

CO₂ Mineralization in Concrete Production: Another Solution to Concrete Sustainability

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CarbonCure Technologies




Agenda

- 01 Who is CarbonCure**
- 02 CO₂ Mineralization**
- 03 CarbonCure Technologies**
- 04 Durability**
- 05 Global Presence**
- 06 Concluding Remarks**




Agenda

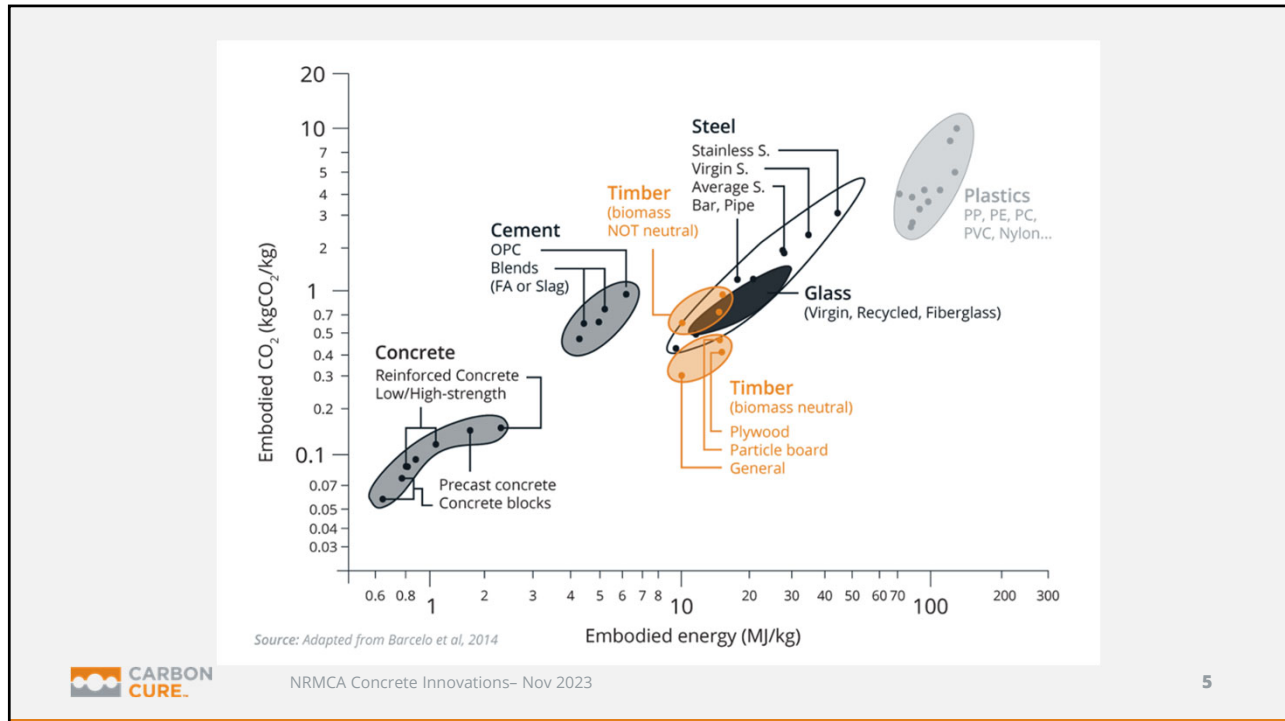
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CONCRETE INDUSTRY

Represents about 8% of the total CO₂ global emissions due to the cement

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CONCRETE INDUSTRY

Concrete is the most used construction material in the world, after water

CO₂ Reduction Emissions in Concrete Industry

PCA Carbon Neutrality Roadmap

The value chain



- Everyone contributes - Cement/Concrete producers, A/Es, Construction companies, Public sector.
- Cement/Concrete producers:
 - Aggregates optimization
 - Blended cements (IL, IS, IP)
 - SCMs (ashes, slags, etc.)
 - **CO₂ Mineralization**



