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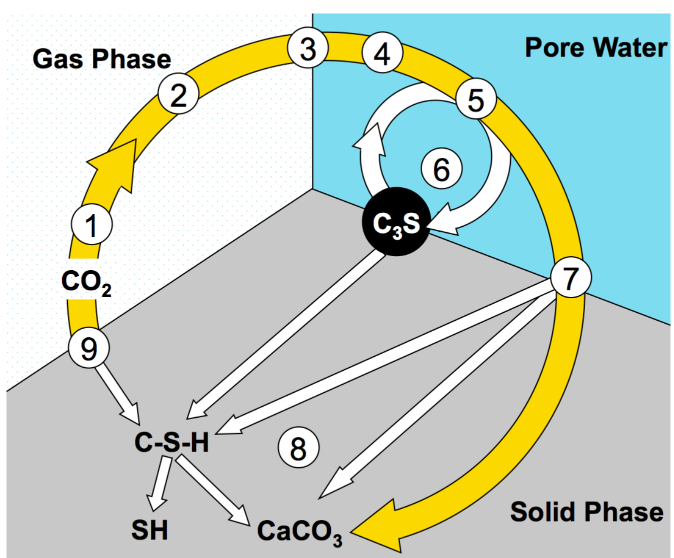

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The presence of H^+ ions causes the pH of the developing cementitious system to drop. The pH can recover as the microstructure matures.

6. Dissolution of cement phases C_3S and C_2S. This occurs rapidly, cyclically, and exothermically. Cement grains are covered by a loose layer of calcium silicate hydrate gel that dissolves to release Ca^{2+} and SiO_4^{4-} ions.

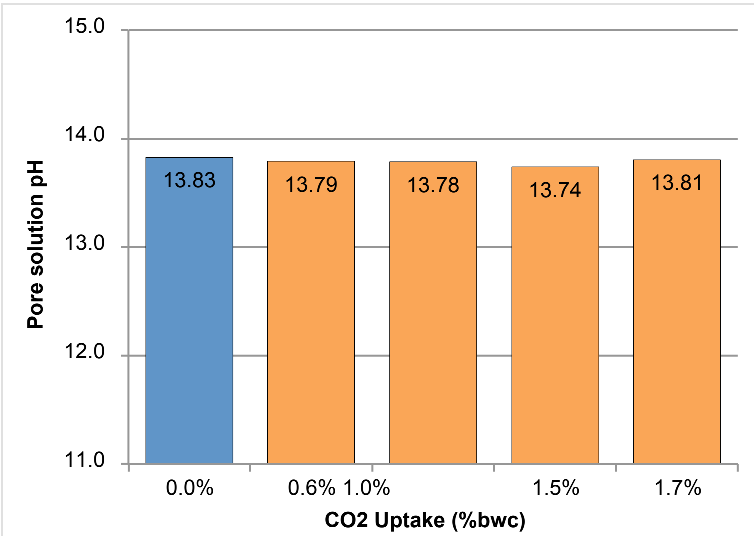
7. Nucleation of thermodynamically stable $CaCO_3$ and conventional formation of C-S-H gel.

8. The $CaCO_3$ precipitates as a solid phase. Calcite is the preferred polymorph.

9. Secondary carbonation also occurs; sustained reaction of carbon dioxide and the cement paste can see C-S-H gel formed through the parallel early hydration decalcified and producing a calcium-depleted silicate hydration and $CaCO_3$.

Early age carbonation reactions can involve calcium that, on balance, would otherwise have hydrated to form calcium hydroxide and contribute to high pH. However, the early age carbonation does not hinder the long-term development of the concrete microstructure as the concrete matures. Therefore, calcium hydroxide will develop during later hydration and the pore solution pH development continues as normal once the carbonation application ends.

Recent research conducted by CarbonCure Technologies (at right) has shown that an early age carbonation process has a minimal effect on the pH of the pore solution of mature concrete. Paste samples we created with varying levels of carbonation (expressed as CO_2 content by weight of cement) that were achieved within 120 seconds of carbon dioxide injection during mixing. The paste was then cast into cylindrical specimens and moist cured. The pore solution was extracted at 28 days and the pH was measured. The decline was minimal and suggests no risk of depassivation of ferrous reinforcement.



Pore solution pH of carbonated paste samples

The effects of early age carbonation on the properties of concrete are being studied by several parties. In particular, ongoing research is developing an understanding about the impact of early age carbonation on carbonation shrinkage or carbonation uptake during the service life.

Context

The widely held notion that "carbonation is deleterious for concrete" is specifically rooted in the harmful effects of weathering carbonation on mature hydrated microstructures. Conversely, early age carbonation

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involves different chemical reactions affecting an immature microstructure. The attendant material and environmental benefits of the carbon dioxide-cement interaction can be leveraged with a carefully considered carbonation approach.

CarbonCure Technologies focuses on using early age carbonation to sequester CO_2 in the cement paste to produce better concrete. While concrete carbonation has long been only considered to negatively impact concrete as a building material, the use of CO_2 now enables the development of a 'green' concrete building material.

Sources

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