Growth and Synthesis of Hydrates

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Objectives:
In this project, synthetic calcium silicate hydrate (C-S-H) is produced at high Ca:Si molar ratios with controlled amount of oxide compositions and water contents. Kinetic and thermodynamic modelling will be employed to study this system.

Synthetic C-S-H

In the cementitious system, C-S-H precipitation often occurs with the formation of other phases including ettringite, Ca(OH)2, and CaCO3 Additionally, C-S-H has a variable stoichiometry and water content. As a result, this project focuses on studying C-S-H in an isolated system.

Sample Preparation

Pure-phase C-S-H is synthesized in a process combining double decomposition and dropwise precipitation. Calcium and silicate solutions at supersaturation conditions in respect to C-S-H are combined at a high pH while controlling temperature and mixing. The precipitate is collected after 3-5 hours of equilibration, and is handled carefully so as to prevent the formation of other phases post-synthesis.

Characterization

X-ray diffraction and thermogravimetric analysis are used to quantify the C-S-H samples and the presence of any additional phases. Inductively-coupled plasma spectrometry and x-ray fluorescence are used to quantify the produced Ca:Si molar ratios. Electron microscopy will be used to analyze the morphology of the produced samples.

Importance of sulfates & aluminates in cement

Sulfates and aluminates have an effect on the rheology, setting times, and compressive strengths of cement. In many cases, these elements are added to Portland cement to induce desired qualities. These materials affect the chemistry of cement hydrates, and consequently the growth and nucleation of these materials. Kinetic and thermodynamic modelling of synthetic C-S-H will provide insights on this phenomena.