All About Fracking – A Review

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Fracking: The Process

Here's how it's done. First, a well is drilled into a target shale rock formation like the Marcellus shale underlying Pennsylvania, New York and Ohio. The borehole is about 12 to 20 inches in diameter. Steel casing piping is inserted into the well, then cement is pumped in, sealing the casing to the wall of the borehole. The specific cement is formulated to expand on curing. (Common Portland cement contracts about 0.5% on curing, which produces leaks along the well bore, so a special formulation is needed.)

Failure of cement seals is the major failure mode responsible for contamination travelling from one rock stratum to another. Cementing failure is blamed for at least 25 instances so far of groundwater pollution in Pennsylvania, mostly in older vertical wells.

Once the well casing is cemented in place, the pipe and peripheral cement layer in the target production strata are perforated at specific points. This is done with explosive-driven projectiles that are forced about a foot into the formation. The well is then washed out with a slug of concentrated hydrochloric acid, which can increase the cavity significantly, especially in carbonate rock. If the rock is a silicate rock, the acid treatment is less effective.

The fracking process usually starts with mechanically plugging off sections of the perforated well bore. Each section is washed with a slug of acid. At the top of the well, the water tanks are connected to the mixing tanks, which feed a line-up of twenty 2,000-horsepower pumper trucks in parallel, producing a flow of 4,000 gallons per minute at a pressure of 10,000 pounds per square inch.

In shallower wells, high-pressure water is sufficient to fracture the formation, creating fissures emanating as much as 100 feet into the formation. If the pressure is reduced, the deformed formation relaxes, collapsing the pores and expelling the water back up the well bore. This is called "flowback water." To minimize relaxation, silica sand is slurried into the water, carrying the sand into the pores and propping them open. The high linear velocity produces turbulent flow, and keeps the proppant from settling in the casing.

A variety of chemicals is added to the fracking fluid to improve the operating characteristics of the process, and it has often been claimed that the exact composition of this toxic cocktail is proprietary. However, the categories of additives are generally well-known to people working in the field, and it's simply a matter of selecting a suitable member of each category to formulate the cocktail used at a given well.

When the process pressure is relieved, some of the flowback water is expelled, typically over a week or two. Over time, the flowback water is diluted by water native to the formation. This is called "produced water," and its composition varies with the rock formation. This brine in the Marcellus shale contains toxic levels of barium, strontium and radium. In Long Beach, California, produced water is augmented with sea water and is reinjected into the producing formation to prevent land subsidence in the harbor.

Wells initially produce natural gas (which is predominantly methane) at high pressure and high volume, but these rates decline over several years, and most wells are then abandoned as uneconomical, often in ten years, but sometimes, with repeated fracking injections and high prices, they can continue to produce as long as twenty years.

Fracking: The Objections

New gas and oil technology is responsible for a number of changes in the economy, in land use, and in impacts on people's lives. For example, farms or forests are turned into sterile, noisy drill pads or pipeline easements that are not good neighbors. Let's look at some of the major objections.

- *Water pollution:* A large fraction of the anti-fracking reports deal with the risk of water pollution. The rush to get wells into production compounds the problem. Operators proceeded without first establishing baseline levels of potential contaminants. Current best practices, however, require monitoring the potentially affected water prior to drilling, and then monitoring the operation and the post-abandonment period as well. Then, of course, the chemical additive cocktail is introduced during operation of the process, and many of the components used to facilitate the process are toxic and enter the environment as "flowback water" and as "produced water." (These terms were discussed above.) The potential for affecting potable water supplies is quite high, and highly-expensive tertiary wastewater treatment has thus far not been required of the well operators.

- *Air pollution:* This quality-of-life concern arises because oil and gas wells, pipelines, storage tanks and other equipment can leak. Some of the volatile substances released are really smelly and not very healthy. Large motors on the well site are often powered by fuels with loud and smelly exhaust as well.

- *Radiation:* "Produced water" from some wells, particularly in the Marcellus region, contains high concentrations of naturally-occurring radioactive materials, principally decay products from uranium deposits underlying the shale. Radium and radon are of particular concern, but their "daughter" isotopes include lead and polonium. Barium, strontium and calcium, which contribute to water hardness, are found in the Marcellus region. Radioactive material trapped in sediment and hardness-induced scale deposits can exceed radiological safety limits by significant factors.

- *Aesthetics:* Some oil and gas fields are in desolate areas. Others, such as those in the Marcellus region, are in forested areas of Pennsylvania, Ohio and potentially in New York as well. If people live nearby, their landscape and infrastructure will be affected by well drilling and production operations. Past industry practices show that these operations are disproportionately located in areas with lower economic status.

- *Induced seismic activity:* Re-injection of wastewater has been shown to induce earthquake swarms in Ohio and Texas, and most dramatically in central Oklahoma. In the latter case, a multimillion dollar damage suit was recently filed in the Native American court system, which has sovereign jurisdiction over legal actions concerning tribal lands.

There are lots of things not to like, if you have a fracking neighbor. While some jobs and some economic activity in the local area may be created for some number of years, and a few people will do handsomely, there is a price to be paid. Not only is it not sustainable, but the local environment and way of life are permanently altered, and the bulk of the profits go elsewhere. That's a high price to pay.

Fracking: The Methane Problem

Methane's global warming footprint is now widely recognized. It is a much more potent climate change contributor than carbon dioxide – from 25 to 75 times as potent. Fossil fuel production and distribution is a significant source.

Methane may be released as the well is being drilled, since the casing has not yet been cemented in place. Sometimes blowouts happen at this stage, such as BP's infamous Deep Water Horizon disaster in the Gulf of Mexico, but fortunately that's not too common an occurrence.

After a well is completed, methane can be collected for use, or sometimes flared (as in "burned up"). Flaring is usually a temporary disposal technique to reduce the risk of explosion, and is less common than it used to be.

Best practices today require collecting the production gas by piping it to a collection and processing facility. From there, the "natural gas" (which is 90% or more methane) enters the commercial market as a fuel for furnaces, water heaters, cooking, etc., in homes and businesses. Some is also used as an industrial building block in chemical synthesis.

A dirty secret about the American natural gas distribution system is that it is leaky. On average, the leak rate is about 5.8%, which is quite substantial. These leaks are an economic loss, and also an explosion hazard. For example, some gas delivery pipes in New York City are over 130 years old, well past their useful life. These iron pipes are bolted together, but pipes and bolts rust and will invariably give rise to leaks. Repair and replacement are quite expensive – in the billions of dollars for cities – and our infrastructure spending has not come close to keeping up.

A final sobering thought is that if we could reduce the leakage rate by at least half, methane would then have an environmental footprint as low as coal for the same amount of energy production. That doesn't say much for fracked gas as the ultimate solution for our energy and environmental woes.