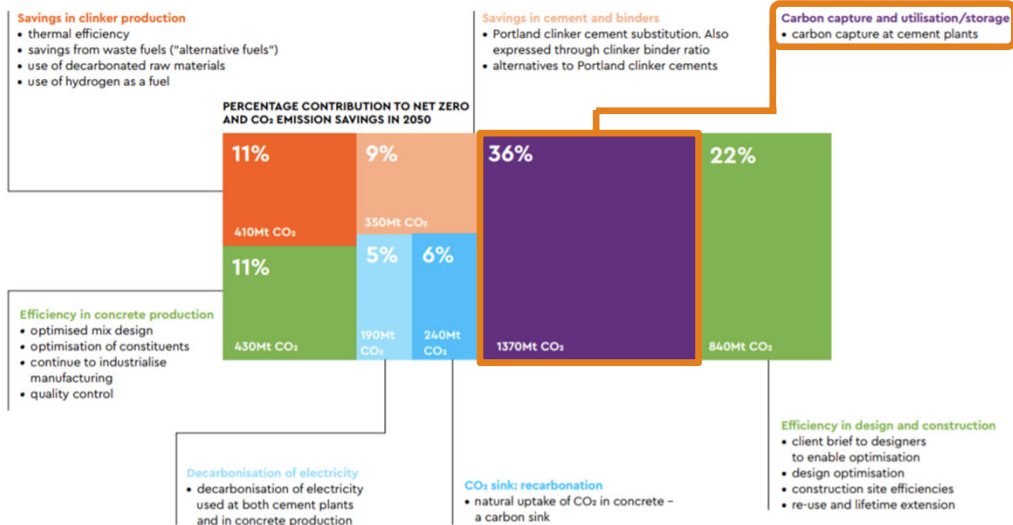
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7

CO₂ Reduction Emissions in Concrete Industry

ACTIONS TO A NET ZERO FUTURE

GCCA Carbon Neutrality Roadmap



8

Who is CarbonCure?

Carbon removal tech manufacturer for concrete



Founded in
Halifax, Nova Scotia, Canada in 2012



More than
775 systems sold worldwide



Grand Prize Winner
of the Carbon XPRIZE



Backed by
Blue Earth Capital, Breakthrough Energy Ventures, Amazon, Microsoft, Mitsubishi Corporation, Samsung Ventures, Taronga Ventures + more



CarbonCure's mission is to annually reduce & remove 500 million metric tons of CO₂ emissions from the atmosphere. That'd be like taking 100 million cars off the road for a year.



Who is CarbonCure Technologies?

CO₂ Mineralization in Concrete

- CO₂ injection in concrete during mixing.
- CO₂ mineralizes and forms calcite nanoparticles that never get released again (permanently sequestered)
- CO₂ mineralization partially improves mechanical properties, thus allowing potential mix adjustments (i.e., cement reduction)
- **Removal + Reduction**



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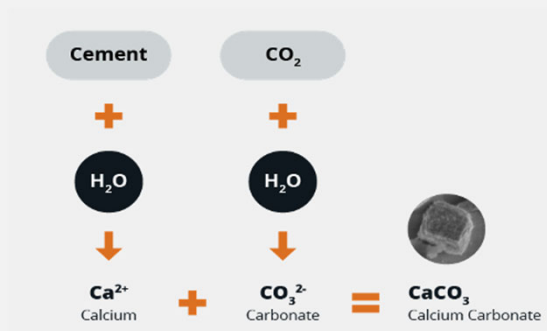


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11

What happens when CO₂ is injected?

Converting CO₂ into a mineral



When mineralization reaction occurs, **CO₂ converts** into solid calcium carbonate (CaCO₃), **calcite** being the main phase (chemically most stable).

