GREAT ENERGY CHALLENGE

Fracking Water: It's Just So Hard to Clean

5 MINUTE READ
PUBLISHED OCTOBER 4, 2013

ANOTHER CRACK IN the "fracking is safe" story for the industry to address.

You know that fracking thing? For the uninitiated, hydraulic fracturing (a.k.a. fracking) is the technique of injecting water, sand and chemicals at high pressures into shale and other tight rock formations to release the fuel trapped inside. Combined with horizontal drilling, fracking has allowed us to access huge amounts of heretofore unrecoverable natural gas.

What a bonanza: a new and sizable source of natural gas. And, at first blush, a fuel that's good for the environment: natural gas is the cleanest of the fossil fuels and has already begun displacing coal, the dirtiest fossil fuel, in U.S. power plants.

Complications With Fracking

But alas, as with most too-good-to-be-true things, fracking's got some downsides. Among the more vexing is the potential for significant environmental costs. Measurements suggest that, at least in some cases, drilling operations that include fracking have caused contamination of surface and drinking water, and fracking operations, like all natural gas drilling, cause the leakage of methane, a powerful greenhouse gas, into the atmosphere. Since the fracking rush is way past the start phase, these are probably not non-starters for fracking, but they do represent huge challenges for industry and government who need to make sure they are appropriately addressed.

Wastewater Complication

Now a paper published this week in the journal *Environmental Science and Technology* by Nathaniel Warner formerly of Duke University and colleagues focuses on another of those environmental costs: disposal of wastewater.

Hydraulic fracturing, as the term implies, involves water — both at the front end with fracking fluid, the water-based chemical cocktail that is injected into the shale, and at the back end where there is flowback water and produced water.

Flowback water (which literally "flows back" during the fracking process) is a mixture of fracking fluid and formation water (i.e., water rich in brine from the targeted shale gas-rich rock). Once the chemistry of the water coming out of the well resembles the rock formation rather than the fracking fluid, it is known as produced water and can continue to flow as long as a well is in operation. (For more, see "Natural Gas, Hydrofracking and Safety: The Three Faces of Fracking Water.")

As a general rule, you would not want to take a shower much less drink flowback or formation water, nor would you want to just pour the stuff into a river or stream (although that has been known to happen, as described hereand here). Fracking wastewater can contain massive amounts of brine (salts), toxic metals, and radioactivity. And so the gas companies have a problem: what to do with the stuff.

Ideally, the water would be reused or recycled, eliminating the need for immediate disposal. And indeed there is a lot of that. In the Marcellus Shale gas country of Pennsylvania, for example, a large percentage of the water, in the vicinity of 70 percent, is currently reused. And methods to reuse more are being developed. Even so, that leaves a massive amount of toxic wastewater to be disposed of.

One disposal route is injection into deep wells, and a good deal of flowback and produced water from the Marcellus Shale is transported to Ohio for just such a deep burial. But this method has its own problems — the injection process has the inconvenient habit of causing an earthquake every now and again.

Another alternative is waste treatment: removing the contaminants and then dumping the"clean" water into a nearby sewer or river. But you can't use a standard municipal water treatment plant to treat flowback and produced water as those facilities are just not designed to handle the level of contamination, especially radioactivity, found in these waters. (See here, here, here, here and here.)

But there are so-called brine treatment plants that are at least in principle equipped to handle that level of contamination. Although they've been in use for quite some time to treat water from conventional oil and gas operations, many facilities of this type have been found lacking and some have even incurred fines for failure to meet Clean Water Act or other regulatory standards.

Left: contaminated water in. Center: sludge. Right: cleaner water out. Operators at an oil and gas wastewater treatment plant I visited last year claim the cleaned water on the right is suitable for dumping into the municipal waste water stream. LEFT: CONTAMINATED WATER IN. CENTER: SLUDGE. RIGHT: CLEANER WATER OUT. OPERATORS AT AN OIL AND GAS WASTEWATER TREATMENT PLANT I VISITED LAST YEAR CLAIM THE CLEANED WATER ON THE RIGHT IS SUITABLE FOR DUMPING INTO THE MUNICIPAL WASTE WATER STREAM.

So how well do these facilities really do? What is their downstream impact? Warner and his colleagues set out to find out.

The Effluent From a Plant Designed to Treat Fracking Effluent

Specifically, the authors looked at the effluent from the Josephine Brine Treatment Facility in western Pennsylvania and its impact on downstream water quality and sediment. The plant, which only treats oil and gas wastewater, dumps its effluent into Blacklick Creek, a kayaking and whitewater destination. Over a two-year period beginning in August 2010, Warner et al. collected effluent as well as downstream and background water and sediment samples, and analyzed them for key contaminants and radioactivity.

You could say that the results raise some concerns:

- While radioactive "radium [was] substantially (>90%) reduced in the treated effluents," stream sediments at the point of discharge were about 200 times background levels. The good news is that most of the radium appears to be localized in those nearby sediments**. The concern is that by hanging around at elevated concentrations, it can potentially be a long-term source of radiation for nearby aquatic life. It also has the potential to be remobilized and transported downstream eventually.
- Chloride and bromide concentrations downstream of the plant were on average 4.5 and 12 times background levels. The plant was found to contribute about 90 percent of the downstream chloride content. Bromide enrichment can be a problem for downstream drinking water treatment facilities given that carcinogenic compounds form during chlorination in the presence of bromide.

Indeed, these problems have been on the radar of the U.S. Environmental Protection Agency and the Pennsylvania

Department of Environmental Protection "since at least July 2011, when the agency tested the sediments at Blacklick Creek and found radioactivity higher than the base line established by EPA." (Read more here.) In a settlement [pdf] with EPA, Fluid Recovery Services LLC, the parent company of the Josephine Brine Treatment Plant and two other facilities where contamination was found, agreed to required upgrades, tighter treatment standards, and monitoring for radioactivity once the plant begins accepting shale gas wastewater. (More here [pdf].)

The Effluent From a Plant Designed to Treat Fracking Effluent

Effluent isn't the only byproduct. As part of the treatment, chemicals are added to the fracking wastewater to precipitate out salts and metals. And just like the water from the plant, plant operators must have a place to send the precipitates to. Warner et al. calculate that each kilogram of the resulting sludge could contain roughly 900 becquerels of radium* (at 900 becquerels of radioactivity, 900 atoms of radium decay every second emitting a high-energy alpha particle and leaving behind a radioactive gas, radon). This level of radiation exceeds the level for application to soil and may also exceed some landfill limits as well. And if it exceeds landfill limits, then it has to be treated as a hazardous waste, which is another can of radioactive and contaminated worms in its own right.

Are all treatment plants like Josephine? I suspect not. One advanced plant I visited during an eco-fact-finding trip to Pennsylvania in June 2012, run by Eureka Resources, appeared to do a pretty thorough job of getting contaminants out of wastewater from fracking operations (see photo), but even it has garnered some air quality violations from EPA. And plants like Eureka's are not a panacea: even these plants have to deal with the sludge that's left behind; they are expensive, and at least for now, their current capacity is quite limited.

You gotta feel bad for the gas companies. Their shale gas boom keeps coming up with cracks they need to seal up — in this case the crack is leaking some really foul water.

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End Note

* Assumes half of the wastewater treated at the facility is wastewater from Marcellus Shale gas wells.

** In 2011, the Pennsylvania Department of Environmental Protection found levels of radium were still elevated in samples collected 20 meters downstream from the point of discharge.