CU Boulder's Carbon Negative Concrete Creates Buzz

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By Thomas Beck, AIA, NCARB

A research team led by the University of Colorado and their colleagues have been awarded $3.2 million from the U.S. Department of Energy's Advanced Research Project Agency – Energy (ARPA-E). This award was given to expand the development and production of their recently developed biogenic limestone-based portland cement which is carbon neutral. (https://www.colorado.edu/today/2022/06/23/cities-future-may-be-built-algae-grown-limestone) This recent discovery has many large news outlets buzzing, as well as industry groups like E+T Engineering & Technology, Construction Europe, Global Construction Review, and many others.

The issue with the current method is that the manufacturing of concrete greatly contributes to the accumulation of greenhouse gases. Until the research team's development becomes the standard practice, annual global cement production makes up seven percent of all greenhouse gases. To put this into perspective, this is approximately two gigatons (2 billion tons) of carbon dioxide.

Currently, portland cement (most common cement type, used worldwide) is made by extracting then burning limestone at a high temperature. This method of concrete production is largely responsible for the extensive amounts of carbon dioxide emitted in this industry. Our local producer of portland cement is "Cemex" in Lyons, CO.

"For the industry, now is the time to solve this very wicked problem. We believe that we have one of the best solutions, if not the best solution, for the cement and concrete industry to address its carbon problem" said Wil Srubar, lead project investigator and associate professor in Civil, Environmental, and Architectural Engineering at CU Boulder.

Srubar's Research Group, Living Materials Laboratory, discovered that using biologically grown limestone in place of quarried limestone creates a carbon neutral way to produce portland cement. Biologically grown limestone is accomplished through a natural process in which calcareous (abundance of calcium carbonate) microalgae completes photosynthesis. In simpler terms, the photosynthesis process produces limestone from which algae grow. This process is very similar to the process of growing coral reefs. It is also important to note that algae produces calcium carbonate quickly, meaning that supply would not likely be an issue.

This method is carbon neutral and possibly even carbon negative. Carbon neutral means that the product absorbs an equal amount of carbon from the atmosphere as it produces. Carbon negative is achieved when more carbon is absorbed than is produced by the product.

Ground limestone is often used as a filler like aggregate displacing twelve to fifteen percent of the concrete mix. By using limestone produced by microalgae, concrete could become carbon negative by pulling carbon out of the atmosphere and storing it permanently.

The biologically grown limestone must undergo the process of heating (as does quarried limestone) which releases carbon. However, it has less harmful effects on the environments as it is not quarried. Further, the microalgae uses the carbon dioxide that is currently in the atmosphere, therefore, the CO2 released equals the CO2 captured by the microalgae (carbon neutral). "The real reason why algae-derived 'biogenic' limestone is a gamechanger, is the fact that heating it only releases carbon dioxide that was previously extracted from the atmosphere during the algae's lifetime. The net effect on

the total amount of CO2 in the atmosphere is therefore neutral. This stands in contrast to the production of cement from quarried limestone, which releases carbon that had been stored away for millions of years. This is what the researchers mean when they refer to the cement as 'carbon-neutral'. (https://www.springwise.com/innovation/property-construction/algae-grown-limestone-for-cement)

As Srubar said, "This could theoretically happen overnight, as biogenic limestone can "plug and play" with modern cement production processes." The sooner this method is put into play, the sooner we will see it's affects on the environment.

By doing some simple math, if this new method of concrete production is used, we know that twenty gigatons of carbon dioxide will be saved from being produced or emitted over a ten-year span. Further, if this concrete is in fact carbon neutral, then it could absorb an additional 200,500,000,000 tons of carbon dioxide over the next ten years. That is the same in weight as 1,002,500,000 commercial size airplanes of carbon dioxide that could be removed from the atmosphere in a ten-year span.

"We see a world in which using concrete as we know it is a mechanism to heal the planet," said Srubar. "We have the tools and the technology to do this today."

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