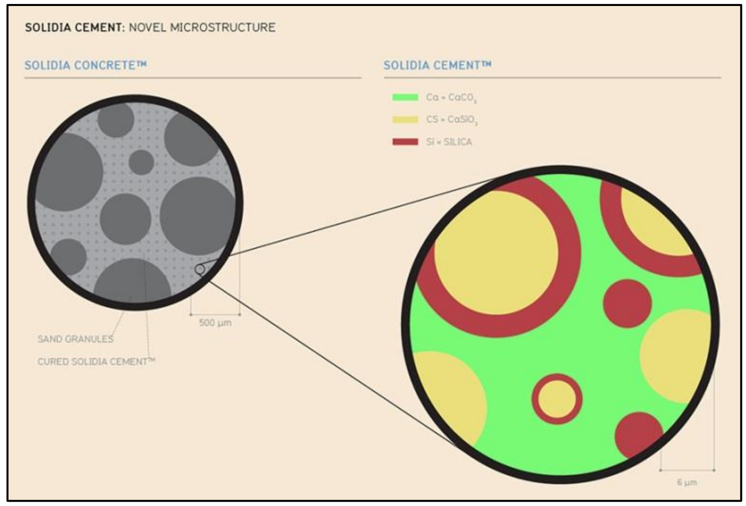
The Science behind Solidia Cement™ and Solidia Concrete™





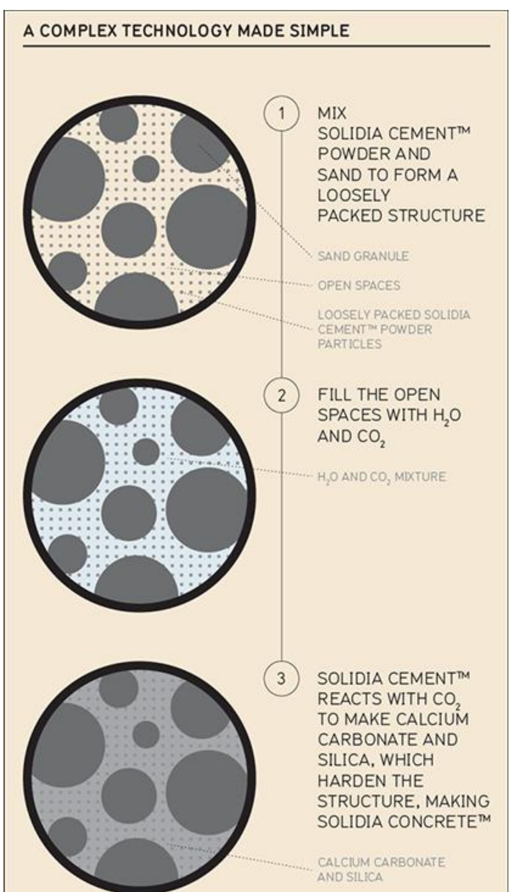

Easy to adopt, the patented processes of Solidia Technologies® allow cement and concrete manufacturers the world over to produce Solidia Cement™, which has a lower-energy use and lower-emission chemistry than ordinary Portland cement (OPC), along with Solidia Concrete™, which cures with carbon dioxide (CO_2) instead of water and performs better.



A durable replacement for OPC-based concrete, Solidia Concrete sequesters CO_2 equal to 5% of its weight during curing, and it can be designed for compressive strength, abrasion resistance and freeze-thaw cycling resilience that are equal to, or better than, that of traditional concrete.

Better Cement and Concrete through Chemistry

Solidia Cement™ is a non-hydraulic cement composed primarily of low-lime-containing calcium silicate phases, such as wollastonite / pseudowollastonite ($CaO{\cdot}SiO_2$), and rankinite ($3CaO{\cdot}2SiO_2$). This contrasts with the high-lime alite ($3CaO{\cdot}SiO_2$) and belite ($2CaO{\cdot}SiO_2$) phases that comprise OPC. The setting and hardening characteristics of Solidia Cement are derived from a reaction between CO_2 and the calcium silicates. During the carbonation process, calcite ($CaCO_3$) and silica (SiO_2) form and are responsible for the strength development in concrete.



