^{29}Si-enriched C_3S and its hydration

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Novel Way of Studying Cement Hydration

This work aims at providing a scientific understanding concerning the retardation process that aluminate ions produce on the silicate hydration of cement. To be able to do this, it is important to investigate the system at the molecular level. In particular, we use a novel approach to study hydration of ^{29}Si-enriched tricalcium silicate (C_3S) pastes in-situ by solid-state Nuclear Magnetic Resonance (NMR) experiments.

Results and Discussion

The results obtained without the use of any drying methods reveal unique information concerning different stages of cement hydration. In particular, the ^{29}Si-enriched NMR showed that during first hours of reaction no significant layer of hydrates were formed on the surface of C_3S, but its surface and sub-surface were hydroxylated to a large extend. The quantitative analyses of the NMR data provided an opportunity to detect a change in silicon coordination during the hydration period. For instance, at the end of the acceleration stage a switch from formation of dimers to longer chains was observed, which provided interesting clues with regard to the debate on the origin of the deceleration period.

In the presence of aluminate ions retardation of C_3S hydration was observed during the first 10 h, afterwards this effect vanished and an increase of the amount of hydrated products was detected. Solid-state ^{27}Al one pulse NMR has proven the formation of AFm phases from the first hours of hydration and the presence of TAH and incorporation of Al in C-S-H at later stages of reaction.

In-situ time resolved study of the silicon speciation of ^{29}Si enrichment is an approach presented in this work that has the potential of resolving the more than century old questions on cement hydration. Moreover, the concepts demonstrated here can be extended to other systems represented by silicates, aluminates and water that are very common constituents on the surface of earth and as such, the reaction with each other is of large importance.