National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Materials and Coatings

Carbonated Cement for Production of Concrete with Improved Properties

Supporting CO2 Emissions Reduction in Cement Manufacturing

NASA's Marshall Space Flight Center has developed a new cement composition and manufacturing method that enables carbon dioxide (CO_2) emissions reduction in cement manufacturing while also providing a cement with improved performance capabilities. Building off of their expertise in life-support oxygen-control systems for spacecraft, the researchers have demonstrated a process whereby carbon is reduced to solid form from captured CO_2 emissions, and becomes an inherent component of the cement product. The inventors, along with their collaborators at California State University-Chico, have demonstrated the technical viability of the innovation with laboratory testing that has indicated that, in addition to reduced CO_2 emissions, cement compositions with enhanced properties can be attained. The inventors are pursuing opportunities to evaluate this innovation in actual cement-making applications.

BENEFITS

- Provides an integrated systems approach to reducing CO2 emissions from cement manufacturing with capture as well as storage/use in the cement product itself
- Demonstrates the potential to enhance cement properties via a carbon-containing additive, particularly in durability against salt effects
- Uses waste heat from cement manufacturing to drive the carbon capture reaction
- Uses iron present in the cement as the key catalyst for the Bosch process

THE TECHNOLOGY

The NASA cement innovation describes a method to make solid carbon material from CO_2 captured during the cement-making process, and for using that carbon material in the mixture to improve cement properties. Doing so provides a direct use for the captured CO_2, eliminating any CO_2 storage/disposal issues and providing an improved cement product.

The innovation employs a chemical reaction, known as the Bosch process, which uses hydrogen gas and catalysis to reduce the CO_2 to solid carbon and water. Cement manufacturing is uniquely suited to the use of the Bosch process. Cement manufacturing requires high temperatures, and harnessing this excess heat limits the total energy required to maintain a Bosch process at a cement plant. Also, cement contains iron, a metal shown to be an exceptional catalyst for the Bosch process. Thus, the cement product itself can be used as the catalyst for the reaction, also serving as a carbon sink. This eliminates any requirements for the storage or disposal of the waste carbon captured from CO_2 emissions.

Test evaluations at the bench scale have provided encouraging indications of enhanced mechanical properties for the carbon-containing cement materials. In particular, the findings suggest that the carbon in the concrete might delay the environmental breakdown of concrete due to the blocking effect of the carbon on harmful ions (e.g., chlorine).

APPLICATIONS

The technology has several potential applications:

- Energy and manufacturing – Cement manufacturing process with integrated carbon capture and storage
- Materials – Novel cement material composition with improved properties

PUBLICATIONS

Patent No: 10,000,413

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More Information

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