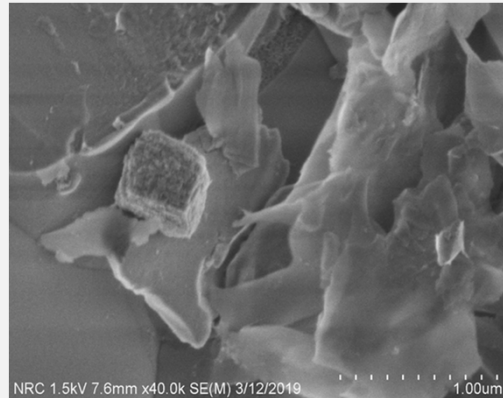
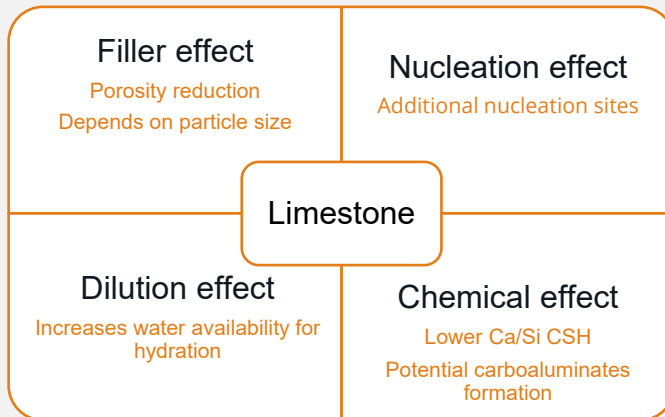


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12

What happens when CO₂ is injected?

Cement Hydration Enhancement



Source: CarbonCure Technologies

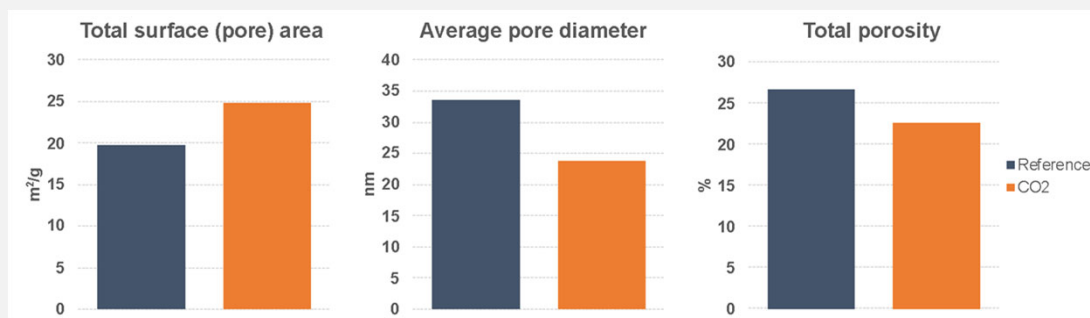


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13

What happens when CO₂ is injected?

Filler Effect



Source: CarbonCure Technologies

Reduction of total porosity and pore size



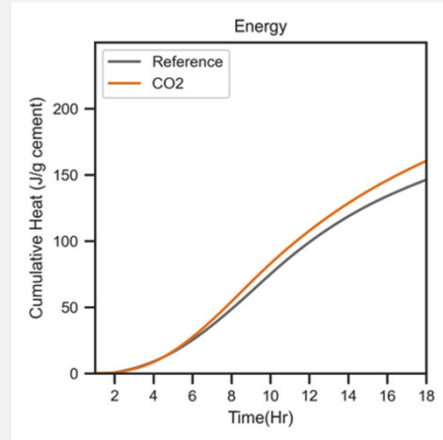
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14

What happens when CO₂ is injected?

Nucleation, Dilution, and Chemical Effects

- Exothermic reaction
- Heat release can be measured
- Sample with CO₂ releases more heat, indicative of **more reactivity**.



