

Aluminium and alkali uptake in calcium silicate hydrate

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Abstract

The production of cement is responsible for 5-8% of global man-made CO₂. The replacement of Portland cement by supplementary cementitious materials (SCMs), such as fly ash or black furnace slag, offers the potential to reduce these CO₂ emissions. The industrial application of SCMs based materials is hindered by the fact that novel, low-CO₂ cementitious materials have different chemical compositions and will form other hydrates than present in Portland cements. High contents of silica and aluminium in SCMs may lead to dramatic changes in composition and structure of the C-S-H phase.

A series of experiments have been carried out to investigate the solubility, structure and composition of C(-A)-S-H gel as a function of different parameters such as Ca/Si ratio, pH, aluminium, alkali in order to achieve a better understanding of the behaviour of aluminium and alkali in C-S-H.

In the presence of aluminium, C-S-H has been found to incorporate aluminium. For a C-S-H with Ca/Si ratio close to 1 and Al/Si \leq 0.1, only C(-A)-S-H phase formed. At higher Al/Si ratios, C-S-H was intermixed with calcium aluminate phases such as strätlingite or hydrogarnet. However, even in the presence of additional solids, both the dissolved aluminium concentration and the uptake of aluminium in C-S-H increased. This increase of the aluminium uptake with increasing dissolved aluminium concentrations could suggest solid solution behaviour in C-A-S-H.

In the presence of potassium hydroxide, pH of the solution was higher which lead to (i) portlandite precipitation, (ii) higher dissolved aluminium concentrations and (iii) higher aluminium uptake by the C-S-H. Also in the presence of alkalis, the aluminium uptake in C-S-H correlated positively with the dissolved aluminium concentrations. While the alkali uptake decreased with increasing Ca/Si ratio, the presence of aluminium did not significantly influence the uptake of alkalis by the C-S-H.