The production of Solidia Cement and Concrete begins with a patented process for bonding together and hardening a collection of loosely packed particles. Dubbed reactive hydrothermal liquid phase densification (rHLPD), the process uses a liquid solution to 1) penetrate into the pores between the particles, 2) react with the particles, and 3) create “bridges” between the particles to lock them into place. This last step is precisely what happens when OPC reacts with water to bond together the sand and aggregate particles that constitute conventional concrete.

rHLPD can work in a wide variety of chemical systems. One system involves a reaction between a water-CO_2 solution and a family of calcium-silicate minerals similar in chemistry to OPC. The reaction, which spontaneously occurs at near-ambient conditions, creates “bridges” composed of silica and calcium carbonate. These compounds, and the unique bridging structures formed by them, are more stable and intrinsically stronger than the bonds formed in conventional concrete.

Solidia Concrete is defined by both its proprietary curing process and its formulation – a blend of water, coarse and fine aggregate, and Solidia Cement. In addition to reducing the CO_2 emitted during its manufacture by 30%, Solidia Cement only reacts with CO_2; it does not react with water, as OPC does. During the curing process, CO_2 – from waste flue gas – reacts with Solidia Cement to form calcium carbonate. In other words, it is permanently transformed from a gas to a solid that resembles natural limestone. The gas could only be released if it were put into a high temperature kiln.

The curing of concrete products made using Solidia Cement is derived from a reaction between low-lime calcium silicate phases and gaseous carbon dioxide (CO_2) in the presence of moisture. During the carbonation curing process, calcite ($CaCO_3$) and silica gel (SiO_2) are formed and are responsible for the development of strength within the concrete. This is in contrast to the hydration process occurring in OPC-based concrete, which involves the hydration reaction between high-lime calcium silicate phases and water to form calcium-silicate-hydrate gel and calcium hydroxide.

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Savings of Time, Water and Energy and CO_2 Reduction in Manufacturing

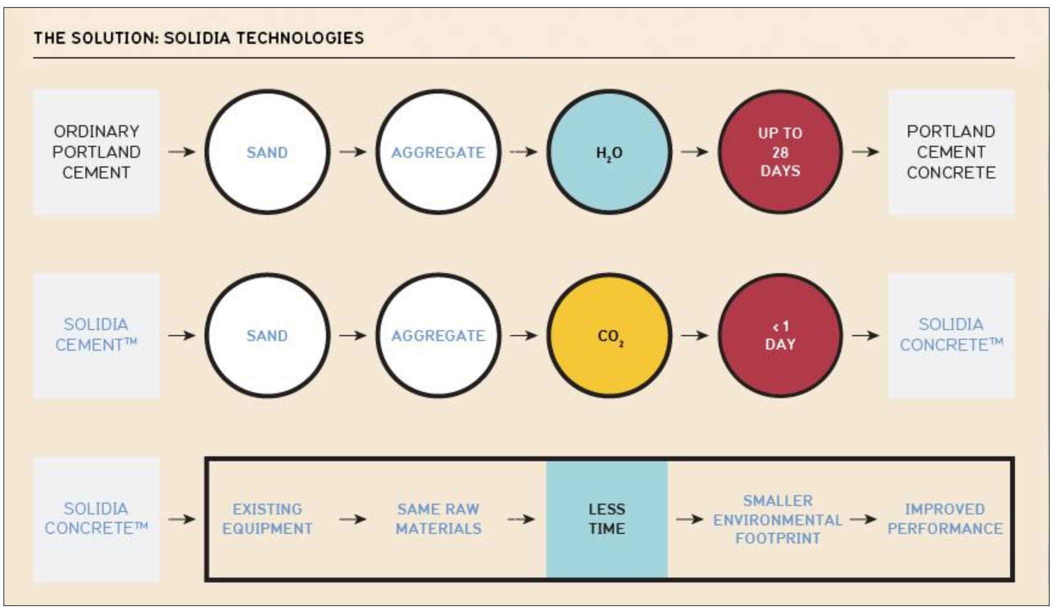
The clinker of Solidia Cement is produced at a temperature of about 1200^{O}C, which is roughly 250^{O}C lower than the sintering temperature used in Portland cement clinker manufacturing. The resulting process uses 30% less energy and emits 30% less CO_2. When the reduced CO_2 emissions associated with Solidia Cement production are considered along with the ability of that cement to sequester CO_2 during concrete curing, the CO_2 footprint associated with the manufacturing and use of cement can be reduced by up to 70%. This reduction is equal to 550 kg of CO_2 per tonne of cement. 30 Solidia Concrete blocks will absorb 22 kg of CO_2 at production. In one year, a tree will do the same.

