Patented technology captures carbon dioxide from power plants

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Researchers from the University of California, Santa Cruz (UCSC), and Lawrence Livermore National Laboratory (LLNL) have invented a new method for controlling the emission of carbon dioxide from power plants. The technique, which mimics natural weathering processes, converts carbon dioxide gas into soluble compounds that can be disposed of in the oceans.

Any strategy for curbing the progress of global warming is likely to include technology that captures and stores carbon dioxide, a byproduct of burning fossil fuels that is widely regarded as the leading contributor to global climate change. About one third of U.S. carbon emissions comes from large point sources such as power plants.

"It has become clear to me that in addition to ringing alarm bells about the carbon dioxide problem, Earth scientists need to also think about ways to help solve the problem, beyond just leaving fossil fuels in the ground," said coinventor Gregory Rau, a research scientist with UCSC's Institute of Marine Sciences who also works at LLNL.

Rau and LLNL researcher Ken Caldeira developed the new carbon sequestration method, called Accelerated Weathering of Limestone. The U.S. Department of Energy, which sponsored their work, has now patented the technology.

The process involves reacting carbon dioxide in the stream of waste gas from a power plant with water and calcium carbonate (limestone) or

other carbonate compounds. Instead of carbon dioxide emissions, the plant generates wastewater rich in soluble bicarbonate ions, which can be released beneath the surface of the ocean. Rau said he expects this would have little impact on the ocean.

"Limestone weathering is one of the ways the Earth naturally mitigates increases in atmospheric carbon dioxide," Rau said. "But nature is slow. We propose to speed up the limestone weathering reaction."

When carbon dioxide dissolves in water, the water becomes acidic, which makes it corrosive to limestone. Dissolution of limestone by carbonated water generates soluble bicarbonate ions. This is the process by which rainwater erodes limestone cliffs and creates limestone caves and sinkholes.

Because the waste-gas stream of a power plant has a high carbon dioxide concentration, water acidification will be rapid and will lead to an efficient dissolution of the limestone, Rau said.

In one of the model systems devised by Rau and Caldeira, waste gases bubble up through a slurry of water and limestone particles. Water is constantly sprinkled onto the slurry, and wastewater laden with bicarbonates is pumped out.

The bicarbonates in the wastewater are in equilibrium with dissolved carbon dioxide. Direct contact with ambient air would shift the equilibrium, resulting in the escape of carbon dioxide back into the atmosphere. To prevent this, the wastewater must be released below the ocean surface, where it can mix and be diluted with ocean water before coming into contact with the atmosphere.

Alternative techniques for carbon sequestration include capture and purification of waste carbon dioxide, followed by direct injection into

the deep ocean or underground into depleted oil fields or salt formations. But these methods are costly, and deep ocean injection would not neutralize the acidifying potential of carbon dioxide, Rau said.

Oceans absorb a large portion of the carbon dioxide present in the atmosphere. Scientists expect that the acidification of oceans resulting from increased atmospheric carbon dioxide will have deleterious effects on marine life, especially corals, mollusks, and other creatures that make their shells or skeletons out of calcium carbonate.

But wastewaters from Accelerated Weathering of Limestone would carry the waste carbon mostly in the form of dissolved bicarbonates, which should minimize adverse effects and might even benefit coral reefs, Rau said.

Coal-burning power plants already use limestone scrubbing to remove sulfur dioxide from their smokestack emissions, he said. It might be possible to combine sulfur and carbon dioxide removal in one step or in successive steps. Alternatively, Accelerated Weathering of Limestone might be more appropriate for power plants that burn natural gas, a cleaner fuel that does not require sulfur removal. In either case, the water needed for the sequestration reaction could come from the vast quantities of water already used as coolant, Rau said.

Accelerated Weathering of Limestone would be most cost effective in gas-burning plants located close to water and limestone sources, he said. These conditions are met by several power plants along the Florida and California coasts, which could serve as testing grounds for this carbon dioxide sequestration method.

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