Calcium Silicate Cement: Water and Hydration

RUIKANG Li (Neo)

Hongkong Kannry Industrial Co., Ltd. | www.kannrybio.com

Abstract. Compare calcium silicate cements using water per gram of reactive solids as well as water per gram of total powder. This note uses a dilution example to separate these effects and outlines checks for reactant consumption and binder formation.

Keywords: calcium silicate; hydration; reactive solids; water demand

1. State what the denominator contains

In calcium silicate cement systems, hydration produces calcium silicate hydrate (C-S-H) with limited long-range order. XRD alone can therefore miss part of the developing binder; complementary spectroscopy is useful [1]. Keep crystalline reactant consumption and hydrate formation as separate observations.

Worked example: 10.0 g reactive powder with 3.0 g water has w/r = 0.30 g/g. Replace 20% of that powder with a nonreactive additive while holding water at 3.0 g: total powder is still 10.0 g, but reactive powder is 8.0 g and w/r rises to 0.375. A changed response may reflect dilution as well as the additive surface.

Use a three-arm comparison to separate these effects. The values below are an arithmetic example, not a recommended water demand. An additive treated as nonreactive for the calculation must still be checked for chemical or nucleation effects in the real system.

2. Track the binder as it develops

2.1 Record heat on two bases. Where calorimetry is available, report heat per gram of total powder and per gram of reactive powder. Use a consistent mixing-to-insertion delay. Early heat released before insertion is missing from the recorded integral and can distort comparisons of fast formulations.

2.2 Pair phase data with physical tests. Measure setting and wet mechanical behavior at defined ages and temperature. Compare residual crystalline phases with a complementary hydration-sensitive measurement. A weak C-S-H diffraction signal is not proof that no binder formed, and a hard surface is not proof that the whole specimen reacted.

2.3 Control the exposed surface. Keep mold geometry, sealing and curing conditions constant. Separate intended aqueous curing from uncontrolled exposure to laboratory air. Before attributing a new phase to an additive, compare the starting blend and an identically stored baseline cement.

3. Development decision

Choose the comparison basis according to the question: fixed total solids for practical handling, fixed reactive solids for dilution analysis. When the conclusions differ, retain both results instead of selecting only the more favorable comparison.

Table 1. Development comparison and interpretation controls.

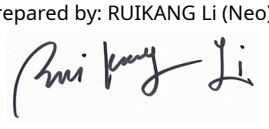
Formulation	Reactive / additive / water	Purpose
Base cement	10.0 / 0 / 3.0 g	Reference at w/r 0.30
Fixed total-powder ratio	8.0 / 2.0 / 3.0 g	Dilution plus additive effect
Fixed reactive ratio	8.0 / 2.0 / 2.4 g	Comparable w/r of 0.30
Dry powder control	Same solid blend; no water	Identify starting XRD peaks

Scope. These mass-balance examples do not specify the phase composition or performance of any commercial calcium silicate product.

References

1. Li Q, Hurt AP, Coleman NJ. The Application of 29Si NMR Spectroscopy to the Analysis of Calcium Silicate-Based Cement using Biodentine™ as an Example. J Funct Biomater. 2019;10(2):25. doi:10.3390/jfb10020025.

Prepared by: RUIKANG Li (Neo)



Reviewed by: Alex | Technical content: Approved

Review date: