Metals supercharge a promising method to bury harmful carbon dioxide under the sea

September 22 2021

Credit: CC0 Public Domain

There's a global race to reduce the amount of harmful gases in our atmosphere to slow down the pace of climate change, and one way to do that is through carbon capture and sequestration—sucking carbon out of the air and burying it. At this point, however, we're capturing only a fraction of the carbon needed to make any kind of dent in climate change.

Researchers from The University of Texas at Austin, in partnership with

ExxonMobil, have made a new discovery that may go a long way in changing that. They have found a way to supercharge the formation of carbon dioxide-based crystal structures that could someday store billions of tons of carbon under the ocean floor for centuries, if not forever.

"I consider carbon capture as insurance for the planet," said Vaibhav Bahadur (VB), an associate professor in the Cockrell School of Engineering's Walker Department of Mechanical Engineering and the lead author of a new paper on the research in *ACS Sustainable Chemistry & Engineering*. "It's not enough anymore to be carbon neutral, we need to be carbon negative to undo damage that has been done to the environment over the past several decades."

These structures, known as hydrates, form when carbon dioxide is mixed with water at high pressure and low temperature. The water molecules re-orient themselves and act as cages that trap CO_2 molecules.

But the process initiates very slowly—it can take hours or even days to get the reaction started. The research team found that when they added magnesium to the reaction, hydrates formed 3,000 times faster than the quickest method in use today, as rapidly as one minute. This is the fastest hydrate formation pace ever documented.

"The state-of-the-art method today is to use chemicals to promote the reaction," Bahadur said. "It works, but it's slower, and these chemicals are expensive and not environmentally friendly."

The hydrates form in reactors. In practice, these reactors could be deployed to the ocean floor. Using existing carbon capture technology, CO_2 would be plucked from the air and taken to the underwater reactors where the hydrates would grow. The stability of these hydrates reduces the threat of leaks present in other methods of carbon storage, such as injecting it as a gas into abandoned gas wells.

Figuring out how to reduce carbon in the atmosphere is about as big a problem as there is in the world right now. And yet, Bahadur says, there are only a few research groups in the world looking at CO_2 hydrates as a potential carbon storage option.

"We are only capturing about half of a percent of the amount of carbon that we'll need to by 2050," Bahadur said. "This tells me there is plenty of room for more options in the bucket of technologies to capture and store carbon."

Bahadur has been working on hydrate research since he arrived at UT Austin in 2013. This project is part of a research partnership between ExxonMobil and the Energy Institute at UT Austin.

The researchers and ExxonMobil have filed a patent application to commercialize their discovery. Up next, they plan to tackle issues of efficiency—increasing the amount of CO_2 that is converted into hydrates during the reaction—and establishing continuous production of hydrates.

Bahadur led the team, which also includes Filippo Mangolini, an assistant professor in the Walker Department of Mechanical Engineering. Other team members include: From the Walker Department of Mechanical Engineering, Aritra Kar, Palash Vadiraj Acharya and Awan Bhati; from Texas Materials Institute at UT Austin, Hugo Celio; and researchers from ExxonMobil.

More information: Aritra Kar et al, Magnesium-Promoted Rapid Nucleation of Carbon Dioxide Hydrates, *ACS Sustainable Chemistry & Engineering* (2021). DOI: 10.1021/acssuschemeng.1c03041