

ENERGYWIRE

Carbon storage projects hit a hurdle: Corroding steel

EPA has concluded that dozens of planned projects contain dangerous design flaws — a discovery that may slow the rollout of a technology central to the Biden administration's plans to confront climate change.

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Carbon capture and sequestration technology is a crucial component of President Joe Biden's plans to sharply curb emissions of greenhouse gases. | John Minchillo/AP

ENERGYWIRE | A leak at the country's first commercial carbon dioxide sequestration project was likely caused by corrosion of the steel used in the well, a finding by federal regulators that poses a significant risk to dozens other projects around the country planning to use the same type of metal.

The steel, 13 Chrome, has been used for decades in oil and gas wells, but it appears to be vulnerable to corrosion when exposed to the liquids in carbon sequestration wells. Using an alternate material would likely be more expensive and could delay many of the projects that the agricultural and energy industries are hoping to deploy to access the federal tax credits and address the pollution driving climate change.

Carbon sequestration technology, which typically injects climate-warming carbon dioxide into deep underground saline aquifers, is a nascent technique that the Biden administration has hoped will offer polluting industries a viable path to reducing their impact on the climate. The 2022 Inflation Reduction Act includes billions of dollars in incentives for carbon capture and sequestration as part of its effort to cut greenhouse gas emissions sharply.

Both EPA and the well's owner, Archer-Daniels-Midland, have pointed to the corrosion of the 13 Chrome stainless steel used at the Decatur, Illinois, facility for a leak in a monitoring well that allowed liquid carbon dioxide to escape from the containment reservoir. The company [reported a second leak](#) on a separate monitoring well to EPA last week and is running additional tests to shed light on what might have caused it.

EPA moved quickly after being notified of the leak at the first monitoring well by ADM during a site inspection in June, issuing a warning less than two weeks later to the dozens of other companies with projects in the works that they should not rely on that steel. The 13 Chrome pipes have been a go-to material for the oil and gas industry for years and feature in plans for many of the new carbon capture projects pending before the EPA.

In a June 25 email obtained by POLITICO, EPA told companies that are currently applying to EPA for carbon injection well permits that 13 Chrome and a type of cement commonly used by the industry to secure those pipes “are *NOT suitable for construction of these wells in most instances*, particularly under potentially corrosive conditions when both water and CO₂ are present.”

The discovery of the vulnerability has prompted EPA to reassess the 150 pending well permit applications that rely on those materials. And it is requiring companies to either switch to more corrosion-resistant materials or justify their use with rigorous technical analyses specific to the site. It is unclear how many of the [pending applications](#) at EPA included the use of 13 Chrome, but industry experts say it was likely a large proportion of them.

At least two facilities other than ADM's are currently operating carbon injection wells containing 13 Chrome: Six injection wells operated by Dakota Gasification Company and one injection well operated by Red Trail Energy, both in North Dakota.

The design problems threaten to further slow the rollout of the technology that is crucial to the Biden administration's plans to confront climate change, and that companies are eager to launch, thanks to lucrative tax incentives including in Democrats' Inflation Reduction Act. The mandate to move to stronger materials could also undercut the economics of some projects.

More fundamentally, the issues with the well pipes underscore how novel carbon capture and storage technology is, since emerging research is still reshaping assumptions about how to build projects that can safely and permanently store large quantities of the greenhouse gas more than a mile underground.

"My first reaction when I saw this notice from the EPA was I said, 'Oh my gosh, what about all the [carbon sequestration well] permits that are filed out there right now?' A lot of them are using 13 Chrome," said Jon Grimmer, president of carbon capture company Verde CO2 and a former petroleum engineer who started his career at Exxon Mobil. "The ripple effect here could be very big."

The problems with 13 Chrome stem from the chemical reaction that happens when carbon dioxide is pumped into a saline aquifer, as most carbon injection projects envision. That reaction produces a form of carbonic acid, an extremely corrosive liquid. Until recently there has been very little research into which metals could withstand it over time.

Verde had experienced the problems first hand last year when it tested 13 Chrome steel against the saline conditions in potential reservoirs around the Gulf of Mexico and other areas eyed for carbon sequestration.