Fuente: CarbonCure Technologies

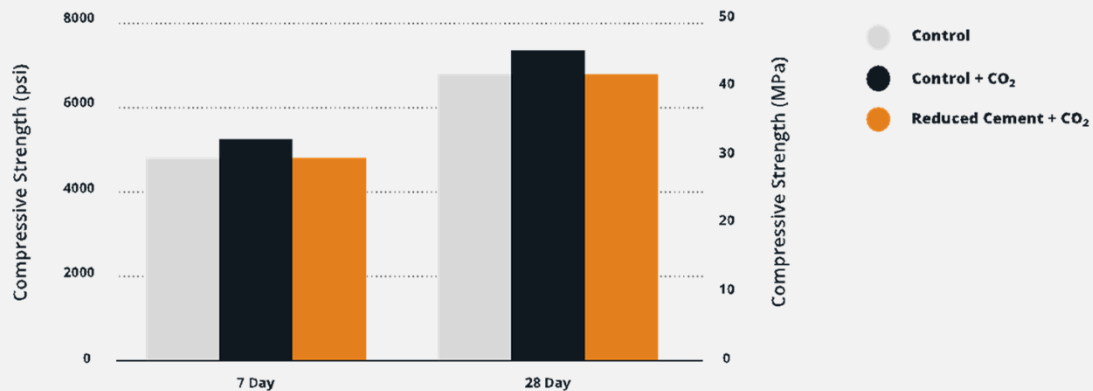


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15

What happens when CO₂ is injected?

Compressive Strength Effect



Fuente: "Calculating Sustainability Impacts of CarbonCure Ready Mix" (2017).




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16




Agenda


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CarbonCure Technologies

CarbonCure Technologies can all be used together to achieve maximum impact

<p>15-25 lbs of CO₂ saved per yd³ 7-11 kgs of CO₂ saved per m³</p>  <p>CarbonCure Ready Mix</p>	<p>20-30 lbs of CO₂ saved per yd³ 12-18 kgs of CO₂ saved per m³</p>  <p>CarbonCure Precast</p>	<p>15-25 lbs of CO₂ saved per yd³ 7-11 kgs of CO₂ saved per m³</p>  <p>CarbonCure Reclaimed Water</p>
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CarbonCure Ready Mix & Precast

CarbonCure Technologies can all be used together to achieve maximum impact

15-25 lbs of CO₂ saved per y³
7-11 kgs of CO₂ saved per m³



**CarbonCure
Ready Mix**

20-30 lbs of CO₂ saved per y³
12-18 kgs of CO₂ saved per m³



**CarbonCure
Precast**

15-25 lbs of CO₂ saved per y³
7-11 kgs of CO₂ saved per m³



**CarbonCure
Reclaimed Water**



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19

CarbonCure Ready Mix & Precast

Liquid Admixture

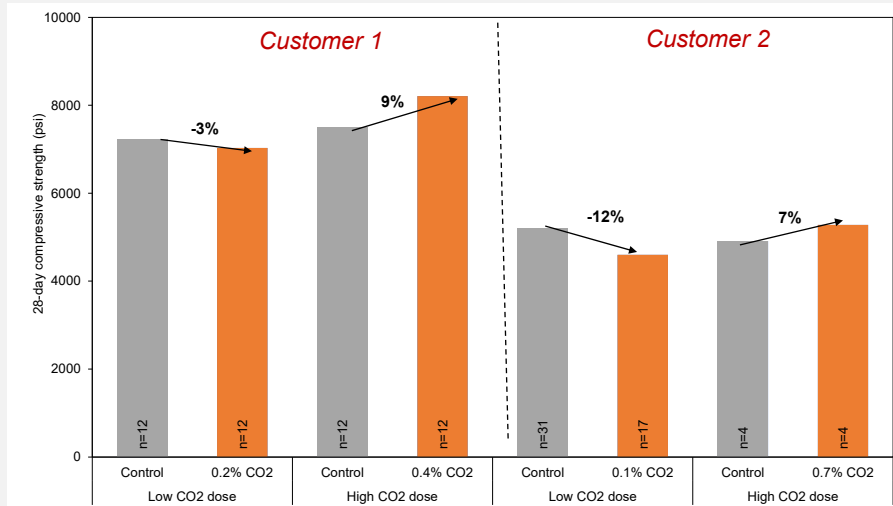


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20

CarbonCure Ready Mix & Precast

IL Cement – Field Cases



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21

CarbonCure Reclaimed Water

Reclaimed Water Treatment

15-25 lbs of CO2 saved per y3
 7-11 kgs of CO2 saved per m3



CarbonCure
 Ready Mix

20-30 lbs of CO2 saved per y3
 12-18 kgs of CO2 saved per m3



CarbonCure
 Precast

15-25 lbs of CO2 saved per y3
 7-11 kgs of CO2 saved per m3



CarbonCure
 Reclaimed Water



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22

CarbonCure Reclaimed Water

Reclaimed Water Treatment



- Reclaimed Water (RW) can be reutilized
- Contains reactive cementitious fines (variability)

