Researchers use wastewater treatment to capture CO2, produce energy

4 August 2015

Cleaning up municipal and industrial wastewater can be dirty business, but engineers at the University of Colorado Boulder have developed an innovative wastewater treatment process that not only mitigates carbon dioxide (CO_2) emissions, but actively captures greenhouse gases as well.

The treatment method, known as Microbial Electrolytic Carbon Capture (MECC), purifies wastewater in an environmentally-friendly fashion by using an electrochemical reaction that absorbs more CO_2 than it releases while creating renewable energy in the process.

"This energy-positive, carbon-negative method could potentially contain huge benefits for a number of emission-heavy industries," said Zhiyong Jason Ren, an associate professor of Civil, Environmental, and Architectural Engineering at CU-Boulder and senior author of the new study, which was recently published in the journal *Environmental Science and Technology*.

Wastewater treatment typically produces CO_2 emissions in two ways: the fossil fuels burned to power the machinery, and the decomposition of organic material within the wastewater itself. Plus, existing wastewater treatment technologies consume high amounts of energy. Public utilities in the United States treat an estimated 12 trillion gallons of municipal wastewater each year and consume approximately 3 percent of the nation's grid energy.

Existing carbon capture technologies are energy-intensive and often entail costly transportation and storage procedures. MECC uses the natural conductivity of saline wastewater to facilitate an electrochemical reaction that is designed to absorb CO_2 from both the water and the air. The process transforms CO_2 into stable mineral carbonates and bicarbonates that can be used as raw materials by the construction industry, used as a chemical buffer in the wastewater treatment cycle itself or used to counter acidity downstream from the process such as in the ocean.

The reaction also yields excess hydrogen gas, which can be stored and harnessed as energy in a fuel cell.

The findings offer the possibility that wastewater could be treated effectively on-site without the risks or costs typically associated with disposal. Further research is needed to determine the optimal MECC system design and assess the potential for scalability.

"The results should be viewed as a proof-of-concept with promising implications for a wide range of industries," said Ren.

Power companies have many reasons to perk up at the possibility of a carbon-negative wastewater treatment solution. The Environmental Protection Agency's Clean Power Plan, expected to take full effect in the year 2020, will require power plants to comply with reduced CO_2 emission levels.

The study may also have positive long-term implications for the world's oceans. Approximately 25 percent of CO_2 emissions are subsequently absorbed by the sea, which lowers pH, alters ocean chemistry and hence threatens marine organisms, especially coral reefs and shellfish. Dissolved carbonates and bicarbonates produced via MECC, however, could act to chemically counter these effects if added to the ocean.

"This treatment system generates alkalinity through electrochemical means and we could potentially use that to help offset the effects of ocean acidification," said Greg Rau, a senior researcher at the Institute of Marine Sciences at the University of California Santa Cruz and a co-author of the study. "This is one of several environmentally-friendly things this technology does."

Many wastewater treatment plants are located on coastlines, raising the possibility that future MECC implementation in these facilities could couple both CO_2 and ocean acidity mitigation.

Provided by University of Colorado at Boulder