Spray-Lock®
CONCRETE PROTECTION

SCP Tech Brief: Calcium Hydroxide Consumption by Colloidal Silica

Concrete in service can sometimes be exposed to chemical attack. Two principal factors affect concrete's durability in chemical attack situations are: 1) the concrete's permeability and 2) readily available reactants in the concrete. When portland cement reacts chemically with water it produces several reaction products. Calcium Silicate Hydrate (C-S-H) is the primary reaction product of hydration, contributing the most to strength and other desired properties of concrete. An additional reaction product is Calcium Hydroxide (CH), which has little or no cementitious properties, and contributes very little to the strength of hardened concrete. CH is often described as a weak link in concrete as it is easily attacked by chemical agents and is also easily leached by water. Pozzolans containing silica, however, are able to react with CH and form secondary C-S-H, increasing concrete's strength and reducing permeability[1].

Spray-Lock Concrete Protection (SCP) products enter concrete through capillary voids, reacting with CH to form more C-S-H. Because of the colloidal silica's extremely small particle size, it has a tremendous amount of pozzolanic potential, greater even than silica fume[2]. During the reaction, SCP products consume some of the available CH, reducing the opportunity for CH to react with chemical agents that commonly attack concrete such as nitrates and sulfates.

Research has demonstrated that CH is consumed by colloidal silica and is illustrated in figures 1 and 2 below[3].

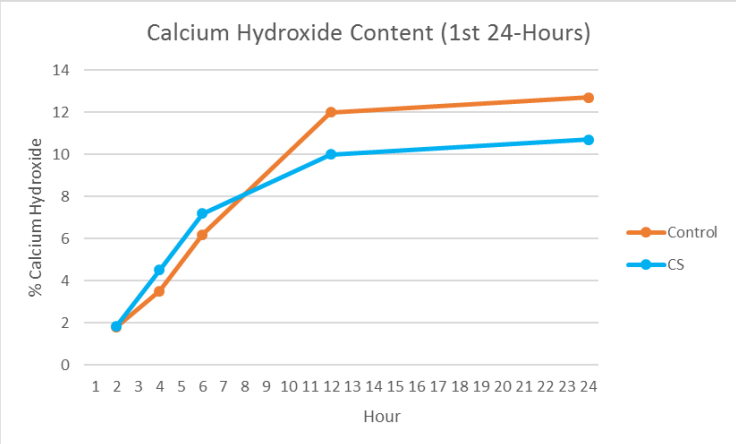

Figure 1: Calcium Hydroxide Consumption by Colloidal Silica, 1st 24-hours.

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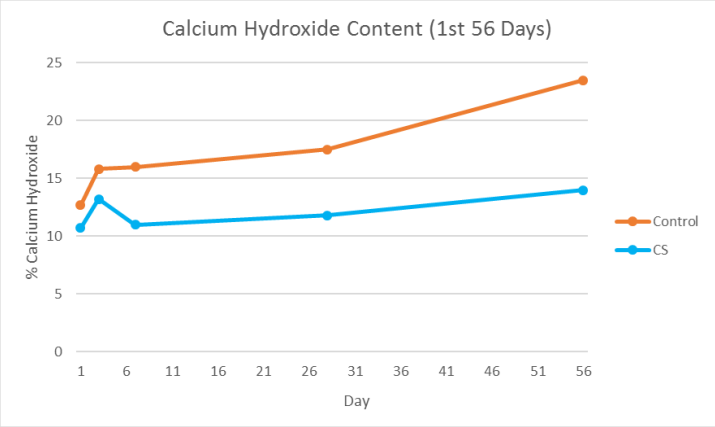

Figure 2: Calcium Hydroxide Consumption by Colloidal Silica, 1st 56 Days

One concern among concrete technologists may be that the colloidal silica could exhaust the supply of CH for reaction with other pozzolans present in the concrete. Research has shown that this is not the case, with pozzolan contents as high as 80% by weight of cementitious materials demonstrating improved performance with colloidal silica additions. As with most concrete technologies, SCP recommends testing of its products with project-specified concrete mixtures and constituent blends to establish SCP's performance with local raw materials.

References:

[1] Kosmatka, S.H. & Wilson, M.L. *Design and Control of Concrete Mixtures*, EB001, 15th edition, Portland Cement Association, Skokie, Illinois, USA, 2011, pp. 72-73.

[2] Singh, L.P., Karade, S.R., Bhattacharyya, S.K., Yousuf, M.M., & Ahalawat, S. "Beneficial role of nanosilica in cement based materials – a review," *Construction and Building Materials* 47 (2013), 1069-1077.

[3] Hou, P., Kawashima, S., Kong, D., Corr, D., Qian, J., & Shah, S. "Modification effects of colloidal SiO_2 on cement hydration and its gel property," *Composites* Part B 45 (2013) 440-448.

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