- CO₂ injection to stabilize fines
- Water and fines reutilization (virgin cement reduction)

- CO₂ mineralization: nano-calcite particles
- 10 – 15% CO₂ bwc (in RW)

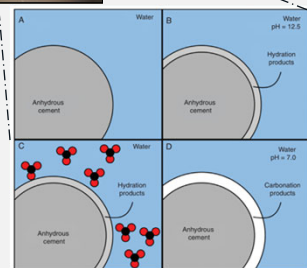


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23

CarbonCure Reclaimed Water

Reclaimed Water Treatment



A. Hydration initiates when water and anhydrous cement make contact.

B. Hydration products form on the cement particle surface.

C. When CO₂ is added, it mixes in the solution and reacts with calcium-bearing phases in the hydrating cement or with the major clinker phases.

D. This reaction forms a coating of CaCO₃ around the cement grain, preventing further hydration.

Addition of CO₂ stabilizes the reclaimed water for beneficial and consistent reuse.

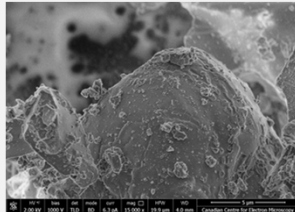
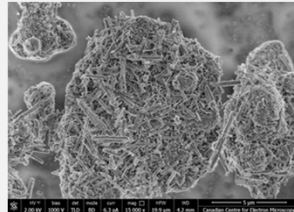
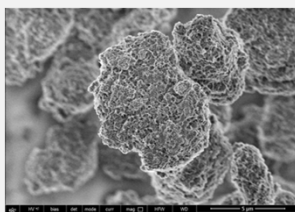
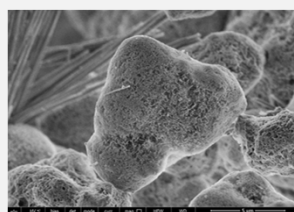



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24

CarbonCure Reclaimed Water

Reclaimed Water Treatment

	0 h	72 h	
Untreated			<p>Growth of hydration products noticeable in untreated reclaimed water samples at 72 hours</p>
CO₂ Stabilized			

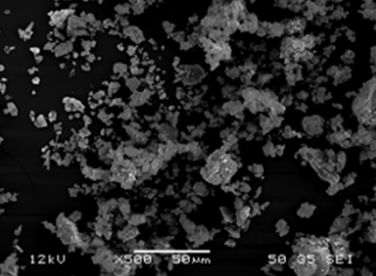


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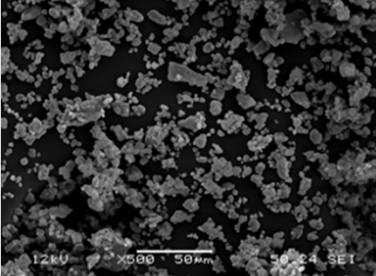
25

