Capturing Carbon with Precast

CO_2 accelerated concrete curing may reduce greenhouse gases and produce a better product

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CARBON SENSE SOLUTIONS PRESIDENT AND CEO ROBERT NIVEN.

The concrete industry recognizes its responsibility to utilize available technology to minimize greenhouse gas (GHG) emissions in production whenever it is economically feasible. GHG emissions are believed to be a major contributor to global warming. In industry initiatives to reduce its carbon footprint, the precast concrete industry may have a new, sustainable technology available to reduce carbon dioxide (CO_2) emissions and improve product and process conditions at its production facilities. This article takes a look at the potential of carbon capture and storage (CCS) technology as it applies to precast concrete facilities.

Pollution solution set in stone

A revolutionary, inexpensive, steam-curing/alternative concrete curing process now being tested in Canada holds tremendous promise for the precast industry's effort to reduce CO_2 emissions. Carbon sequestration is another term for carbon capture.

By using this process to capture gas emissions from standard industrial facility heaters or steam boiler

equipment, the average precast plant could dramatically reduce both operating costs and mitigate negative environmental effects associated with production. Robert Niven, President and CEO of Carbon Sense Solutions, Inc. has developed a bolt-on retrofit system to existing or new precast concrete equipment that uses combustion exhaust gases and mixes them with concrete during the concrete curing process to trigger a chemical reaction within the mixture.

The reverse limestone calcination reaction in this mineral carbonization system uses captured carbon dioxide, the GHG (CO2) emission from on-site combustion equipment, to create limestone within the concrete during curing. To use the analogy of a sponge (for curing concrete), the calcium carbonate (limestone) produced in the reaction is deposited throughout the empty voids of the sponge (concrete), thereby reducing permeability and increasing strength by way of the Apollonian packing principle.

Carbon capture can replace steam curing

Not only might precast production facilities reduce their GHG emissions and thereby their carbon footprint, producers might also realize significant energy savings. Furthermore, in addition to the green advantage of reducing GHGs, the CCS process shortens concrete cure time, improves efflorescence and results in a more impermeable product with a longer service life.

Essentially, this process may eliminate the need for heat or steam-accelerated curing at some facilities altogether, substituting instead a chemical reaction between carbon dioxide and calcium-containing elements found in concrete [where calcium oxide or CaO = C, and silica dioxide or SiO2 = S, C2S (alite) and C3S (belite)]. Essentially, this process permanently locks the CO2 from plant-generated CO2 into the concrete matrix.

Briefly, potential benefits to precast operations from the CCS process include:

- Energy savings of 44 percent
- Water savings of 39 percent
- Superior products: 28-day concrete compressive strength in one hour; improved concrete impermeability and negligible shrinkage cracking
- "Green" process enhanced with steel slag aggregate (water and heat the only by-products)
- Bolt-on technology works with existing or new equipment
- Exclusive licensing creates a "green" product distinction in a commodity market

Scrubbing with concrete

"Our process provides long-term concrete strength by accelerating early strength development," Niven explained. "It usually takes up to 28 days to reach the same strength rating that the carbonation process can provide in just a day. In the spirit of industrial symbiosis, we consume an industrial waste product (CO2-rich combustion gases) to provide a value-added product that is simple enough to deploy across the world."

