Carbon capture process produces hydrogen and construction materials

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Ph.D. researcher Olawale Oloye and Professor Anthony O'Mullane from the QUT Centre for Clean Energy Technologies and Practices developed the electrochemical capture and conversion of carbon dioxide process which also generates hydrogen and a host of useable by-products.

"This process involves the capture of CO_2 by its reaction with an alkaline solution produced on demand, to form solid carbonate products which can be used, for example, as construction materials, thereby keeping carbon dioxide out of the atmosphere," Professor O'Mullane said.

"This can be done using a simple calcium source in water. To further improve efficiency, we added a low-toxicity, biodegradable chemical called MEA to increase the amount of CO_2 drawn out of the atmosphere and into the water.

"Next, the hydrogen evolution reaction during electrolysis ensured that the electrode was continually renewed to keep the electrochemical reaction going while also generating another valuable product, green hydrogen.

"This means if this electrolysis process is powered by renewable electricity, we are producing green hydrogen alongside the calcium carbonate ($CaCO_3$)."

Professor O'Mullane said the use of renewable energy to capture CO_2 and create calcium carbonate may be of use in the cement industry, which has a significant CO_2 footprint.

"We envision this technology would benefit emission-intensive industries such as the cement industry whose CO_2 footprint is 7 to 10% of anthropogenic CO_2 emissions due to the initial clinking (heating) step that converts $CaCO_3$ into CaO (lime) with the emission of large amounts of CO_2.

"By coupling the mineralization process to produce $CaCO_3$ from the emitted CO_2 during the clinking step we could create a closed loop system and reduce a significant percentage of the CO_2 involved in cement production.

Given that urbanization is expected to grow over the next 50–100 years, the demand for cement and concrete will continue to increase and with it the need to significantly reduce the industry's CO_2 footprint if the world is to meet its emission reduction targets.

"This mineralization approach could be used to produce other commercially important metal carbonates such as strontium carbonate ($SrCO_3$) and manganese carbonate ($MnCO_3$), both of which have many industrial uses."

Professor O'Mullane said they tested the process on seawater as potable water was too precious a resource in Australia to make large-scale carbon capture using this process viable.

"We found we could use seawater once it had been treated to remove sulfates. To do this we first precipitated calcium sulfate or gypsum, another building material, and then carried out the same process to successfully turn CO_2 into calcium carbonate, thus providing proof of concept of a circular carbon economy."

More information: Olawale Oloye et al. Electrochemical Capture and Storage of CO 2 as Calcium Carbonate, *ChemSusChem* (2021). DOI: 10.1002/cssc.202100134 Olawale Oloye et al. Electrochemical Capture and Storage of CO 2 as Calcium Carbonate, *ChemSusChem* (2021). DOI: 10.1002/cssc.202100134

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