CarbonCure Reclaimed Water

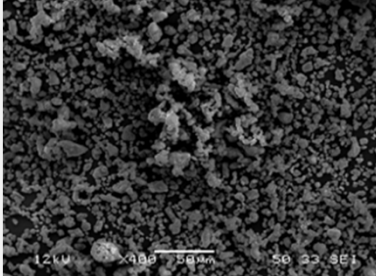
Reclaimed Water Treatment




5% CO₂ addition
Not enough to stop hydration



15% CO₂ addition
Enough to stop hydration



25% CO₂ addition
Stops hydration, more fine material

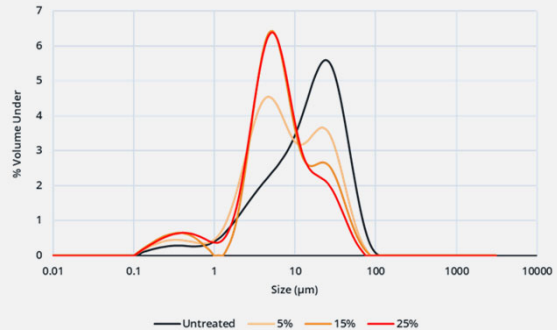
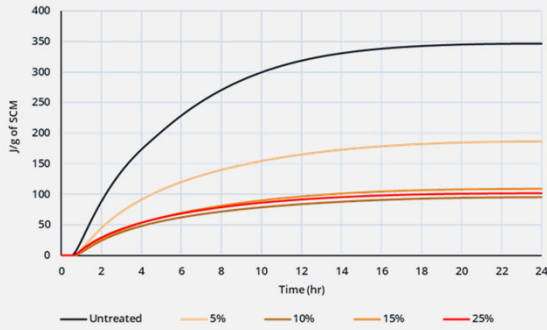


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26

CarbonCure Reclaimed Water

Reclaimed Water Treatment



Reactivity: With addition of CO₂ the treated solids still possess residual reactivity that can contribute to the strength development of concrete.

Filler effect: Compressive strength can be increased through better particle packing. RW treated with CO₂ produces particle sizes that are finer than the original cement particles.

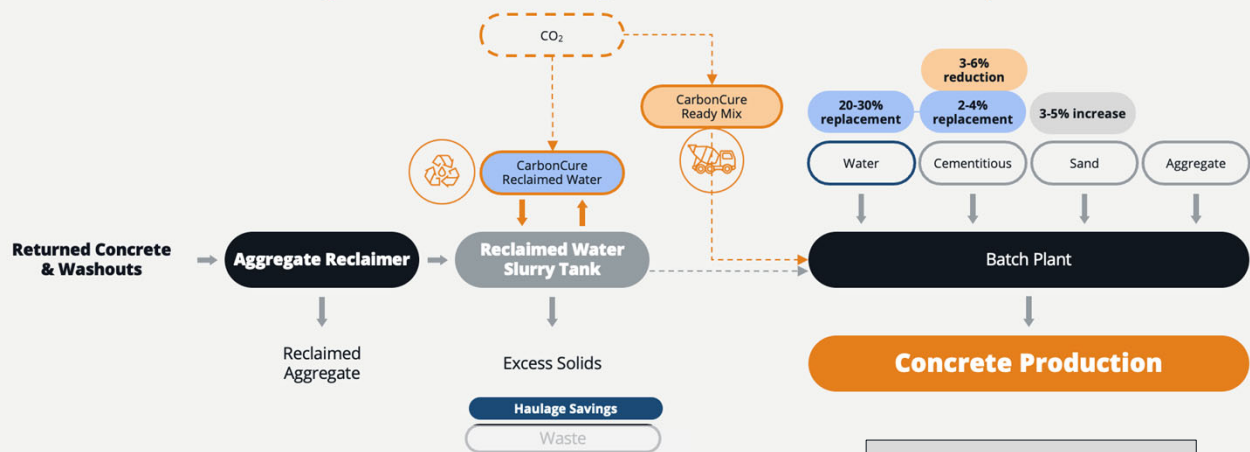


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27

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28

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Durability



Corrosion!!!



Durability



Extensive durability testing has verified that there are no adverse impacts, including :

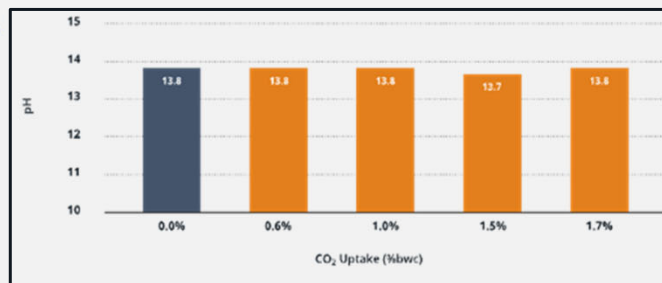
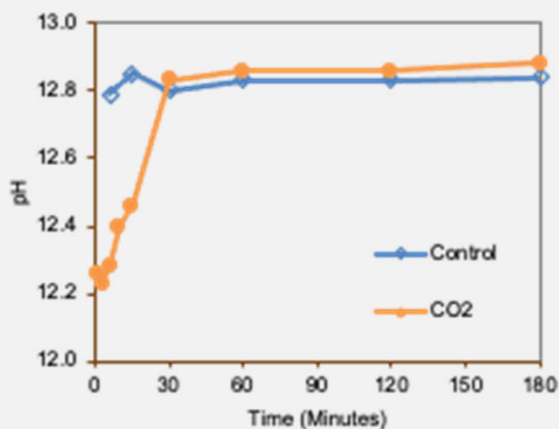
- Academic studies by University of Toronto, University of New Brunswick, and Technological University of Singapore
- US state DOTs
- AASHTO (UP3 testing)
- Concrete producers
- Third party concrete consultants



