Necessity-the-Mother-of-Invention: Biobricks

(Rachel Armstrong)

[Biomason and StoneCycling Launch BioBasedTile®](https://www.stonecycling.com/news/biomason-stonecycling-biobasedtile/)
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The Necessity: reducing greenhouse gas emissions to slow global warming

The Context

Bricks have been used for construction for thousands of years. The earliest known bricks date back to 7500 BC and were made from mud that was sun-dried. Around 2500 BCE during the Indus Valley Civilization, clay bricks were fired which were stronger and more durable than mud bricks. The Romans also made extensive use of fired clay bricks in their buildings, when the process became widespread, which has led to the preservation of many Roman structures to this day. The use of bricks has continued to evolve and improve, as manufacturing techniques have changed to generate a popular building material that is durable, versatile and affordable.

Today, the primary ingredients of bricks are clay and sand. Other materials like water, straw and other organic matter can also be added to alter the properties of the mixture. After being dug up from the ground, the clay is mixed with water in a process known as pugging, or wedging, which creates a workable consistency. This is then molded into the desired brick shape using a mould and left to dry in the sun or in a drying room for several days. Once the brick has dried, it is fired in a kiln at temperatures of up to 1100-1300°C (2000-2400°F) for several hours to cause a chemical reaction known as sintering. This fuses the clay particles together to create a hard, durable material. This high-energy process typically involves burning fossil fuels such as coal, natural gas, or oil to generate the heat needed.

Brick piles placed on the factory floor, courtesy Freepik.

The Challenge

The process of kilning bricks results in significant carbon emissions that contribute to climate change, which result both from the combustion of fossil fuels used to heat the kiln, as well as byproducts from the chemical reactions that occur during firing. Every tonne of fired bricks produces 500-700 kg of carbon dioxide, which uses between 4 and 17 tons of coal.

Bricks dry outside a kiln in Bangladesh. Courtesy, Faizul Latif Chowdhury/Wikimedia Commons

How to reduce or eliminate this enormous release of greenhouse gas?

The Invention

To reduce the environmental footprint of the construction industry, companies are harnessing the natural processes of microbes to achieve the sintering process in ways that do not require a furnace. Working at ambient temperatures, microbes can make calcite crystals that chemically bind clay and sand, to create bricks with the consistency of natural sandstone, with a hugely reduced carbon footprint.

Inspired by the carbon-neutral cement produced by coral reefs (like plants on the land, corals in the sea can also capture carbon dioxide from the atmosphere and transform it into building material for reefs that is rather like cement by using calcium carbonate), BioMason patented a biotechnological process that combined naturally occurring bacteria, carbon, and calcium in a brick-shaped mould to grow a new mineral product called Biocement®. This is possible as certain bacteria such as *Sporosarcina pasteurii* and *Bacillus pseudofirmus*, carry out a *biomineralization* process called microbially-induced calcite precipitation (MICP) that results in a calcium carbonate mineral deposit. They do it by producing an enzyme called urease, which breaks down urea (the major constituent of urine) into ammonium ions and carbonate ions. These then react with calcium ions to form calcium carbonate deposits that bind together the sand particles: brick production is 'farmed' rather than kilned. The result is a strong solid material that reaches maximum strength within 24 to 72 hours (title image).

The Significance

If every building used microbially-cured bricks instead of kiln-fired bricks, the impact would be like switching off the world's kilns. The use of microbially-produced calcium-carbonate based bricks can dramatically reduce the amount of carbon dioxide produced during the brick manufacturing process. BioMason is paving the way to low-carbon building solutions across the US and Europe by aiming to reduce carbon emissions from the global concrete industry by 25% in 2030.