Solidia allows manufacturers to reduce their water consumption by up to 80%. The adoption of these technologies by the global cement and concrete industry could save approximately two billion tons, or two trillion liters, of water per year. By using Solidia's patented systems, cement and concrete producers will also see an up to 30% reduction in fuel consumption.

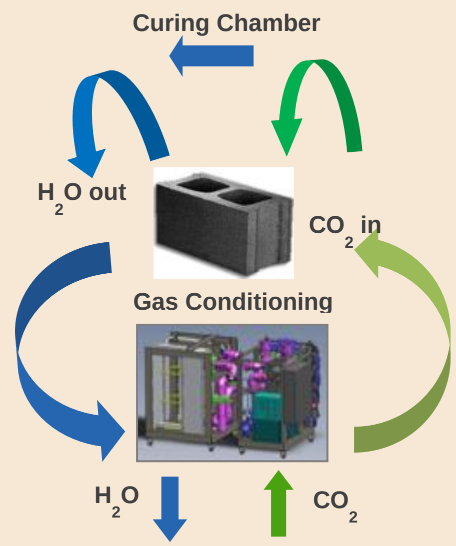
A Complex Technology Made Simple for Easy Adoption

Solidia has taken a complex technology and made it easy for the industry to implement. The technological process used to produce Solidia Cement is adaptable and flexible, allowing a wide variety of cement raw meal formulations and production methods. Solidia Cement is made from the same calcareous and siliceous raw materials as OPC. Its manufacture needs neither specialized equipment nor additional unit operations, and existing OPC plants can be used without modification. Solidia Cement can be manufactured in any part of the world, wherever Portland cement is produced. Solidia cures to full strength in 24 hours instead of the 28 days required for OPC. This translates into time, money and inventory space savings for cement and concrete producers. The difference comes with a refined 'recipe' that uses less limestone and a chemical reaction that occurs at a much lower temperature.

Solidia Concrete can be produced by manufacturers of traditional concretes and can be designed to address virtually any precast concrete application. An array of partners from the public and private sectors and academia are helping shift the discovery from theory to application. These third-party, collaborative efforts include applied research, materials testing and characterization, manufacturing logistics and general marketing. Currently in commercialization, the strength and durability of Solidia Concrete products has been tested and verified according to all market standards: ASTM, AASHTO, EN, and CSA.



How CO_2 Curing Works



Solidia Technologies is the future.

Adoption is easy, with the same:

- Equipment
- Batching
- Forming
- Raw materials
- Mix designs

Tests reveal higher product performance and improved production processes, with:

- 28-day strength in 24 hours
- No primary efflorescence
- Increased durability
- White cement replacement
- Wider color palette
- Color consistency
- Better finishes
- Faster clean-up
- Inventory reduction
- Streamlined secondary processing
- Water reuse and recycling

Sustainability offers real benefits:

- Reduced CO_2 footprint
- Lower water consumption
- Lower energy use
- Ability to remix and recycle products during production
- Near zero waste

See white papers on:

- Solidia Cement™
- Solidia Concrete™
- Addressing Water Scarcity
- Freeze-thaw Performance

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