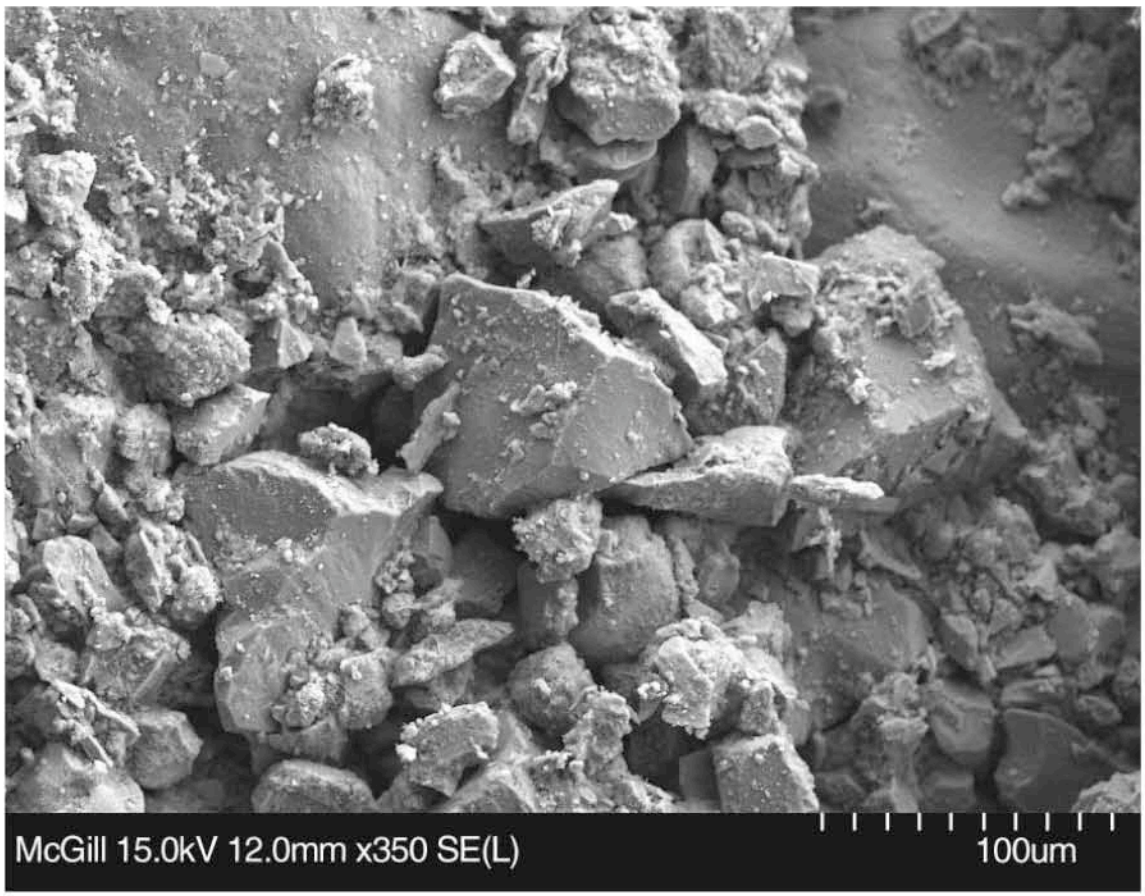
The process promises to offer the precast concrete industry a new and valuable greenhouse gas mitigation tool with added material property and production improvements.

– Bill Dooley

The process makes the concrete act as a scrubber. The process does require minor changes to the concrete mix design and manufacturing process. The retrofit developed by Carbon Sense Solutions can cost about $100,000, depending on the facility and a precast plant would likely realize a return on investment within six months, according to Niven. The retrofit is straightforward, made of components easily found anywhere. "We wanted the process to be flexible and inexpensive – applicable globally – so it could be used widely," said Niven.

CCS pilot project receives support

A multi-phase pilot study will begin in eastern Canada this winter. Some opportunities still exist for new project partners to contribute to the project. Most of Niven's testing to date has been on precast concrete pavers. The first industrial pilot will involve a small-scale demonstration on a variety of dry- and wet-cast products. The second phase of testing will include a mock-up for large precast concrete product elements during full



This image from an electron microscope shows the precast material before the carbonation process. The carbonation process turns elements in the precast mixture to limestone, thereby eliminating 27 days of cure time and resulting in a product that is stronger and less permeable.

production. Because this process promises both environmental and product quality benefits, the pilot programs are being closely watched by the precast industry and government officials in Canada. Canadian industry partners and the Canadian provincial government have an incentive to collaborate:

The Canadian province of Nova Scotia passed the Environmental Goals and Sustainable Prosperity Act in 2007, requiring 1990-level greenhouse gases to be reduced 10 percent by 2020.

In his endorsement of the process, Bill Dooley, vice president of the Cement Association of Canada said, "To the best of my knowledge, the process promises to offer the precast concrete industry a new and valuable greenhouse gas mitigation tool with added material property and production improvements. We encourage Carbon Sense Solutions to conduct a thorough pilot study of the CO2 Accelerated Concrete Curing process to validate the process' economic, GHG reduction, material property and production benefits." The pilot program has the support of Brian Hall, national marketing director for the Canadian Precast/Prestressed Concrete Institute: "It is imperative that innovative greenhouse gas mitigation tools are implemented as early as possible to lessen the effects of global warming."

The CCS pilot programs hope to demonstrate the feasibility of the process on a large scale and solve remaining technical challenges before commercial distribution.

According to Niven, a strong commercialization effort is needed to demonstrate:

- Greenhouse gas mitigation potential
- Economic feasibility
- Technical feasibility

Global effort to capture carbon

Niven is among many academic and industry experts researching and demonstrating approaches to reduce the global carbon burden. He presented findings in March at the Atlantic Climate Change Conference in Halifax, Nova Scotia. Niven plans on presenting more information in October at the Accelerated Chemicals for Environmental and Materials Engineering conference in Rome and/or