After seeing the corrosion that occurred, "we had some real concerns," Grimmer said. The company decided to stockpile more corrosion-resistant Super 25 Chrome — a version of the steel that EPA recommended as an alternative in a June 25 email to companies planning to develop carbon sequestration wells.

But 25 Chrome is both significantly more expensive and harder to obtain than the more common 13 Chrome. A ton of 25 Chrome can cost \$40 compared to \$7 a ton for 13 Chrome, said Mike Matson, a Boston Consulting Group consultant who specializes in the carbon sequestration industry, citing a recent vendor price. Only one steel mill in the United States makes 25 Chrome, so the vast majority of the material is imported from mills in Asia, and lead times can be up to a year.

Bruce Craig, a metallurgist and corrosion expert who has been consulting for the oil and gas industry for decades through his firm MetCorr, said that while companies like Verde and some of the major oil companies opted to go with higher grade materials, many others plowed ahead with 13 Chrome for their proposed carbon storage projects, concluding it would be sufficient since early projects like the ADM site and a handful of others have used it.

Choosing materials requires an extremely site-specific calculation based on factors such as the impurities in the injection stream and the chemistry and temperature of the reservoir, Craig said. He has conducted laboratory tests and modeling for dozens of projects, he said.

“We haven’t found anywhere 13 Chrome would work. We just don’t think that’s an alloy that’s suitable,” Craig said.

He argued that project developers should run their own analysis rather than immediately reach for one of the other metals EPA recommended.

The EPA regulations governing carbon injection wells require that the materials last for the geologic lifetime of the project and be compatible with all fluids that they are likely to come into contact with, but they don’t spell out which specific materials meet that standard. The Department of Energy, which is [preparing to spend more than \\$1 billion](#) to help launch the initial carbon capture and sequestration projects, said it “is aware” of the memo the EPA sent to permit applicants regarding the corrosion issue. DOE is encouraging project developers to work with regulators to ensure they are using materials appropriate to the specific site conditions, a DOE spokesperson said in an email.

“All DOE projects must comply with all applicable laws and regulations, including the material requirements outlined in EPA-issued Class VI permits,” the spokesperson said, referring to the classification of the carbon sequestration wells. “Should EPA make any changes to the EPA Class VI regulations based on the recent communication, DOE would evaluate the impacts to the cost and timing of affected DOE projects at that time.”

Switching to higher grade materials will add time and expense to projects, but since well metals typically make up only a small slice of a project’s overall costs, it’s not likely to

affect their overall viability, industry experts said.

“Designing and building carbon sequestration projects is so hard in so many other places, that this is a thing I can solve,” said Andrew Duguid, an engineer who consults on carbon storage projects as vice president at Advanced Resources International, Inc.

In fact, the carbon capture industry overall might welcome the EPA’s direction to use the stronger steel because it will take away some guesswork over materials, said Boston Consulting’s Matson.

“There were a lot of things left to the operator’s discretion,” Matson said. “Statements like that were in some ways actually more frustrating to the industry. It’s almost like, ‘just tell me what to do, I built this well, but let me know what spec to use.’”

EPA has also been in communication with the three states it has granted the authority to implement the carbon injection well program within their borders — North Dakota, Wyoming and Louisiana — about its concerns regarding 13 Chrome. It is unclear whether or how those states will incorporate EPA’s concerns into their work, though. None of the states’ regulatory offices responded directly to questions about how they would respond to the new 13 Chrome worries when asked.

“North Dakota intends to monitor the situation regarding the ADM site and evaluate the information/science behind the investigation of that incident as it becomes available,” a spokesperson for the North Dakota Department of Mineral Resources said by email.

All of the facilities have testing and monitoring plans in place, she said, and the state “intends to follow those testing and monitoring plans as approved until the science indicates changes are appropriate/necessary.”

A spokesperson for Basin Electric Power Cooperative, which runs the Dakota Gasification project, said the company has not been contacted by either EPA nor North Dakota regulators concerning the material.

CORRECTION: This article has been updated to correct the prices of 13 Chrome and 25 Chrome steel.

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