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31

Durability



Source: CarbonCure Technologies

Source: CarbonCure Technologies




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32





Agenda

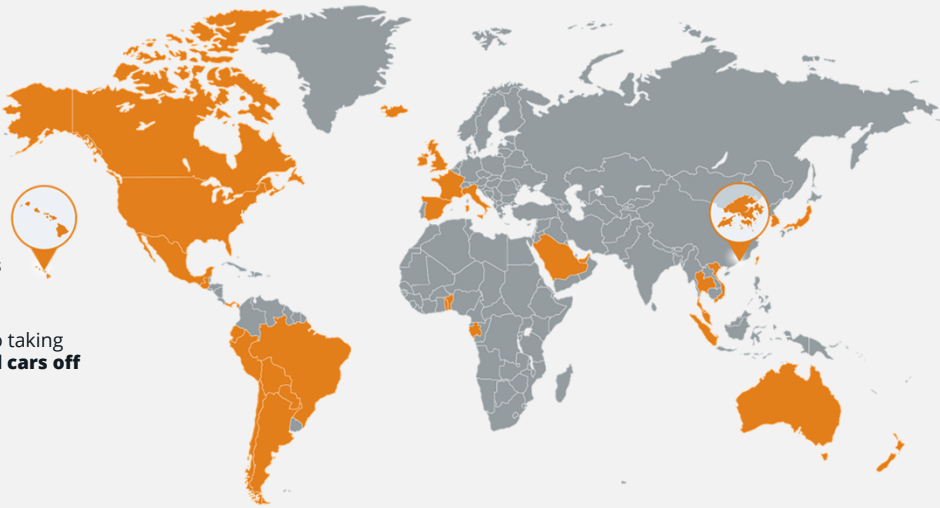
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Where we are Deployed

As of November 2023

-  More than **775 systems sold across 35 countries**
-  Used in **5M+ truckloads of concrete**
-  Resulting in **375,000+ metric tons of CO₂ saved to date**
-  Which is equivalent to taking **83,000+ gas-powered cars off the road for a year**



 34

Global Formality

PARIS AGREEMENT

VERRA

United Nations Framework Convention on Climate Change

CARBON CURE.

- Non-governmental organization¹
- ~80% global volume of decarbonization quantification (not only concrete industry)
- Verra developed methodology for CO₂ utilization in concrete (~4 years)
- CarbonCure works with auditors who follow Verra's methodology to avoid double-counting (greenwashing)
- To be certified: Scalable + Inventive

35

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CARBON CURE.

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36

Slide 35

- 1 @gcarrero@carboncure.com Si le puedes echar un ojo a este slide cuando tengas unos minutos. Te agradezco cualquier comentario que tengas.

También tengo abajo en las notas lo que pienso decir durante la presentación de este slide. Si puedes, también me dices si te parece bien o si cambiarías algo. Muchas gracias

Igor De la Varga, 11/8/2023

Concluding Remarks

- CarbonCure **injects CO₂ in concrete** while being mixed, where it **mineralizes** and is **permanently “sequestered”**.
- Carboncure **enhances cement hydration** in concrete; mix adjustments (i.e., cement reduction) are possible (**removal + reduction**).
- **No negative effects on concrete durability**. Small amounts of CO₂ (although, global production volume offers an opportunity).
- **RMX y RW technologies**.
- Totally **compatible with other low carbon technologies** (e.g, SCMs, chemical admixtures, etc.)
- Paris Agreement - UNFCCC - Verra >>> verify/validate carbon footprint reduction to **avoid double counting**
- **Carbon credits** generation



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37



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38



Thank You

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