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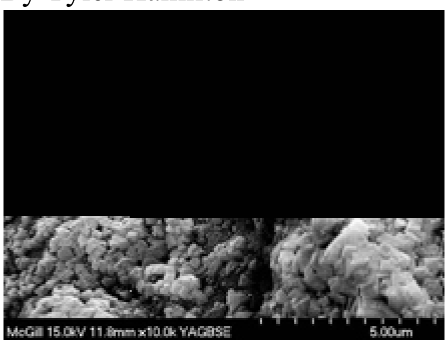
A Concrete Fix to Global Warming

A new process stores carbon dioxide in precast concrete.

By Tyler Hamilton



Carbon dioxide in concrete: This micrograph shows the crystal structure of concrete cured in the presence of carbon dioxide. A Canadian company says that its curing process can store 60 tons of carbon dioxide inside 1,000 tons of precast concrete products, such as concrete blocks, while saving energy.
Credit: Carbon Sense Solutions

A Canadian company says that it has developed a way for makers of precast concrete products to take all the carbon-dioxide emissions from their factories, as well as neighboring industrial facilities, and store them in the products that they produce by exposing those products to carbon-dioxide-rich flue gases during the curing process. Industry experts say that the technology is unproven but holds great potential if it works.

Concrete accounts for more than 5 percent of human-caused carbon-dioxide emissions annually, mostly because cement, the active ingredient in concrete, is made by baking limestone and clay powders under intense heat that is generally produced by the burning of fossil fuels. Making finished concrete products--by mixing cement with water, sand, and gravel--creates additional emissions because heat and steam are often used to accelerate the curing process.

But Robert Niven, founder of Halifax-based Carbon Sense Solutions, says that his company's process would actually allow precast concrete to store carbon dioxide. The company takes advantage of a natural process; carbon dioxide is already reabsorbed in concrete products over hundreds of years from natural chemical reactions. Freshly mixed concrete is exposed to a stream of carbon-dioxide-rich flue gas, rapidly speeding up the reactions between the gas and the calcium-containing minerals in cement (which represents about 10 to 15 percent of the concrete's volume). The technology also virtually eliminates the need for heat or steam, saving energy and emissions.

Work is expected to begin on a pilot plant in the province of Nova Scotia this summer, with preliminary results expected by the end of the year. If it works and is widely adopted, it has the potential to sequester or avoid 20 percent of all cement-industry carbon-dioxide emissions, says Niven. "If the technology is commercialized as planned, it will revolutionize concrete manufacturing and mitigate hundreds of megatons of carbon dioxide each year, while providing manufacturers with a cheaper, greener, and superior product." He adds that 60 tons of carbon dioxide could be stored as solid limestone--or calcium carbonate--within every 1,000 tons of concrete produced. Further, he claims that the end product is more durable, more resistant to shrinking and cracking, and less permeable to water.

"It almost sounds too good to be true," says civil engineer Rick Bohan, director of construction and manufacturing technologies at the Portland Cement Association, in Skokie, Illinois. He points out that the idea of concrete carbonation has been around for decades but has never been economical as a way to strengthen or improve the finished product. In the late 1990s, researchers showed how carbon dioxide could be turned into a supercritical fluid and injected into concrete to make it stronger, but the required high pressures made the process too energy intensive. Carbon Sense Solutions claims to achieve the same goal but under atmospheric pressure and without the need for special curing chambers. "I'd be really skeptical," adds Bohan. "But if someone has a revolutionary process, we'd love to see it."

Precast concrete products represent between 10 and 15 percent of the North American cement and concrete market. While the figure in some European markets is 40 percent, most concrete is mixed and poured at construction sites outside the control of a factory setting (and Carbon Sense Solutions' process). "Considering concrete is the most abundant man-made material on earth, and that the precast market is growing, the estimated carbon dioxide storage potential of this is 500 megatons a year," Niven says. "That is on par with other global carbon dioxide mitigation solutions, such as carbon capture and geological storage."

Research professor Tarun Naik, director of the University of Wisconsin-Milwaukee's Center for By-Products Utilization, says that all concrete absorbs carbon dioxide over time if left to cure naturally--but only up to a point. The gas usually penetrates the first one or two millimeters of the concrete's surface before forming a hard crust that blocks any further absorption. Naik says that something as simple as using less sand in a concrete mix can increase the porosity of the finished product and allow more ambient carbon dioxide to be absorbed into the concrete. It's simpler than Carbon Sense Solutions' accelerated curing process and can be applied to a much larger market, he says.

Other groups are taking aim at emissions from the cement-making process itself. Researchers at MIT are seeking new ingredients in cement that are less energy intensive, while companies such as Montreal's CO2 Solution have an enzymatic approach that captures carbon-dioxide emissions from cement-factory flue stacks, converts the greenhouse gas into limestone, and feeds it back into the cement-making process. Calera, backed by venture capitalist Vinod Khosla, even claims that it can remove a ton of carbon dioxide from the environment for every ton of cement it produces.