of exposure to compressor stations. The shale gas boom and associated infrastructure has been in place for over a decade, so it may be possible to begin investigating the impact to chronic exposure to these chemicals. One method of achieving this is to create a health registry, as has been previously explained.^{xix} Establishing a population of exposed individuals can provide a more thorough understanding of reported health effects in the short-term, but can also create a population to follow through time, elucidating the long-term impact of exposure to this family of chemicals.

- *Radioactive Exposure*

Finally, it would be beneficial to determine the risk of radioactive exposure associated with compressor stations. It has been established that radioactive materials are present within the shale underground, and are being mobilized through the extraction process of hydraulic fracturing. It has been observed that radon levels across Pennsylvania have been rising, potentially due to these processes.^{xx} Natural gas samples taken at the input of four PA compressor stations has ranged from 28.8 to 58.1 pCi/L, with fence monitors measuring up to 0.8 pCi/L, double the average outdoor concentration.^{xxi} These levels suggest that there is significant potential for human health impacts. The effects of radon exposure are typically long-term, reinforcing the need for extended monitoring of exposed individuals through a health registry.

In summary, though many questions about compressor stations and their health impacts upon communities still exist, it is necessary to begin to take action for individuals affected by their presence. Continued research on the topics mentioned above will help complete the picture, but initial research and anecdotal reports have demonstrated a clear negative impact on human health. Compressor stations are a necessary component of the natural gas transportation system, so it is unlikely any substitution or removal will occur in the near future. Tighter chemical emission regulations and increased engineering innovations guided by recent research can begin to tackle the problem of degrading air quality and negative human health impacts.

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