Using Silicates for Moisture Mitigation

When a Simple Science Meets Marketing Extremes

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Simple Science

The Intended Purpose Given Silicate Chemistry by R&D

The reaction of water with calcium silicates in Portland cement produces a Calcium-Silicate-Hydrate that acts as a binder providing the basic strength and properties of concrete. The basic reaction of Portland cement to form hydraulic concrete follows:

$$2CaO{\cdot}SiO_2 + 7H_2O \rightarrow \mathbf{3CaO{\cdot}2SiO_2{\cdot}4H_2O} + 3Ca(OH)_2 \qquad \textbf{C-S-H}$$

$CaO{\cdot}2SiO_2{\cdot}4H_2O$ is often abbreviated as C-S-H and is amorphous in crystalline structure or having a lack of specific form.

The reaction of sodium silicate (solution or colloid) and calcium hydroxide (Portlandite) produces a form of Calcium-Silicate-Hydrate of slightly different character. This form often referred to as C-S-H (I) is fundamentally different in composition and properties than that produced from hydration of Portland cement. This reaction follows:

$$Na_2SiO_3 + 4H_2O + 3Ca(OH)_2 \rightarrow \mathbf{3CaO{\cdot}SiO_3{\cdot}4H_2O} + 2NaOH \quad \textbf{C-S-H (I)}$$

$3CaO{\cdot}SiO_3{\cdot}4H_2O$ is often abbreviated as C-S-H (I) and is often referred to a C-S-H gel. This form of C-S-H tends to be more soluble in water (hydrophilic) and prone to expansion or swelling if additional silicate is released from the aggregate.

Silicates can be supplied in various physical forms from simple sodium silicate solution to colloidal suspensions of silicate nano-particles (5nm) to even larger silica polymer dispersions (45nm).

Sodium silicate, also known as “crystalline silica” has been used in differing applications within the cement industry for decades. They can act as accelerators and concrete sealers. Unlike typical waterproofing sealers that act to repel water or function as a barrier coating; soluble silicates do not form a repellent surface. Rather, silicates penetrate superficially to form a C-S-H gel which moderately densifies the concrete surface through a method best described as “pore-blocking”.

Colloidal silica consists of dense, amorphous particles of SiO2. Their reaction chemistry is identical to sodium silicates however rate kinetics are improved. Sodium silicates are alkaline solutions with pH ranges of 12-13, compared to 9-11 for colloidal silica. Sodium silicates are also composed of silicate monomers, as opposed to colloidal silica composed of polymeric silicates. Finally, the viscosity of sodium silicates is much higher and having a rheology closer to that of a syrup. While colloidal silica has a viscosity closer to water forming cloudy suspensions. Colloidal silica has a multitude of applications, however for the cement industry this is typically as an admixture to enhances paste density in deep well cementing applications.

Marketing Extremes

The Unintended Purpose Given Silicate Chemistry by Marketing

Extrapolating the data derived from R&D verification of properties related to surface densification and mixing this with concepts related to moisture mitigation has resulted in the marketing of silicate chemistry as a tool effective in restricting moisture vapor emissions. Silicates in either crystalline or colloidal form are not membrane-forming, do not produce a continuous film on the concrete surface and are ineffective at reducing concrete permeance sufficiently to be categorized as repellents or moisture mitigation solutions.[1]

In studies conducted by CTL Group laboratory measurements in accordance with ASTM E96 *Standard Test Methods for Water Vapor Transmission of Materials* it was concluded that no appreciable difference in water vapor transmission rates were found with concrete slabs treated with several commercially available silicate products to that of the untreated concrete controls.[2]

Given the complexity of silicate interactions, the undefined nature of the cured matrix and the myriad reactions taking place; it’s easy to be confused by the chemistry associated with concrete. Preying upon this confusion has been a staple of the flooring industry related to moisture mitigation for decades and continues. New silicate products are continually introduced claiming extraordinary properties of concrete penetration, water repellency, and reductions in moisture vapor emissions. The facts are, it just doesn’t add up under the scrutiny of analysis. Certainly, a densification of concrete takes place but that’s the only trick silicates have. Anything else becomes a figurative slight of hand.

[1] M Kubal, “Above-Grade Waterproofing” Construction Waterproofing Handbook, 2nd Edition, 2008

[2] H Kanare, “Comments on Silicates as Concrete admixture”, CTL Group, 2010